West Milford Township Public Schools

Energy Savings Plan

Project Number: ESG-Project #DPBWI00566

West Milford, New Jersey | Revised August 5, 2019

energy systems group

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SECTION 1. EXECUTIVE SUMMARY

Various energy conservation measures were evaluated in the development of this Energy Savings Plan (ESP). Energy Systems Group has performed field verifications, collected data and taken field measurements to ensure the development of the most cost-effective solutions as well as accurate savings calculations. Various solutions were reviewed with the school district's administration to develop a set of Energy Conservation Measures (ECMs) that allow the school district to address the facility's priority items while reducing the total annual energy spend for the District. This study expands upon the original local government energy audit (LGEA) conducted by TRC Energy Services. The original audit was used for building descriptions as well as an overall indication of the District needs.

Priority items include:

- Upgrade Interior lighting throughout the eight schools, Administration Building and Maintenance facilities with newer LED technology
- Addition of cooling to serve the Macopin Middle School Auditorium
- Boiler replacements at Macopin Middle School and Marshall Hill Elementary School
- Retro-commissioning for the eight schools, Administration Building and Maintenance facilities
- Building envelope upgrades at the eight schools, Administration Building and Maintenance facilities
- Cogeneration unit at West Milford High School
- Unit Ventilator Refurbishments at the eight schools
- Upgrade HVAC controls to DDC

Energy Savings

Energy saving calculations performed in the development of this ESP was completed using Microsoft Excel worksheets with Bin weather data to accurately model the building systems. Additional spreadsheets were used for measures that are not affected by the weather, such as lighting savings. Energy savings have been provided electronically for ease of review. All of the energy savings calculations that have been performed are in accordance with the New Jersey Clean Energy Program Protocols to Measure Resource Savings.

Benefits

The measures investigated in this Energy Savings Plan could result in an annual utility savings of 1,326,283 kWh's of electricity and save 95,652 therms of natural gas. The total utility cost savings is $6,770,027 over the life of the project (19 years). Additionally, these energy savings will result in a net reduction of greenhouse gases and will reduce the school district's carbon footprint by 2,941,000 lbs. of CO_2 annually. All these savings are achieved while improving the classroom environment and renewing many items that have been in service beyond useful life expectancy.

SECTION 2. PROJECT DESCRIPTION

This Energy Savings Plan (ESP) addresses the following facilities. Any description in this report-stating “district wide” or similar refers only to the buildings listed below:

West Milford Public Schools	
Administration Building	46 Highlander Rd, West Milford, NJ 07480
Apshawa Elementary School	140 High Crest Drive, West Milford, NJ 07480
Macopin Middle School	70 Highlander Drive, West Milford, NJ 07480
Maple Road Elementary School	36 Maple Road, West Milford, NJ 07480
Marshall Hill Elementary School	210 Marshall Hill Road, West Milford, NJ 07480
Paradise Knoll School	103 Paradise Road, Oak Ridge, NJ 07438
Upper Greenwood Lake Elementary School	41 Henry Road, Hewitt, NJ 07421
Westbrook Elementary School	46 Highlander Drive, West Milford, NJ 07480
West Milford High School	67 Highlander Drive, West Milford, NJ 07480
Bus Garage	51 Highlander Drive, West Milford, NJ 07480

Facility Descriptions

Administration Building

Background Information

The Administration Building is located at 46 Highlander Road, West Milford, New Jersey. This 8,000 ft^2 facility was originally built in 1976. The residential style building is two floors and has conference rooms, office space, and a kitchenette.

Building Occupancy

The building is occupied by about 18 full time staff.

Hours of Operation

- Monday through Friday 8:00 am to 4:30 pm (staff)

Envelope

Building Envelope

The building is constructed of concrete block with a vinyl-siding façade and has a pitched roof that is covered with asphalt shingles. The building has double-pane windows, which are in good condition and show little sign of excessive infiltration. The exterior doors are constructed of vinyl and are in good condition.

Lighting

Administration Building Lighting

Lighting & controls: The building is primarily lit by linear fluorescent fixtures which contain 32W T8 lamps with electronic ballasts as well as some compact fluorescent lamps (CFL). Majority of fixtures are 2-lamp or 4-foot long troffers with diffusers. Exit signs throughout the building use LED technology. Majority of rooms throughout the building have manual wall switches for lighting controls.

The exterior lighting is minimal and consists primarily of high pressure sodium (HPS) fixtures that are controlled by photocells. There are recessed can fixtures under the canopies with incandescent lamps.

Mechanical Systems

HVAC Systems: The building is heated by a forced air system which consists of a gas-fired 450 MBh output furnace that is of standard 80% efficiency and in fair condition. The unit was installed about six years ago; however, the distribution ductwork is likely as old as the building. Insulation is in poor condition or missing ductwork.

Domestic Hot Water Systems

The domestic hot water heating system for the facility consists of a gas fired 40-gallon storage tank water heater. It has a capacity of 40 MBh and is standard 80% efficiency. It is in good condition and was recently installed. This heater provides domestic hot water to sinks throughout the building.

Domestic Hot Water

Building Controls (HVAC Controls)

The cooling system is controlled by a manual dial thermostat. The typical occupied set point is 72°F. The heating system is controlled by a manual dial thermostat. The occupied temperature set point is typically set at 72°F and is manually set back to 62°F over nights and weekends.

Plug Load

The plug loads in the building include general office and café equipment. There are roughly 33 computer work stations throughout the facility. It appears that there is no centralized PC power management software installed. There is also a refrigerated beverage vending machine, which is not currently controlled based on occupancy.

Office equipment is regularly left in the 'on' state at all times allowing the individual machine to revert to the 'Sleep' mode based on an internal timer. This measure will plug the office equipment into a networkable device that will allow for scheduling of the plugged in equipment.

Building Plug Load

ESG observed to following significant plug load technologies:

Device Type:	Quantity:
Computer	33
Small Printer	5
Medium Printer	7
Large Printer	2
Shredder	3
Projector	2
Microwave	1
Medium Fridge	1
Large Fridge	1
Coffee Machine	3
Toaster	1
TV	2

Plumbing/Water System

There are two (2) restrooms in the Administrative Building. A sampling of restrooms found that faucets are rated for 1.5 gallons per minute (gpm), the toilets are rated at 1.6 gallons per flush (gpf) and the urinals are rated at 1.0 gpf.

Apshawa Elementary School

Background Information

Apshawa Elementary School is located at 140 High Crest Drive, West Milford, New Jersey. This 41,500 ft^2 facility was originally built in 1966 and is in good condition Apshawa Elementary School consists of one floor of classroom space, office space, a kitchen, library, and a gymnasium.

Building Occupancy

Approximate enrollment is 262 students with a staff of 55 people.

Hours of Operation

- Monday through Friday 8:30 am to 2:50 pm (students/staff) (September through June)
- Monday through Friday 6:30 am to 11:00 pm (custodial staff) (September through June)
- Summer daycare 6:30 am to 3:00 pm

Envelope

The building is constructed of concrete block and structural steel with a brick façade. The building has a flat roof in good condition. The building has single-pane windows in decent condition with no apparent excess air infiltration. The exterior doors are typically aluminum, some with glass panes and are in good condition. The exterior door seals have worn out and this deficiency and may contribute to a significant amount of air infiltration.

Building Envelope

Lighting

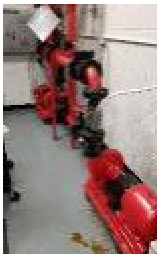

Apshawa Elementary School Gymnasium

The majority of the facility lighting was upgraded to LED technology in the summer of 2017. There are a few linear fluorescent T8 fixtures, linear fluorescent T12 fixtures, as well as some incandescent lamps. These were found in a hallway, restrooms, and storage rooms. The multipurpose room is lit by 4-lamp T5HO lamp high bay fixtures. The exit signs throughout the building are LED.

The exterior lighting is provided by high-pressure-sodium wall pack fixtures, metal halide area lighting fixtures, and some compact fluorescent wall pack fixtures at the entrance of the building. These fixtures are on during daylight hours.

Lighting Controls: Lighting fixtures throughout the building are manually controlled by wall switches.

Motors


Motors

The HVAC systems that serve the building utilize fan and pump motors which are generally in good condition and high efficiency. These systems include hot water pump motors, exhaust fan motors and supply fan motors. All motors in excess of 5 horsepower were analyzed for retrofit and/or upgraded with a variable frequency drive.

Mechanical Systems

HVAC Systems and Equipment: The building is heated by a hot water system consisting of two (2) fuel oil fired 2242 MBH non condensing hot water boilers, a circulation loop, and distribution devices. The boilers have a nominal combustion efficiency of 86.7%. The boilers are configured in a constant flow primary distribution with two (2) 5 HP hot water pumps, which operate in lead/lag fashion. They are constant speed, high-efficiency motors and are in good condition. Hot water is supplied at 180°F when the outside air temperature is low and the set point is adjusted linearly to 130°F when the outside air is above 65°F. The boilers provide hot water to heating-ventilation (HV) units, perimeter radiators, and hot water unit heaters. The boilers are fully modulating. They are in good condition and well maintained.


Boilers

Domestic Hot Water Systems


Domestic Hot Water

The domestic hot water heating system for the facility consists of one propane fired 200 MBH storage tank waters, which have a capacity of 90 gallons. This system has a nominal efficiency of 80% and serves the entire building. This equipment was installed a few years ago and is in good condition. However, the distribution supply piping was noted to be missing insulation. This system serves hand washing sinks throughout the building and the kitchen.

Building Controls (HVAC Controls)

The unit ventilators throughout the building have supply fan motors, dampers, and valves that operate through the use of a pneumatic control system. This system is original to the building is appears to be in fair operating condition. The air compressors for this system are located in the boiler room, are in fair condition, and are equipped with high-efficiency motors.


Building Controls

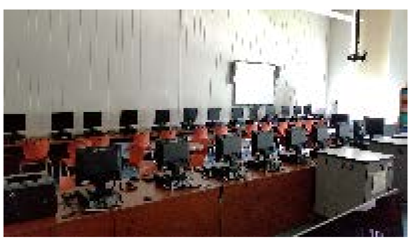
Kitchen Equipment

The school has an all-electric kitchen that is used to prepare lunches for almost every student each school day. Most of the cooking is done using a combination oven and convection oven. Bulk prepared foods are held in an electric holding cabinet. Equipment is standard to high efficiency and is in good condition.

The kitchen has a number of stand-up refrigerators with either a solid or glass door. There is also a standup freezer with a solid door and a refrigerator chest. All equipment is standard to high efficiency and in good condition.

Plug Load

There are roughly 70 computer work stations throughout the facility. It is assumed that there is no centralized PC power management software installed. Plug loads throughout the building include general café and office equipment. There are classroom typical loads with as projectors and fans.



Building Plug Load

ESG observed to following significant plug load technologies:

Device Type:	Quantity:
Computer	70
Small Printer	1
Speakers	6
Large Printer	4
Large Fans	4
Projector	17
Microwave	8
Small Fridge	4
Large Fridge	2
Coffee Machine	2
Electric Unit Heaters	2
Fans	27
Smart Board	3

Plumbing/Water System

There are restrooms throughout this facility. A sampling of restrooms found that majority of the faucets are rated for 2.2 gallons per minute (gpm) or higher, while there are a few that are already low-flow and rated for 0.5 gpm.

Macopin Middle School

Background Information

Macopin Middle School is located at 70 Highlander Drive, West Milford, New Jersey. This 120,000 ft^2 facility was originally built in 1959, with an addition in 1962, and is in fair condition. The building is one floor at varying elevations consisting of classroom space, a gymnasium, auxiliary gymnasiums, a kitchen, a cafeteria, a library, an auditorium, and office spaces.

Building Occupancy

Approximate enrollment is 530 students with a staff of 83 people.

Hours of Operation

- Monday through Friday 6:30 am to 2:20 pm (students/staff), 11:00 pm for custodians
- Weekends 8:00 am to 4:00 pm for athletics
- Summer custodial hours 7:00 am to 3:00 pm

Envelope

The building has a flat roof that is in fair condition. The building has double-pane windows with metal frames in fair condition. The exterior doors are constructed of aluminum or metal with glass panes and are in good condition. However, the door seals have worn out, which increases the level of outside air infiltration. Based on visual inspections of the building envelope, there are wall cracks as well as some cracks around window frames. These building envelope deficiencies can lead to excessive infiltration.

Building Envelope

Lighting

The building is primarily lit by 32-Watt linear fluorescent T8 lamps with electronic ballasts, as well as some compact fluorescent lamps (CFL), incandescent, and LED general purpose lamps. Fixture types include 2-lamp or 4-lamp, 2-foot or 4-foot long troffers, surface mounted wraparound fixtures and some of the original finned continuous row fixtures. Most fixtures are in fair condition; however, some fixtures are missing lenses, which are no longer available in the market.


Macopin Middle School Lighting

Exterior wall pack fixtures include metal halide lamps and ballasts. The building overhang canopies have compact fluorescent lamp fixtures. The pole mounted flood fixtures are either metal halide or high pressure sodium and illuminate the parking lot areas. There are also a few LED flood and spot light fixtures.

Lighting Controls: Most lighting fixtures in classrooms and break rooms are controlled by occupancy sensors. The remainder are manually controlled by wall switches. The gym rooms contain 4-lamp T5HO (high output) high bay fixtures which are controlled by occupancy sensors. The exit signs throughout the building are LED. The exterior light fixtures are controlled by a time clock or photocell, depending on the location.

Motors

The HVAC systems that serve the building utilize fan and pump motors which are generally in good condition and high efficiency. These systems include hot water pump motors, exhaust fan motors and supply fan motors. All motors in excess of 5 horsepower were analyzed for retrofit and/or upgraded with a variable frequency drive.


Motors

Mechanical Systems


Boilers

HVAC Systems and Equipment: The building is heated by a hot water system which includes five (5) gas-fired, 1,615 MBH non-condensing hot water boilers. The boilers are fully modulating. They are in fair condition, installed about 16 years ago and are well maintained. The boilers have a nominal thermal efficiency of 83%. The hot water system includes a total of four zones. The constant flow primary distribution to Zone one is provided by two 10 HP hot water pumps operating in lead/lag fashion. These are in poor condition. Zone two is provided by two (2) 2 HP hot water pumps and Zones three & four are provided by 1/3 HP hot water pumps, which are all in fair condition. All pumps operate at constant speed and are driven by standard efficiency motors.

Designation	System Quantity	Location	Floor/ Serves	Manufacturer	Model/ Make	Date	Efficiency	Capacity
Boiler	5	Boiler Room	Entire Building	PK Thermific	-	±2003	83%	1615MBH

There is a packaged roof top unit that was installed about 15 years ago serving the office area. Some classrooms and offices are equipped with window air conditioning (AC) units, which are manually turned on and off during the summer months for cooling. These range in capacity, efficiency and condition. They range in efficiency between 9.2 EER to 12.0 EER.

HVAC Systems

Designation	System Quantity	Location	Floor/Serves	Manufacturer	Model/ Make	Date	Efficiency	Cooling Capacity per Unit (Tons)
Window AC	40	Offices Classrooms Conference Room	Offices Classrooms Conference Room	Varies	Varies	±2004	-	0.67 0.83 1.00
Packaged AC	1	Office	Offices	Varies	Varies	±2004	-	3

Domestic Hot Water Systems

The domestic hot water heating is an indirect system which includes the use of a 79-gallon storage tank. The main hot water heating system boilers provide hot water for this system via a heat exchanger. The system is in good condition. Hot water is provided to hand washing sinks throughout the building and the kitchen.

Domestic Hot Water

Designation	System Quantity	Location	Floor/ Serves	Manufacturer	Model/ Make	Date	Efficiency	Capacity
DHW	1	Boiler Room	Entire Building	Techtanium	-	-	-	79 Gal

Building Controls (HVAC Controls)

The unit ventilators throughout the building have supply fan motors, dampers, and valves that operate through the use of a pneumatic control system. This system is original to the building and appears to be in fair operating condition. The air compressor for this system is located in the boiler room, was recently installed, and is in good condition with high efficiency motors.

Building Controls

The heating system is equipped with basic heat timer controls, which includes outdoor air temperature reset. Hot water is supplied at 180°F when the outside air temperature is low, and the setpoint is adjusted linearly to 130°F when the outside air is above 65°F. The boilers provide hot water to unit ventilators throughout the building, perimeter radiators, and hot water unit heaters. The boiler system cannot be locked out at higher outside air temperatures because the indirect domestic hot water system is dependent upon the operation of the boiler.

Kitchen Equipment

The school has a kitchen that is used to prepare lunches for almost every student each school day. Most of the cooking is done using a number of electric ovens and one propane stove. There is an electric fryer and bulk prepared foods are held in a number of electric holding cabinets. A majority of this equipment is high efficiency and in good condition.

The kitchen has a walk-in low temperature freezer and a cooler. These are used to store food prepared for school lunches. The walk-in cooler temperature is maintained at about 35°F. There are a few glass front free standing refrigerators and a refrigerated chest. All equipment is standard to high efficiency and in fair to good condition.

Plug Load

There are roughly 223 computer work stations throughout the facility. It is assumed that there is no centralized PC power management software installed. Based on a visual inspection of computer labs, a majority of computers were left on. Plug loads throughout the building include general café and office equipment. There are classroom typical loads such as smart boards, projectors, and fans.

Building Plug Load

There are also several residential style refrigerators throughout the building. These vary in condition and efficiency. There were a few noted to be almost empty. These should be considered for consolidation and removal of unnecessary refrigerators throughout the building. Refrigerated drink machines located in the faculty room and cafeteria do not currently have controls.

ESG observed to following significant plug load technologies:

Device Type:	Quantity:
Desktop Computer	223
Coffee Maker	10
Toaster	5
Refrigerator	9
Microwavee	11
Small Fan	3
Wheelchair Elevator	4
Projector	24
Laptop Cart	14
Smart Board	8
Mini Fridge	12
Speaker	6
Printer	49
Large Aquarium	2
Small Aquarium	2
Stereo	5
Misc. Sound Equipment	3
Large Xerox- Type Printers	4
Electric Heaters	3
Shredder	3
Scoreboard	1
Tredmills	7
TV	3
Woodshop Equipment	1
Orbital Sanders	5
Large Floor Fans	7
Scanners	3

Plumbing/Water System

There are restrooms throughout this facility. A sampling of restrooms found that majority of the faucets are rated for 2.0 gallons per minute (gpm) or higher. Toilets are rated at 1.6 gallons per flush (gpf) or higher.

Maple Road Elementary School

Background Information

Maple Road Elementary School is located at 36 Maple Road, West Milford, New Jersey. This 45,360 ft^2 facility was originally built in 1968 and is in poor condition. Maple Road Elementary School is one floor and consists of classroom space, a gymnasium, media center, kitchen, and office space.

Building Occupancy

Approximate enrollment is 300 students with a staff of 64 people.

Hours of Operation

- Monday through Friday 8:30 am to 3:00 pm (students)
- Monday through Friday 6:30 am to 11:00 pm (staff)
- Monday through Friday Summer hours are 3:00 pm – 11:00 pm (staff)
- Daycare operates 7:00 am to 3:00 pm weekdays 11 months of the year
- Saturday and Sunday no use

Envelope

The building has a flat roof that is in poor condition and is in need of replacement to stop current water leaks and to increase the amount of roof insulation. This structure is constructed of concrete block and structural steel with a brick facade. The facility has double-pane windows, which are in fair condition. The exterior doors are constructed of aluminum and are in good condition, however the door seals have worn out, increasing the level of outside air infiltration. Upon visual inspection there are wall cracks at the roof/wall intersection as well as around window frames further leading to excessive infiltration.

Building Envelope

Lighting

Maple Road ES Gymnasium

The building is primarily lit by 32-Watt linear fluorescent T8 lamps with electronic ballasts as well as some compact fluorescent lamps (CFL) and incandescent lamps. Most of the fixtures are 2-lamp, 3-lamp or 4- lamp, 2-foot or 4-foot long troffers or wrap fixtures. About half of the classrooms have fixtures that are in good condition, and half have fixtures that are in poor condition with yellowed lenses. The multipurpose room is lit by 4-lamp T5HO lamp high-bay fixtures. The exit signs throughout the building are LED.

Exterior lighting is provided by high pressure sodium wall pack fixtures and metal halide area lighting fixtures, and there are compact fluorescent wall pack fixtures at the entrance of the building. The compact fluorescent wall pack fixtures were noted to be on during daylight hours.

Lighting Controls: The classroom lights are manually controlled by wall switches. The majority of classrooms have remote-mounted occupancy sensors. Exterior lighting is controlled by a time clock.

Motors

Motors

The HVAC systems that serve the building utilize fan and pump motors which are generally in good condition and high efficiency. These systems include hot water pump motors, exhaust fan motors and supply fan motors. All motors in excess of 5 horsepower were analyzed for retrofit and/or upgraded with a variable frequency drive.

Mechanical Systems

Boilers

HVAC Systems and Equipment: The building is heated by a hot water system which includes two (2) gas-fired, 2,242 MBH non-condensing hot water boilers. The boilers have a nominal combustion efficiency of 83% and are fully modulating. They are in good condition, installed about seven years ago and are well maintained.

The boilers are configured in a constant flow primary distribution with two (2) 5 HP hot water pumps which operate in lead/lag fashion. They are constant speed, standard efficiency motors and are in fair condition. Hot water is supplied at 180°F when the outside air temperature is low and the setpoint is adjusted linearly to 130°F when the outside air is above 65°F. The boilers provide hot water to unit ventilators throughout the building, baseboard radiators and hot water unit heaters.

Some classrooms, offices and the faculty room have unitary window air conditioning (AC) units for cooling in the summer months. These range in capacity but are all in fair to good condition. They range in efficiency between 9.8 EER to 13.0 EER.

HVAC System

Designation	System Quantity	Location	Floor/ Serves	Manufacturer	Model/ Make	Date	Efficiency	Capacity
Boiler	2	Boiler Room	Heating System	Buderus	GE615/10	±2012	83%	2242 MBH

Domestic Hot Water Systems

The domestic hot water heating system for the facility consists of a gas fired 200 MBH storage tank water. This has storage capacity of 76 gallons and has a nominal efficiency of 80%. This system is in good condition and serves majority of the building. There is also an electric storage tank water heater that has a 4.5 kW heating element and a capacity of 40 gallons. This equipment is in good condition. These systems serve hand washing sinks throughout the building and the kitchen.

Domestic Hot Water

Designation	System Quantity	Location	Floor/ Serves	Manufacturer	Model/ Make	Date	Efficiency	Capacity
DHW	1	Boiler Roon	DHW	Ruud	RFD76-200-1	-	80%	76 Gal
DHW	1	Boiler Roon	DHW	-	-	-	-	40 Gal

Building Controls (HVAC Controls)

The unit ventilators throughout the building have supply fan motors, dampers, and valves, which operate through the use of a pneumatic control system. This system is original to the building is appears to be in fair operating condition. The air compressor for this system is located in the boiler room, is in fair condition, and is equipped with high efficiency motors.

Kitchen Equipment

Kitchen Equipment

The school has an all-electric kitchen that is used to prepare lunches for almost every student each school day. Most of the cooking is done using a combination oven and convection oven. Bulk prepared foods are held in an electric holding cabinet. Equipment is high efficiency and is in good condition.

Plug Load

There are roughly 80 computer work stations throughout the facility. It is assumed that there is no centralized PC power management software installed. Plug loads throughout the building include general café and office equipment. There are typical classroom loads such as smart boards, projectors, and fans. There are also a number of residential style refrigerators throughout the building.

ESG observed to following significant plug load technologies:

Device Type:	Quantity:
Computer	80
Small Printer	11
Speakers	4
Large Printer	4
Large Fans	2
Projector	8
Microwave	7
Small Fridge	3
Large Fridge	6
Coffee Machine	7
Toaster	2
Fans	12
Smart Board	14
Clothes Washer & Dryer	1

Building Plug Load

Plumbing/Water System

There are many restrooms at Maple Road Elementary School. A sampling of restrooms found that majority of the faucets are rated for 2.2 gallons per minute (gpm) or higher.

Marshall Hill Elementary School

Background Information

Marshall Hill Elementary School is located at 210 Marshall Hill Road, West Milford, New Jersey. This 41,725 ft^2 facility was originally built in 1959 with an addition in 1964 and is in fair condition. Gregory Elementary School is one floor comprised of classroom space, a multipurpose room, media center, kitchen, and office space.

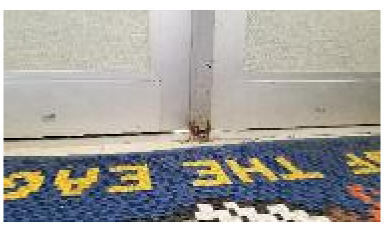
Building Occupancy

Approximate enrollment is 265 students with a staff of 50 people.

<u>Hours of Operation</u>

- Monday through Friday 8:30 am to 3:15 pm (students)
- Monday through Friday 6:30 am to 11:00 pm (staff)
- Monday through Friday Summer hours are 7:00 am – 7:00 pm (staff)
- Saturday and Sunday no use

Envelope



Building Envelope

The building has a flat roof and double-pane windows that are both in fair condition. The exterior doors are constructed of aluminum and are in good condition except that the door seals have worn out, which increases the level of outside air infiltration. Upon visual inspection of the building envelope there are cracks in the walls as well as around window frames. These building envelope deficiencies can lead to excessive infiltration.

Lighting

Lighting is provided mostly by 32-Watt linear fluorescent T8 lamps with electronic ballasts, as well as some compact fluorescent lamps (CFL), incandescent, and LED general purpose lamps. Fixture types include 2- lamp or 4-lamp, 2-foot or 4-foot long troffers or wrap fixtures. Most fixtures are in fair to good condition.

The multipurpose room contains 4-lamp T5HO ("high output") high bay fixtures. Most exit signs are LED; however, there are a few that are still use compact fluorescent lamps.

Marshall Hill ES Gymnasium

Exterior wall pack fixtures are LED, except for one with a high-pressure sodium lamp and ballast. The building overhand canopies have box fixtures with incandescent lamps. The pole mounted flood fixtures are metal halide.

Lighting Controls: Most lighting fixtures in classrooms and offices are controlled by occupancy sensors. The remainder are manually controlled by wall switches. Exterior light fixtures are controlled by a time clock, switch or photocell, depending on the fixture.

Mechanical Systems

Boilers

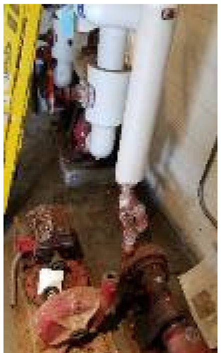
HVAC Systems and Equipment: The building is heated by a hot water system which includes three (3) gas-fired, 1,740 MBH non-condensing hot water boilers. The boilers are fully modulating. They are in fair condition, installed about 17 years ago, and are well maintained. The boilers have a nominal combustion efficiency of 79%.
The boilers are configured in a constant flow primary distribution with two (2) 5 HP hot water pumps operating in lead/lag fashion. They are constant speed, standard efficiency motors and are in poor condition. Hot water is supplied at 180°F when the outside air temperature is low and the setpoint is adjusted linearly to 130°F when the outside air is above 65°F. The boilers provide hot water to unit ventilators throughout the building, perimeter radiators, and hot water unit heaters.

Designation	System Quantity	Location	Floor/ Serves	Manufacturer	Model/ Make	Date	Efficiency	Capacity
Boiler	1	Boiler Room	Heating System	RBI	Futera III	2002	79%	1740 MBH
Boiler	2	Boiler Room	Heating System	Thermific	-	2002	79%	1740 MBH

Portable HVAC Unit

Some classrooms, offices, and the library that have air conditioning (AC) units, either window or portable, for cooling in the summer months. These range in capacity but are all in fair to good condition. They range in efficiency between 9.8 EER to 11.0 EER.

Motors

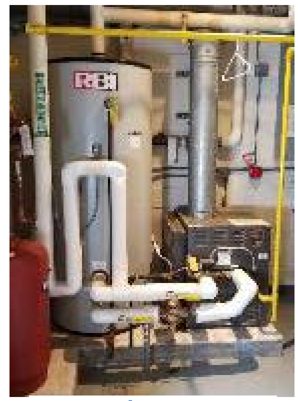


Motors

The HVAC systems that serve the building utilize fan and pump motors which are generally in good condition and high efficiency. These systems include hot water pump motors, exhaust fan motors and supply fan motors. All motors in excess of 5 horsepower were analyzed for retrofit and/or upgraded with a variable frequency drive.

Domestic Hot Water Systems

The domestic hot water heating system for the facility consists of a gas fired 300 MBH storage tank water. This has storage capacity of 200 gallons and has a nominal efficiency of 80%. This system is in good condition. This system serves hand washing sinks throughout the building and the kitchen.



Domestic Hot Water

Designation	System Quantity	Location	Floor/ Serves	Manufacturer	Model/ Make	Date	Efficiency	Capacity
DHW	1	Boiler Room	DHW	RBI	-	-	80%	200 MBH

Building Controls (HVAC Controls)

Building Controls

The unit ventilators throughout the building have supply fan motors, dampers and valves which operate through the use of a pneumatic control system. This system is original to the building appears to be in fair operating condition. The air compressor for this system is located in the boiler room, was recently installed and is in good condition with high efficiency motors.

Kitchen Equipment

The school has an all-electric kitchen that is used to prepare lunches for almost every student each school day. Most of the cooking is done using a convection oven. Bulk prepared foods are held in a number of electric holding cabinets. Equipment is high efficiency and in good condition.

The kitchen has a number of stand-up refrigerators with either a solid or glass door. There is also a standup solid door freezer that is energy efficient. There is a freezer chest as well as many refrigerator chests. All equipment is standard to high efficiency and in fair to good condition.

Plug Load

There are roughly 70 computer work stations throughout the facility. It is assumed that there is no centralized PC power management software installed. Plug loads throughout the building include general café and office equipment. There are classroom typical loads such as smart boards, projectors and fans.

There are also a number of residential style refrigerators throughout the building. These vary in condition and efficiency. A refrigerated drink machine located in the faculty room does not currently have controls.

ESG observed to following significant plug load technologies:

Device Type:	Quantity:
Computer	70
Small Printer	19
Large Printer	2
Oven	1
Projector	23
Microwave	4
Small Fridge	3
Large Fridge	2
Coffee Machine	1
Toaster	1
Fans	58
Smart Board	5
Misc Loads	1

Building Plug Load

Plumbing/Water System

There are restrooms throughout this facility. A sampling of restrooms found that majority of the faucets are rated for 2.0 gallons per minute (gpm) or higher.

Paradise Knoll School

Background Information

Paradise Knoll School is located at 103 Paradise Road, Oak Ridge, New Jersey. This 32,796 ft^2 facility was originally built in 1955, with a back addition in 1964 and a library in 2005. The one story building consists of classroom space, a multipurpose room, a library, a kitchen, and office space.

Building Occupancy

Approximate enrollment is 300 students with a staff of 42 people.

Hours of Operation

- Monday through Friday 8:30 am to 2:40 pm (students)
- Monday through Friday 7:00 am to 11:00 pm (staff)
- Saturday and Sunday no use

Envelope

The building is constructed of concrete block, and structural steel with a brick facade. The facility has flat roofs which are in fair to good condition. The building has double pane windows which are in fair condition and show little sign of excessive infiltration. The exterior doors are constructed of aluminum and in good condition.

Building Envelope

Lighting

Paradise Knoll Gymnasium

Lighting at the facility is provided mostly by 32-Watt linear fluorescent T8 lamps with electronic ballasts as well as some compact fluorescent lamps (CFL) and incandescent lamps. Most of the fixtures are 2-lamp or 4-lamp, 2-foot or 4-foot long troffers with diffusers. The gymnasium is lit by linear fluorescent high bay fixtures with T5HO lamps and electronic ballasts. The exit signs throughout the building are LED.

The exterior lighting includes LED wall pack fixtures as well as some high-pressure sodium lamp wall pack fixtures. There is also an LED screw in lamp fixture, a compact fluorescent lamp fixture, and a linear fluorescent T8 fixture right above some exterior doors.

Lighting Controls: Lighting fixtures throughout the building are manually controlled by wall switches. The back-wing classrooms are controlled by occupancy sensors. The exterior light fixtures are controlled by a timeclock.

Motors

Motors

The HVAC systems that serve the building utilize fan and pump motors which are generally in good condition and high efficiency. These systems include hot water pump motors, exhaust fan motors and supply fan motors. All motors in excess of 5 horsepower were analyzed for retrofit and/or upgraded with a variable frequency drive.

Energy Recovery Unit (ERU)

Energy Recovery Unit

There is a concern regarding radon which is coming from under the building. The radon presents an indoor air quality and safety issue. An energy recovery unit (ERU) was installed a few years ago to address the radon issue. This unit serves the front wing of the building which includes classrooms and office space. The ERU is in good condition, however it is operating to provide a significant amount of ventilation. The supply fan motor runs continuously due to radon safety concerns. Return air is circulated with outdoor air constantly. The furnace also cycles on and off throughout the summer as well. This has led to an excessive amount of energy consumption.

Mechanical Systems

Boilers

HVAC Systems and Equipment: The back wing of the building and the gymnasium is heated by a hot water system consists of two (2) 2337 MBH condensing hot water boilers. The boilers have a nominal combustion efficiency of 93.5%. The boilers are configured in a constant flow primary distribution with two (2) 2HP hot water pump motors for the back wing and two (2) 3HP hot water pump motors for the gymnasium. Both sets of pumps and motors operate in lead/lag fashion. They are constant speed motors, high efficiency and are in good condition. Hot water is supplied at 180°F when the outside air temperature is low and the setpoint is adjusted linearly to 130°F when the outside air is above 65°F. The boilers provide hot water to coils in classroom unit ventilators as well we radiators. The boilers are fully modulating. They are in good condition and well maintained.

Designation	System Quantity	Location	Floor/ Serves	Manufacturer	Model/ Make	Date	Efficiency	Capacity
Boiler	2	Boiler Room	Back Wing & Gym	AERCO	Benchmark 2500	-	93.5%	2337 MBH
RTU 1	1	Roof	Media Center	Munters	PV-MZP-8710	-	-	250 MBH

RTU 2	1	Roof	Classrooms	-	-	-	-	120 MBH
RTU 3	1	Roof	Classrooms & Teacher's Room	-	-	-	-	120 MBH
ERU	1	Roof	Front Wing	-	-	-	-	570 MBH

The roof top units (RTUs) are packaged units, are aging and are of standard efficiency. These units are constant volume and multi-zone. They are gas-fired to provide heating as a furnace in the winter months. They are equipped with compressors and a direct-expansion (DX) coil to provide cooling in the summer months. They serve a few areas of classrooms, the library and teacher's room. Combined, they provide a total of 16 tons of cooling capacity to these areas. Each unit has a supply fan and exhaust fan motor. These motors are constant speed and each unit is assumed to have a standard backward inclined fan.

HVAC System

There are various offices that have window air-conditioning (AC) units. These range in capacity, efficiency and capacity. There are two (2) units that are very old and inefficient.

Domestic Hot Water Systems

There are a few domestic hot water heating systems for the facility. The majority of the building is served by a gas fired 76MBH boiler and a 50-gallon storage tank. The system has a nominal efficiency of 90%. There is a small electric storage tank water heater serving the gymnasium restrooms which is about 30 gallons in size and assumed to have a 4.5 kW heating element. Both of these water heaters were installed a few years ago and are in good condition. This system serves hand washing sinks throughout the building

Domestic Hot Water

There is a tankless gas-fired domestic water heater in the kitchen. This is in good condition and high efficiency. There is a small electric storage tank water heater that serves the lower section restrooms which is about 30 gallons in size and assumed to have a 4.5 kW heating element. This unit is about 20 years old.

Designation	System Quantity	Location	Floor/ Serves	Manufacturer	Model/ Make	Date	Efficiency	Capacity
DHW	1	Boiler Room	Restrooms	A.O. Smith	BTX 80 100	-	90	50 Gal
DHW	1	Tech Closet	Gym Restrooms	Bradford White	M230R6 DS5	-	-	30 Gal
DHW	1	Kitchen	Kitchen	-	-	-	-	-
DHW	1	Closet	Lower Section Restrooms	-	-	±1999	-	30 Gal

Building Controls (HVAC Controls)

Building Controls

The hot water heating system and energy recovery unit are tied to the building energy management system (BEMS). The BEMS aggregates the DDC points from throughout the building. Roughly 50% of the building zones are DDC and the remainder have pneumatic controls which are not tied into the BMS. Per discussions with facility personnel, the heating setpoint is 71°F during occupied periods of time and is set back overnight to 64°F.

The RTUs are controlled by programmable thermostats. Per discussions with facility personnel, the cooling setpoint is 69°F during occupied periods of time and set back overnight to 84°F.

Kitchen Equipment

The school has a kitchen that is used to prepare lunches for almost every student per day. Most of the cooking is done using a double rack oven and convection oven. Both of these are gas fired. Equipment is standard to high efficiency and is in good condition.

The kitchen has a few stand-up refrigerators and a few stand up freezers with solid doors and ranging in capacity. There is also a refrigerator chest. All equipment is standard to high efficiency and in good condition.

Plug Load

There are roughly 52 computer work stations throughout the facility. It is assumed that there is no centralized PC power management software installed. Plug loads throughout the building include general café and office equipment. There are classroom typical loads with as projectors and fans.

ESG observed to following significant plug load technologies:

Device Type:	Quantity:
Computer	52
Small Printer	7
Medium Printer	1
Large Printer	3
Shredder	1
Projector	19
Microwave	4
Small Fridge	1
Large Fridge	3
Coffee Machine	1
Toaster	2
Fans	14
Smart Board	1
Misc Loads	1

Building Plug Load

Plumbing/Water System

There are restrooms throughout this facility. A sampling of restrooms found that majority of the faucets are low flow and rated for 0.5 gallons per minute (gpm). There is also a high flow aerator rated for 2.2 gpm in the kitchen restroom.

Upper Greenwood Lake Elementary School

Background Information

Upper Greenwood Lake Elementary School is located at 41 Henry Road, Hewitt, New Jersey. This 41,000 ft^2 facility was originally built in 1966, with an addition in 1973. The building is one story consisting of classroom space, a multipurpose room, media center, kitchen, and office space.

Building Occupancy

Approximate enrollment is 306 students with a staff of 55 people.

<u>Hours of Operation</u>

- Monday through Friday 8:30 am to 3:30 pm (students)
- Monday through Friday 6:30 am to 11:00 pm (staff)
- Saturday and Sunday rare use

Envelope

Building Envelope

The building is constructed of concrete block and structural steel with a brick facade. The building has a flat roof that is in fair condition. The building has single-pane windows that are in poor to fair condition. These let in a draft causes heating issues. The exterior doors are constructed of aluminum and in good condition, however door seals have worn out, which increases the level of outside air infiltration. Based on visual inspections of the building envelope, there are also wall cracks and the window frames are leaky. These building envelope deficiencies are signs of excessive infiltration and heat loss.

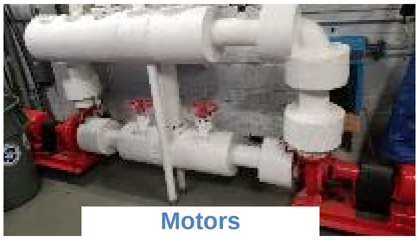
Lighting

Upper Greenwood Lake ES Lighting

Lighting at the facility is provided mostly by 32-Watt linear fluorescent T8 lamps with electronic ballasts as well as some compact fluorescent lamps (CFL) and incandescent lamps. Most of the fixtures are 2-lamp, 3-lamp or 4-lamp, 2-foot or 4-foot long troffers or wrap fixtures. About a quarter of the classrooms have fixtures that are in poor condition with yellowed lenses that may no longer be available for purchase. The multipurpose room is lit by 4-lamp T5HO lamp high bay fixtures. The exit signs throughout the building are LED. The exterior lighting is provided by high pressure sodium wall pack fixtures, metal halide area lighting fixtures and this one LED wall pack fixture.

Lighting Controls: Lighting fixtures throughout the building are manually controlled by wall switches. The exterior light fixtures are controlled by a time clock.

Motors


Motors

The HVAC systems that serve the building utilize fan and pump motors which are generally in good condition and high efficiency. These systems include hot water pump motors, exhaust fan motors and supply fan motors. All motors in excess of 5 horsepower were analyzed for retrofit and/or upgraded with a variable frequency drive.

Mechanical Systems


Boiler

HVAC Systems and Equipment: The building is heated by a hot water system which includes two (2) oil fired 2242 MBH non-condensing hot water boilers. The boilers have a nominal combustion efficiency of 86.7%. The boilers are fully modulating. They are in good condition, installed about five years ago and are well maintained. The boilers are configured in a constant flow primary distribution with two 5 HP hot water pumps, which operate in lead/lag fashion. They are constant speed, standard efficiency motors and are in fair condition. Hot water is supplied at 180°F when the outside air temperature is low, and the setpoint is adjusted linearly to 130°F when the outside air is above 65°F. The boilers provide hot water to unit ventilators, perimeter radiators, and hot water unit heaters throughout the building.

Designation	System Quantity	Location	Floor/ Serves	Manufacturer	Model/ Make	Date	Efficiency	Capacity
Boiler	2	Boiler Room	Entire Building	Buderus	GE615/10	±1979	86.7%	2242 MBH

There are some classrooms and the faculty room that have air conditioning (AC) units for cooling in the summer months. They are either window AC units or portable AC units. These range in capacity but are all in fair to good condition. They range in efficiency between 9.8 EER to 11.1 EER.

Domestic Hot Water Systems

Domestic Hot Water

The domestic hot water heating system for the facility consists of a propane fired 199 MBH storage tank water. This has storage capacity of 72 gallons and has a nominal efficiency of 80%. This system is in fair condition and serves a majority of the building. The systems serve hand washing sinks throughout the building and the kitchen. The distribution piping located in the boiler room was noted to have missing pipe insulation.

Designation	System Quantity	Location	Floor/ Serves	Manufacturer	Model/ Make	Date	Efficiency	Capacity
DHW	1	Boiler Room	DHW	Rheem	G72-250	-	80%	72 Gal

Building Controls (HVAC Controls)

Building Controls

The unit ventilators throughout the building have supply fan motors, dampers, and valves, which operate using a pneumatic control system. This system is original to the building and appears to be in fair operating condition. The air compressor for this system is in the boiler room, which is in fair condition and is equipped with standard efficiency motors. Per discussions with facility personnel, this is scheduled to be replaced in the near future. The proposed unit should be equipped with premium efficiency motors.

Kitchen Equipment

The school has an all-electric kitchen that is used to prepare lunches for almost every student each school day. Most of the cooking is done using a griddle and convection oven. Bulk prepared foods are held in an electric holding cabinet. Equipment is high efficiency and is in good condition.

The kitchen has several reach-in refrigerators with both solid and glass doors. There is also a freezer and refrigerator chests. All equipment is standard to high efficiency and is in fair to good condition.

Plug Load

There are roughly 72 computer work stations throughout the facility. It is assumed that there is no centralized PC power management software installed. Plug loads throughout the building include general café and office equipment. There are classroom typical loads such as smart boards, projectors, and fans. There are also several residential style mini-fridges throughout the building.

ESG observed to following significant plug load technologies:

Device Type:	Quantity:
Computer	72
Small Printer	13
Speakers	4
Large Printer	2
Large Fans	4
Projector	24
Microwave	4
Small Fridge	4
Large Fridge	1
Coffee Machine	2
Fans	35
Smart Board	16

Building Plug Load

Plumbing/Water System

There are restrooms throughout this facility. A sampling of restrooms found that majority of the faucets are rated for 2.2 gallons per minute (gpm) or higher.

Westbrook Elementary School

Background Information

Westbrook Elementary School is located at 46 Highlander Drive, West Milford, New Jersey. This 43,832 ft^2 facility was originally built in 1973. The building is three stories at varying elevations comprised of classroom space, a gymnasium, media center, kitchen, and office space.

Building Occupancy

Approximate enrollment is 310 students with a staff of 51 people.

<u>Hours of Operation</u>

- Monday through Friday 8:35 am to 2:55 pm (students)
- Monday through Friday 7:00 am to 11:00 pm (staff)
- Summer literacy program and basketball program in July
- Saturday and Sunday rare use

Envelope

Building Envelope

The building is constructed of concrete block and structural steel with a brick facade. The building has a flat roof that is only a few years old and is still in good condition. The building has single-pane windows that are in fair condition and show little sign of excessive infiltration. The exterior doors are constructed of aluminum and are in good condition, except that the door seals have worn out, which increases the level of outside air infiltration.

Lighting

Westbrook MPR Lighting

Lighting at the facility is provided mostly by 32-Watt linear fluorescent T8 lamps with electronic ballasts as well as some compact fluorescent lamps (CFL) and incandescent lamps. Most of the fixtures are 2-lamp or 4-lamp, 2-foot or 4-foot long troffers with diffusers. The exit signs throughout the building are LED. The exterior lighting includes a LED wall pack fixture as well as an LED screw-in lamp fixture.

<u>Lighting Controls:</u> The interior lights are manually controlled by wall switches. The majority of classrooms have remote mounted occupancy sensors. The exterior light fixtures are controlled by a photocell.

Motors

Motors

The HVAC systems that serve the building utilize fan and pump motors which are generally in good condition and high efficiency. These systems include hot water pump motors, exhaust fan motors and supply fan motors. All motors in excess of 5 horsepower were analyzed for retrofit and/or upgraded with a variable frequency drive.

Mechanical Systems

Boiler

HVAC Systems and Equipment: The building is heated by a hot water system consists of two (2) 2790 MBH condensing hot water boiler. The boilers have a nominal combustion efficiency of 93%. The boilers are configured in a constant flow primary distribution with two (2) 5 HP hot water pumps which operate in lead/lag fashion. They are constant speed, high efficiency motors and are in good condition. Hot water is supplied at 180°F when the outside air temperature is low and the setpoint is adjusted linearly to 130°F when the outside air is above 65°F. The boilers provide hot water to the roof top unit (RTU), three (3) main heating-ventilation (HV) units, baseboard radiators and hot water unit heaters. The boilers are fully modulating. They are in good condition and well maintained.

Designation	System Quantity	Location	Floor/ Serves	Manufacturer	Model/ Make	Date	Efficiency	Capacity
Boiler	2	Boiler Room	Entire Building	AERCO	Benchmark 3000	-	93%	2790 MBH

The packed air conditioning on the roof of the Westbrook Elementary School is aging, inefficient, and in need of replacement. This cooling system is constant volume multi-zone DX unit with a hot water coil. The unit serves the main office areas, media center, nurses' office, and faculty room. It is approximately 29 tons and 15 years old. It has a single 10 HP high efficiency supply fan motor that is in good condition. The motor is constant speed and the unit is assumed to have a standard backward-inclined fan. The unit utilizes compressors and a direct-expansion (DX) coil.

Package DX Cooling

Domestic Hot Water Systems


Domestic Hot Water

The domestic hot water heating system for the facility consists of a gas fired 500 MBH boiler and a 119 gallon storage tank. The system has a nominal efficiency of 80% and serves the entire building. This equipment was installed a few years ago and is in good condition. This system serves hand washing sinks throughout the building and the kitchen.

Building Controls (HVAC Controls)


Building Controls

The majority of the facility is controlled with a building energy management system (BEMS). The BEMS aggregates the DDC points from throughout the building. Roughly 50% of the building zone controls are DDC, and the remainder have pneumatic controls, which are not tied into the BMS.

Kitchen Equipment

The kitchen has a walk-in cooler and a walk in medium temperature freezer. These are in good condition. The kitchen also has a stand-up refrigerator with a glass door, a freezer chest and two (2) refrigerator chests. All equipment is standard to high efficiency and in good condition.

Plug Load

There are roughly 70 computer work stations throughout the facility. It is assumed that there is no centralized PC power management software installed. Plug loads throughout the building include general café and office equipment. There are classroom typical loads with as projectors and fans.

ESG observed to following significant plug load technologies:

Device Type:	Quantity:
Computer	70
Small Printer	6
Large Printer	4
Shredder	1
Projector	29
Microwave	2
Large Fridge	1
Coffee Machine	2
Toaster	1
Fans	34



Building Plug Load

Plumbing/Water System

A sampling of restrooms found that faucets are already fit with low flow aerators which are rated for 0.5 gallons per minute (gpm).

West Milford High School

Background Information

West Milford High School is located at 46 Highlander Drive, West Milford, New Jersey. This 220,000 ft2 facility was originally built in 1976 and is in fair condition. The High School is two floors of classroom space, a gymnasium, locker rooms, kitchen, cafeteria, library, shops, auditorium, and office areas.

Building Occupancy

Approximate enrollment is 1200 students with a staff of 174 people.

<u>Hours of Operation</u>

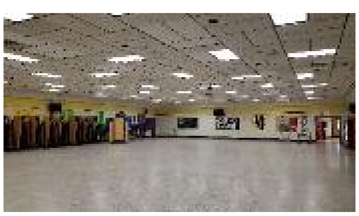
- Monday through Friday 6:00 am to 2:10 pm (students)
- Monday through Friday 6:00 am to 11:00 pm (staff)
- Weekend use is 7:00 am to 2:00 pm (students) and 11:00 pm (staff)

Envelope

The building has a flat roof that is in fair condition. The building has double-pane windows with metal frames in fair condition. The exterior doors are constructed of aluminum or metal with glass panes and are in good condition. However, the door seals have worn out, which increases the level of outside air infiltration. Based on visual inspections of the building envelope, there are wall cracks as well as some cracks around window frames. These building envelope deficiencies can lead to excessive infiltration.

Building Envelope

Lighting



West Milford HS Lighting

Lighting is provided mostly by linear fluorescent fixtures with 32-Watt T8 lamps with electronic ballasts. The large shop areas are lit by fixtures with reduced wattage 28-Watt lamps. There are general purpose fixtures throughout the building that utilize some compact fluorescent lamps (CFL), incandescent, and LED lamps. Fluorescent fixture types include 2-lamp, 3-lamp or 4-lamp, 2-foot or 4-foot long troffers, wraparound fixtures, and industrial fixtures. Most fixtures are in fair condition; however, some fixture are missing lenses. The newer science classrooms are lit by LED fixtures. The exit signs throughout the building are LED.

The exterior lighting includes building mounted wall pack fixtures, pole mounted flood fixtures, and under canopy recessed box fixtures. Higher mounting height fixtures include high pressure sodium lamps and ballasts. The building overhang canopies have traditional incandescent lamps. There were two (2) LED wall pack fixtures noted as well.

Lighting Controls: Most lighting fixtures in classrooms and some offices are controlled by occupancy sensors. The remainder are manually controlled by wall switches. Exterior light fixtures are controlled by a time clock that operate about 12 hours overnight.

Motors

The HVAC systems that serve the building utilize fan and pump motors which are generally in good condition and high efficiency. These systems include hot water pump motors, exhaust fan motors and supply fan motors. All motors in excess of 5 horsepower were analyzed for retrofit and/or upgraded with a variable frequency drive.

Motors

Mechanical Systems

HVAC Systems and Equipment: The building is heated by a hot water system which includes four (4) gas-fired, 3,982 MBH non-condensing hot water boilers. The boilers are high/low fire and are in good condition. They were installed about six years ago and are well maintained. The boilers have a nominal thermal efficiency of 83.9%. Hot water is provided to unit ventilators, heating coils in larger HVAC units, perimeter radiators and hot water unit heaters and radiators throughout the building. There are two (2) 20 HP hot water pumps which operate in lead/lag fashion. There are also two (2) 5 HP hot water pumps which also operate in lead/lag fashion. These primary distribution pumps and motors are constant speed and the triple duty valves were noted to be only partially opened. All pumps operate at constant speed and are driven by premium efficiency motors.

HVAC System

Designation	System Quantity	Location	Floor/ Serves	Manufacturer	Model/ Make	Date	Efficiency	Capacity
Boiler	4	Boiler Room	Heating System	Buderus	-	±2013	83.9%	3982 MBH

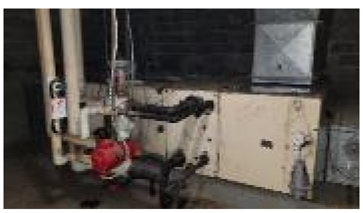
Unit Ventilator

Classrooms throughout the building are conditioned by unit ventilators equipped with fan motors and hot water valves. These have fractional horsepower motors that are in fair condition. Larger areas are conditioned by heating-ventilating (HV) units equipped with hot water heating coils and 1 HP supply fan motors.

The central portion of the building is cooled by a chilled water system that includes a 450 ton water-cooled centrifugal variable speed chiller that is high efficiency and in good condition. Per discussions with facility personnel, they recently completed an $80k chiller retrofit project, which included the replacement of motors, sensors, bearings, and miscellaneous parts. The cooling tower located on the roof of the building is in poor condition and nearing the end of its useful life. Chilled water is provided to larger HVAC units. There are two (2) 30 HP chilled water pumps, which operate in lead/lag fashion. There is also a 15 HP condenser water pump motor and a 10 HP cooling tower fan motor. These motors are constant speed and the triple duty valves were noted to be only partially opened. All pumps operate at constant speed and are driven by premium efficiency motors.

Chiller Water (CHW) Cooling Tower

Each HVAC unit draws air from its own return air shaft and supplies air to its own air shaft. There are eight (8) of these units located in the penthouse mechanical rooms in the building. The central areas such as the gymnasium, auditorium and cafeteria are conditioned by these HVAC units. Each unit is equipped with a hot water heating coil, a chilled water cooling coil and a 5 HP supply fan motor. There are also some fractional horsepower hot water circulator pumps in the penthouse mechanical rooms. All of these HVAC motors are in fair to good condition.



Air Handling Unit

Some classrooms and offices are cooled by window air conditioning (AC) units, which are manually turned on and off during the summer months for cooling. These are a ton or half a ton in capacity. The majority are high efficiency and are in good condition.

The office area and science rooms are conditioned by split air-source heat pump systems that are in good condition and high efficiency. There are also split AC systems that cool the mathematics lab and IT server rooms. These are also in good condition and high efficiency.

Domestic Hot Water Systems

Domestic Hot Water

The domestic hot water heating is an indirect system which includes the use of two (2) gas fired 999 MBH boilers and an 85-gallon storage tank. The system is in good condition with a standard system efficiency of 85%. Hot water is provided to hand washing sinks throughout the building and the kitchen.

Designation	System Quantity	Location	Manufacturer	Model/ Make	Date	Efficiency	Capacity
DHW	2	Boiler Room	-	-	-	85%	85 Gal

Building Controls (HVAC Controls)

The unit ventilators throughout the building have supply fan motors, dampers, and valves, which operate through the use of a pneumatic control system. This system is original to the building appears to be in fair operating condition. The air compressor for this system is located in the boiler room, was recently installed, and is in good condition with a high efficiency motor.

Building Controls

The energy management system includes the use of direct digital controls (DDC) and a Johnson Controls Auto logic software user interface utilizing BACnet data communication protocol. The boiler and hydronic heating system, chiller and chilled water system, science classroom unit ventilators, and exhaust fans are controlled by the building energy management system. The main pumps and re-heat pumps operate in lead/lag fashion. The boiler hot water supply water temperatures are controlled based on outdoor air temperature. The return water and re-heat temperatures are examples of trended points. The gymnasium schedule is between 6:00 AM and 10:00 PM every day of the week.

The heating system is tied to the energy management system with outdoor air temperature reset controls. Hot water is supplied at 180°F when the outside air temperature is low, and the setpoint is adjusted linearly to 130°F when the outside air increases with a lockout at 45°F. Heating space temperature set points vary between 68°F and 72°F in the winter.

The central chilled water system is also tied to the energy management system with condenser water return water temperature reset controls. Cooling space temperature set points vary between 72°F and 76°F in the summer and setback overnights.

BMES Interface

The science classroom unit ventilator schedule is between 6:00 AM and 5:00 PM, Monday through Friday. The unit ventilators are equipped with zone temperature and humidity sensor feedback, supply, and exhaust fan statuses as well as heating valve and economizer damper percentage open. The occupied heating temperature setpoint is 70°F and unoccupied is 68°F. The occupied cooling temperature setpoint is 74°F and unoccupied is 82°F. Heating and cooling is locked out at outdoor air temperature of 60°F.

Kitchen Equipment

The school has an all-electric kitchen that is used to prepare lunches for almost every student each school day. Most of the cooking is done using a number of electric oven, a fryer, steamer, and griddle. Prepared foods are held in a number of insulated holding cabinets. A majority of this equipment is in fair condition and standard efficiency.

The kitchen has a walk-in medium temperature freezer and a walk-in cooler. These are used to store food prepared for school lunches. The evaporators and doors are in good condition and high efficiency. There is also a number of solid door stand-up refrigerators in the kitchen, a few glass front free standing refrigerators and a refrigerated chest. All equipment is standard to high efficiency and in fair to good condition. There are also two (2) ice makers located in the shipping/receiving small garage area, one is in good condition and the other is standard and aging.

Plug Load

There are roughly 430 computer work stations throughout the facility. It is assumed that there is no centralized PC power management software installed. Plug loads throughout the building include general café and office equipment. There are classroom typical loads such as smart boards, projectors, and fans. The shop areas also include tool loads and the gymnasium areas also include workout equipment. There are also a number of residential style refrigerators throughout the building. These vary in condition and efficiency. There were a few noted to be almost empty. These should be considered for consolidation and removal of unnecessary refrigerators throughout the building. Refrigerated drink machines are located in the hallways and lounge areas. These do not currently have controls.

ESG observed to following significant plug load technologies:

Device Type:	Quantity:
Computers	430
Laptop Carts	10
Coffee Maker	17
Refrigerator	14
Microwave	23
Fan	53
Printer	53
Projector	57
TV	33
Smart Board	2
Mini Fridge	17
Speaker	14
Large Aquarium	2
Oven	7
Kilns	3
Misc. Sound Equipment	1
Large Xerox- Type Printers	9
Tredmills	2
Woodshop Equipment	1
Misc Tools	1

Building Plug Load

Plumbing/Water System

There are restrooms throughout this facility. Restrooms have faucets which are rated for 0.5 to 2.2 gallons per minute (gpm).

Bus Garage

Background Information

The Bus Garage is located at 51 Highlander Drive, West Milford, New Jersey. This 5,000 ft^2 facility was originally built in 2005 and remains in good condition. The garage is one floor containing a large garage, an office, kitchenette, lounge, and restroom.

Building Occupancy

The buildings in this complex have on average of 10 occupants a day.

Hours of Operation

- Monday through Friday 5:30 am to 4:00 pm (staff)
- Saturday and Sunday no use

Envelope

Building Envelope

The building is constructed of concrete block and structural steel. The building has a pitched roof and is in good condition. There are sectional steel overhead doors and metal man doors. There are no windows in the building. The doors are in good condition and show little sign of excessive infiltration.

Lighting

Bus Garage Lighting

Lighting & controls: Lighting at the facility is provided mostly by metal halide high bay fixtures. The office, kitchenette, restroom, and lounge are lit by linear fluorescent fixtures with T-8 lamps with electronic ballasts. These fixtures are in fair condition, but many lamps were noted to be out during the on site assessment.

The building's exterior lighting is significant in comparison to the interior lighting electrical consumption. There are wall pack and building mounted flood fixtures that contain metal halide lamps and ballasts.

The exterior fuel pump station is lit by recessed canopy fixtures that likely have 100-Watt metal halide lamps and ballasts. There are also pole mounted flood fixtures that contain 400-Watt metal halide lamps and ballasts. The remaining metal halide fixtures may be replaced with new reduced wattage high performance LED fixtures.

Lighting Controls: Lighting fixtures throughout the building are controlled manually via wall switches. The exterior lighting is controlled by a timeclock that is scheduled between 6:00 PM and 6:45 AM, daily.

Mechanical Systems

HVAC Systems: The Bus Garage is heated by a hot water radiant floor heating system. The system consists of a gas-fired non-condensing 266 MBH Buderus boiler that has a nominal thermal efficiency of 85.7%. The boiler is about 14 years old, is in good condition, and appears to be well maintained. Hot water is supplied at by five (5) fractional horsepower pumps. The hot water heating pipes were noted to be missing insulation in the boiler room. There is an office that has a window air conditioning (AC) unit installed through the wall and is in fair condition. It is about a half ton in cooling capacity and is standard to low efficiency.


Hot Water Heating System

Domestic Hot Water Systems

The domestic hot water is provided by an indirect system that is served from the main gas-fired boiler and 50-gallon storage tank. The system has an input rating of 150 MBH and the system has an efficiency of about 77%. The domestic water circulator pump is fractional horsepower and in fair condition.

Building Controls (HVAC Controls)

The boiler is controlled by a basic heat timer that adjusts supply water temperature based on outdoor air temperature. The window AC is only used periodically in the summer months and is manually turned on and off.

Plug Load

The building has general café and office equipment. The bulk of the plug loads are associated with tools, large floor fans and mechanical lifts.

ESG observed to following significant plug load technologies:

Device Type:	Quantity:
Computers	1
Overhead Door Openers	4
Large Floor Fans	3
Mechanical Lifts	3
Air Compressor for Tools	1
Coffee Maker	1
Toaster	1
Microwave	1
Fridge	1
Printer	1


Building Plug Load

Plumbing/Water System

There is a restroom in the building that has a sink. This faucet has an aerator rated for 2.2 gallons per minute (gpm).

Utility Baseline Analysis

Electric

Electrical energy is provided to West Milford Township Public Schools from Rockland Electric Company except for Paradise Knoll Elementary School, which is provided from Jersey Central Power & Light (JCP&L). Rockland Electric Company is the electric transport company and New Jersey Gas & Electric is the commodity supplier except for Paradise Knoll Elementary School where JCP&L is the electric transport company and Marathon Energy is the commodity provider. One kWh usage is equivalent to 1000 watts running for one hour.

The primary electric rate used by the buildings at West Milford Township Public Schools, is the General Service Secondary (GS).

Natural Gas

West Milford Township Public Schools has natural gas transported by Public Service Electric & Gas (PSE&G) and the supplier is Agera Energy LLC. The gas utility measures consumption in cubic feet x 100 (CCF) and converts the quantity into therms of energy. The buildings fall primarily under the Large Volume Gas (LVG) Rate structure for natural gas.

Fuel Oil

Upper Greenwood Lake and Apshawa Elementary Schools utilize fuel oil for their hot water boilers. Finch Fuel Oil Co. Inc. provides fuel oil to these two schools.

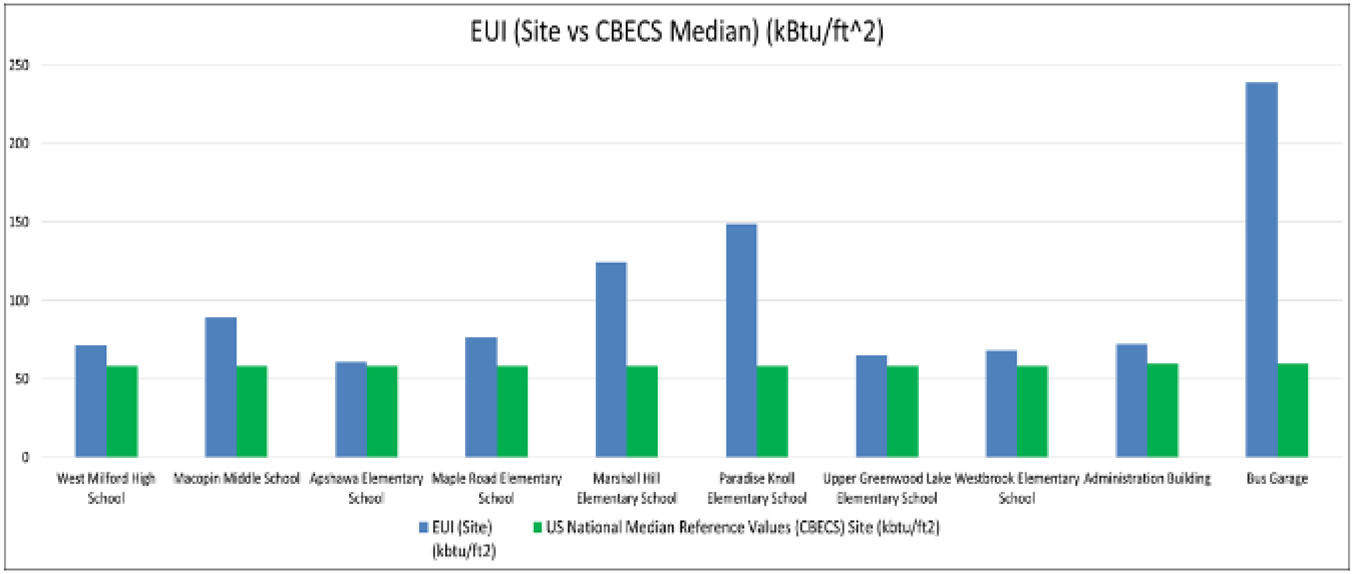
Propane

Macopin Middle School utilizes propane for kitchen equipment. Upper Greenwood Lake and Apshawa Elementary Schools utilize propane for domestic hot water. Propase is provide by Eastern Propane to these schools.

Energy Usage Summary

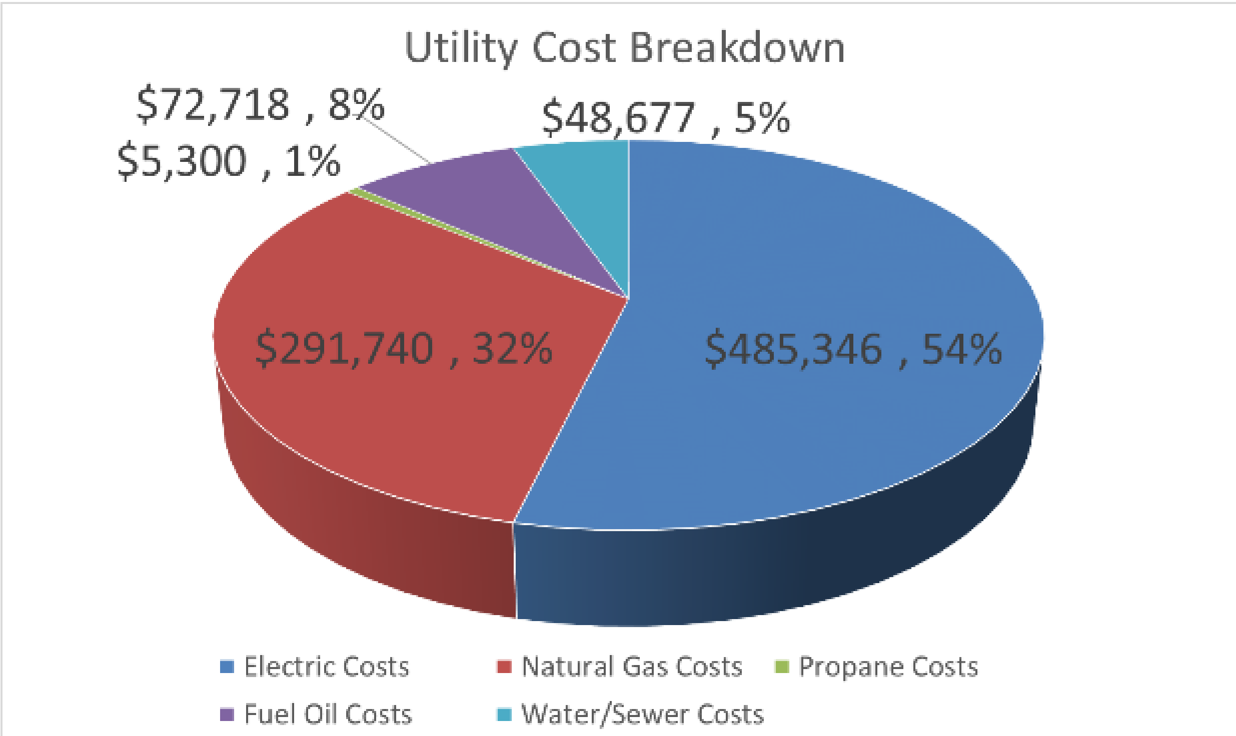
West Milford Township Public Schools Energy Summary Analysis Table

Baseline Data	Electric		Natural Gas		Fuel Oil		Propane		Water	Sewer	Total Utility Cost	EUI
Facility Name	Annual kWh	Total $	Therms	Total $	Annual Gallons	Total $	Annual Gallons	Total $	Total Cost	Total Cost		EUI-Pre (Btu/ft^2)
West Milford High School	1,575,200	$209,067	103,791	$ 87,531	-	$ -	$ -	$ -	$ -	$ 30,144	$326,742	71,615
Macopin Middle School	507,360	$70,080	88,677	$ 75,733	-	$ -	$ 1,009.00	$ 2,916.01	$ -	$ -	$148,728	89,098
Apshawa Elementary School	148,640	$21,324	-	$ -	14,076	$ 35,190	$ 542.00	$ 1,566.38	$ 1,026.00	$ -	$59,107	60,567
Maple Road Elementary School	180,720	$25,479	28,569	$ 23,696	-	$ -	$ -	$ -	$ -	$ -	$49,175	76,581
Marshall Hill Elementary School	235,120	$32,056	43,899	$ 36,477	-	$ -	$ -	$ -	$ -	$ 6,523	$75,056	124,442
Paradise Knoll Elementary School	233,600	$25,596	40,849	$ 34,220	-	$ -	$ -	$ -	$ -	$ -	$59,816	148,866
Upper Greenwood Lake Elementary School	164,040	$23,010	-	$ -	15,011	$ 37,528	$ 283.00	$ 817.87	$ -	$ -	$61,355	65,179
Westbrook Elementary School	258,750	$37,652	21,072	$ 17,897	-	$ -	$ -	$ -	$ -	$ -	$55,549	68,222
Administration Building	81,420	$11,594	2,995	$ 2,835	-	$ -	$ -	$ -	$ -	$ -	$14,429	72,173
Bus Garage/Maintenance	175,446	$21,791	10,893	$ 13,353	-	$ -	$ -	$ -	$ 509.20	$ 6,710	$42,362	337,619
McCormack Field	76,867	$7,697	-	$ -	-	$ -	$ -	$ -	$ -	$ -	$7,697	-
Totals	**3,637,163**	**$ 485,346**	**340,745**	**$ 291,740**	**29,087**	**72,718**	**$ 1,834**	**$ 5,300**	**$ 1,535**	**$ 43,377**	**$ 900,015**	**84,610**



West Milford Public Schools Energy Use Index (EUI) Analysis

The pie chart below shows the distribtuion of these utility costs relative to the entire District energy consumption. At 54% of the total consumption, electricity comprises a larger share of the energy costs.



West Milford Public Schools Utility Cost Breakdown

Marginal Rates

For the purposes of determining how energy conservation measures will affect the utility bill, it is important to understand what portions of the cost can be saved. In general, there are costs associated with utility bills that are fixed and independent of usage, such as the monthly meter charge. For example, in the case of a monthly meter charge, this charge often exists even if the energy usage were zero. An energy conservation measure often cannot produce a cost savings on this portion of the bill. The utility rate structure has to, therefore, be analyzed to determine what portion of the bill a cost savings can be produced using a specific energy conservation measure. For the purposes of this report, the blended average utility rate is the total cost divided by the total energy units. The effective rate is the portion of the bill effected by energy saving or the applied energy conservation measure.

The utility rates identified below were used for purposes of calculating the dollar effect of the energy

Electric

Building Name	Address	Rate	Meter #	Electric Transport Company	Effective Rate (Note 4) Supply $/kWh (Note 8)	Effective Rate (Note 4) Delivery Effective $/kWh	EFFECTIVE RATE (Note 4) TOTAL Effective $/kW	EFFECTIVE RATE (Note 4) TOTAL Eff $/kWh	Total Baseline Electric kWh	Peak Demand Billed (Note 5) kW	TOTAL Electric Cost Cost $	Blended Avg Unit Cost ($ / Unit) (Note 6)	Base Year
West Milford High School	67 Highlander Dr OTHER DOCK	LGS	603056165	Rockland	$0.0790	$0.04182	**$4.49**	**$0.121**	1,575,200	440.0	$ 218,764	$ 0.139	Oct-17 - Oct-18
McCormack Field (LITE BLFLD)	70 Highlander Dr (Lighting Metered)	GS	603126958	Rockland	$0.0790	$0.02113	**N/A**	**$0.100**	76,867	N/A	$ 10,313	$ 0.134	Oct-17 - Oct-18
Macopin Middle School	70 Highlander Dr	GS	062218820	Rockland	$0.0790	$0.04182	**$4.49**	**$0.121**	507,360	184.8	$ 74,008	$ 0.146	Oct-17 - Oct-18
Apshawa Elementary	140 High Crest Dr	GS	701202666	Rockland	$0.0790	$0.04182	**$4.49**	**$0.121**	148,640	72.0	$ 22,556	$ 0.152	Oct-17 - Oct-18
Maple Road Elementary School	26 Mable Rd	GS	601016634	Rockland	$0.0790	$0.04182	**$4.49**	**$0.121**	180,720	81.6	$ 27,210	$ 0.151	Oct-17 - Oct-18
Marshall Hill Elementary School	210 Marshall Hill Rd	GS	601021167	Rockland	$0.0790	$0.04182	**$4.49**	**$0.121**	235,120	72.0	$ 33,946	$ 0.144	Oct-17 - Oct-18
Paradise Knoll Elementary School	103 Paradise Rd	GS	21077227	JCP&L	$0.0769	$0.01564	**$6.42**	**$0.093**	233,600	63.4	$ 30,185	$ 0.129	Oct-17 - Oct-18
Upper Greenwood Lake Elementary	41 Henry Rd	GS	701189934	Rockland	$0.0790	$0.04182	**$4.49**	**$0.121**	164,040	67.2	$ 24,753	$ 0.151	Oct-17 - Oct-18
Westbrook Elementary School	55 Nosenza Pond Rd	GS	070412106	Rockland	$0.0790	$0.04182	**$4.49**	**$0.121**	258,750	135.0	$ 39,817	$ 0.154	Oct-17 - Oct-18
Administration Building	46 Highlander Rd 46 Arnold Rd Admin	GS	601006135	Rockland	$0.0790	$0.04182	**$4.49**	**$0.121**	81,420	46.8	$ 12,511	$ 0.154	Oct-17 - Oct-18
Bus Garage (Large Building)	51 Highlander Dr GAR	GS	701201688	Rockland	$0.0790	$0.04182	**$4.49**	**$0.121**	31,063	11.6	$ 4,673	$ 0.150	Oct-17 - Oct-18
Blue Building (Note 8)	46 Highlander Dr	GS	701224294	Rockland	$0.0790	$0.04182	**$4.49**	**$0.121**	16,212	4.7	$ 2,373	$ 0.146	N/A - N/A
Trailer (Note 8)	Highlander Dr	GS	701224293	Rockland	$0.0790	$0.04182	**$4.49**	**$0.121**	46,324	12.5	$ 6,438	$ 0.139	N/A - N/A
Garage (near trailer) (Bldg A)	51 Highlander Dr (Tan Building)	GS	701010149	Rockland	$0.0790	$0.04182	**$4.49**	**$0.120**	81,847	35.6	$ 12,568	$ 0.154	Oct-17 - Oct-18

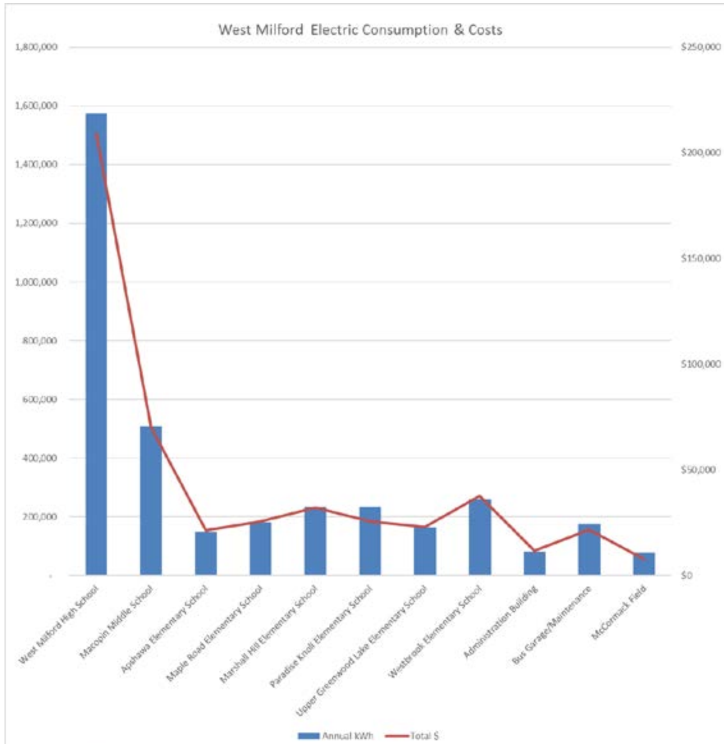
Note 1: Paradise Knoll Elementary electric commodity suppler of electricity for the baseline period is, South Jersey or Marathon Energy and the transport company is Jersey Central Power & Lighting (JCP&L) (see note 3).
Note 2: Rockland electric commodity suppler of electricity for the baseline period is New Jersey Gas & Electric (see note 3). McCormack Field is supplied by Basic Generation Service BGS from Rockland.
Note 3: A new supply contract for Paradise Knoll Elementary contracted with Constellation for 07/9/19 to 7/8/21 at a rate of $0.07694/kWh and a new contracted rate for the Rockland Electric Accounts contracted with Agera Energy starting in 9/2019 for 24 months at a rate of $0.079/kWh is used as the effective supply rates.
Note 4: The effective rate does not include fixed charges and is the portion of energy costs that can be affected by a change in energy or demand. The effective supply kWh rate is the most recent contracted rate with Constellation or Agera Energy. The effective transport $/kWh and $/kW demand rates are based on the Rockland utility tariff rates as of 10/1/18. The total effective $/kWh rate is the summation of the supply and transport effective rates. Summer rate is considered months June through September. A simplified weighed average delivery/transport $/kWh energy rate and $/kW demand rate is used in determining the Total Effective rate for savings calculations. The $/kWh rate was calculated by taking the summation of the Other $/kWh rate times 8/12 plus the Summer $/kWh rate times 4/12. The $/kW demand rate was calculated by taking the summation of the Other $/kW rate times 8/12 plus the Summer $/kW rate times 4/12. The effective rate for JCP&L is calculated in a similar manner and is based on the rates as of 1/1/2019.
Note 5: Peak Demand Billed is the highest billed demand that occurred during the baseline period.
Note 6: The average blended unit cost is the total 12 month utility costs divided by the total 12 month billed kWhs.
Note 7: Rockland Rate GS and JCP&L GS rate is general services rate. The rates are different for each company.
Note 8: Bus Garage Blue Building & Trailer - Only 3 months of data were available. The totals shown are an estimated annual total by take the Dec 2018 - Feb 2019 costs and kWh data and multiplying the 3 months of data by (12/3).
Note 9: The Bus Garage meter was observed onsite however none of the billing information provided was found to have this meter number.

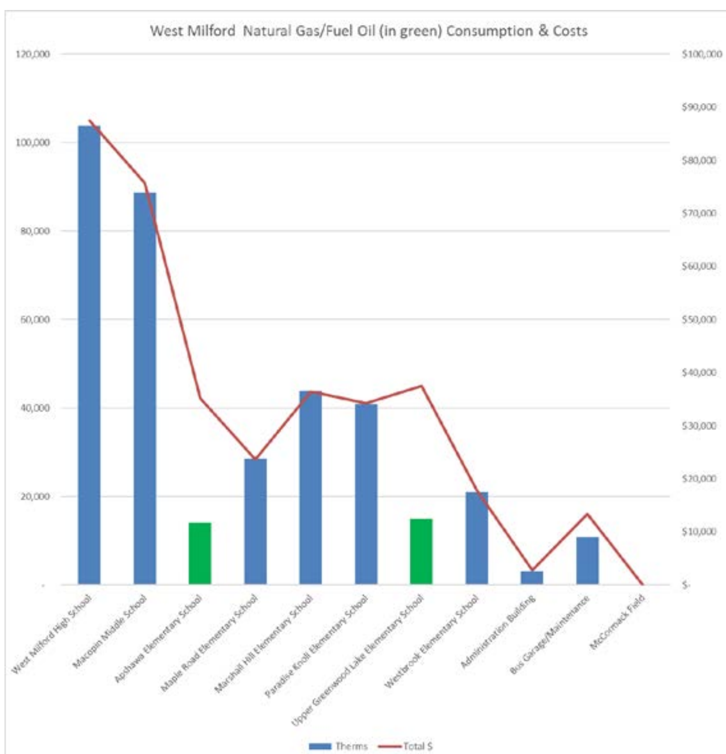
Natural Gas

Building Name	Rate	Address	Meter #	Account #	Account #	Account #	Gas Transport Company	Supply Effective Rate (Note 1)	Total Effective Rate (Note 2)	Baseline Consumption	TOTAL COST	Base Year
								$/therm	$/therm	therms	$	
West Milford High School	LVG	67 Highlander Dr	1784709	73-428-563-04	65-858-114-02	7342856304	PSE&G	$ 0.535	**$0.843**	103,791	$ 88,812	Nov-17 - Nov-18
Macopin Middle School	LVG	70 Highlander Dr	3164399	73-428-567-03	67-448-837-04	7342856703	PSE&G	$ 0.535	**$0.854**	88,677	$ 77,014	Nov-17 - Nov-18
Maple Road Elementary	LVG	Maple Rd	2279584	73-428-561-18	65-021-689-06	7342856118	PSE&G	$ 0.535	**$0.829**	28,569	$ 24,978	Sep-17 - Sep-18
Marshall Hill Elementary	LVG	210 Marshall Hill Rd	3928810	73-428-564-01	66-435-744-04	7342856401	PSE&G	$ 0.535	**$0.831**	43,899	$ 37,758	Nov-17 - Nov-18
Westbrook Elementary School	LVG	Nosenzon Pond Rd	2413272	73-428-562-07	65-384-305-03	7342856207	PSE&G	$ 0.535	**$0.849**	21,072	$ 19,179	Nov-17 - Nov-18
Paradise Knoll Elementary	LVG	103 Paradise Rd	3928880	73-428-566-06	67-100-623-09	7342856606	PSE&G	$ 0.535	**$0.838**	40,849	$ 35,501	Nov-17 - Nov-18
Administration	GSG	46 Highlander Dr	2472359	73-428-569-08	67-576-164-08	7342856908	PSE&G	$ 0.535	**$0.946**	2,995	$ 2,984	Nov-17 - Nov-18
Bus Garage (largest building)	GSG (HTG)	57 Highlander Dr	3215823	73-428-565-09			PSE&G	$ 0.535	**$1.226**	5,222	$ 6,549	Dec-17 - Dec-18
Blue Building (Bldg 47)	GSG	47 Highlander Dr	2445030	73-428-568-00	67-488-700-03	7342856800	PSE&G	$ 0.535	**$0.940**	2,546	$ 2,542	Dec-17 - Dec-18
Garage (near trailer) (Bldg A)	GSG (HTG)	47 Highlander Dr	3356183	73-428-565-09		7342856509	PSE&G	$ 0.535	**$0.929**	3,125	$ 3,052	Dec-17 - Dec-18

Note 1: Natural gas commodity supplier for the baseline period is SFE Energy NJ. The transport company is Public Service Electric & Gas (PSE&G). The PSE&G Master Gas Account Number is 13-013-633-08.
Note 2: For simplification of the rates, the effective rate is the total cost minus $1281.86 or $148.43 fixed service charge for the LVG and GSG rates. This is considered the overall effective rate for savings calculations which integrates the demand and balancing charge into a single blended rate while subtracting out the fixed service charges.
Note 3: The Blended Average Unit Cost is the total costs divided by the total usage.

Utility Breakdown by Building





Utility Escalation Rates

For purposes of calculating the extended value of the energy savings of this project, the following utility escalation rates have been used.

Name of School	Energy					
	Electric Consumption		Annual Electric Demand		Natural Gas/Fuel Oil	
	Escalation Rate	Start Year of Escalation	Escalation Rate	Start Year of Escalation	Escalation Rate	Start Year of Escalation
West Milford High School	2.2%	Year 1	2.2%	Year 1	2.4%	Year 1
Macopin Middle School	2.2%	Year 1	2.2%	Year 1	2.4%	Year 1
Apshawa Elementary School	2.2%	Year 1	2.2%	Year 1	2.4%	Year 1
Maple Road Elementary School	2.2%	Year 1	2.2%	Year 1	2.4%	Year 1
Marshall Hill Elementary School	2.2%	Year 1	2.2%	Year 1	2.4%	Year 1
Paradise Knoll Elementary School	2.2%	Year 1	2.2%	Year 1	2.4%	Year 1
Upper Greenwood Lake Elementary School	2.2%	Year 1	2.2%	Year 1	2.4%	Year 1
Westbrook Elementary School	2.2%	Year 1	2.2%	Year 1	2.4%	Year 1
Administration Building	2.2%	Year 1	2.2%	Year 1	2.4%	Year 1
Bus Garage/Maintenance	2.2%	Year 1	2.2%	Year 1	2.4%	Year 1

SECTION 3. FINANCIAL IMPACT

Energy Savings and Cost Summary

The table below provides a summary of the costs and savings associated with the measures recommended in the Energy Savings Plan. The savings have been calculated based on the savings methodology detailed throughout this report and included in the appendix of this report. Costs for each measure have been estimated based on project implementation experience and industry standards.

ECM ID	Energy Conservation Measure	ECM Hard Costs	Total Savings, $/yr	Simple Payback	Installation Plan	Recommend for Installation
Administration Building						
1	Administration Building - Retro-Commissioning	$2,147	$288	7.44	Public Bidding	Yes
2	Administration Building - Building Envelope Upgrades	$3,301	$382	8.65	Public Bidding	Yes
3	Administration Building - Plug Load Controls	$576	$325	1.77	Public Bidding	Yes
4	Administration Building - Upgrade HVAC Controls to DDC-MER	$26,802	$334	80.35	Public Bidding	Yes
5	Administration Building - Direct Install	$18,102	$2,986	6.06	Direct Install	Yes
Apshawa Elementary School						
6	Apshawa Elementary School - Fuel Economizer	$11,666	$1,430	8.16	Public Bidding	Yes
7	Apshawa Elementary School - Retro-Commissioning	$11,138	$977	11.40	Public Bidding	Yes
8	Apshawa Elementary School - Building Envelope Upgrades	$7,469	$1,260	5.93	Public Bidding	Yes
9	Apshawa Elementary School - Refrigeration Control Upgrades	$6,561	$834	7.87	Public Bidding	Yes
10	Apshawa Elementary School - PPA	$0	$0	N/A	Solar PPA	Yes
11	Apshawa Elementary School - Plug Load Controls	$3,917	$425	9.22	Public Bidding	Yes
12	Apshawa Elementary School - Destratification Fans	$8,156	$1,396	5.84	Public Bidding	Yes
13	Apshawa Elementary School - Unit Ventilator Refurbishment	$128,845	$214	601.70	Public Bidding	Yes
14	Apshawa Elementary School - Pipe and Valve Insulation	$10,877	$1,781	6.11	Public Bidding	Yes
15	Apshawa Elementary School - Upgrade HVAC Controls to DDC-MER	$26,559	$2,072	12.82	Public Bidding	Yes
16	Apshawa Elementary School - Upgrade HVAC Controls to DDC-HVAC	$13,450	$1,570	8.57	Public Bidding	Yes
17	Apshawa Elementary School - Direct Install	$12,149	$1,148	10.58	Direct Install	Yes
Bus Garage/Maintenance						
18	Bus Garage/Maintenance - Retro-Commissioning	$1,342	$730	1.84	Public Bidding	Yes
19	Bus Garage/Maintenance - Building Envelope Upgrades	$4,447	$781	5.69	Public Bidding	Yes
20	Bus Garage/Maintenance - PPA	$0	$0	N/A	Solar PPA	Yes
21	Bus Garage/Maintenance - Upgrade HVAC Controls to DDC-MER	$7,310	$193	37.93	Public Bidding	Yes
22	Bus Garage/Maintenance - Direct Install	$27,952	$4,074	6.86	Public Bidding	Yes
Macopin Middle School						
23	Macopin Middle School - Lighting Upgrades - LED	$306,988	$26,626	11.53	Public Bidding	Yes
24	Macopin Middle School - Addition of Cooling - RTU at Auditorium	$121,449	$0	N/A	Public Bidding	Yes
25	Macopin Middle School - Boiler Replacements	$570,726	$3,877	147.20	Public Bidding	Yes
26	Macopin Middle School - Retro-Commissioning	$32,205	$3,354	9.60	Public Bidding	Yes

ECM ID	Energy Conservation Measure	ECM Hard Costs	Total Savings, $/yr	Simple Payback	Installation Plan	Recommend for Installation
27	Macopin Middle School - Building Envelope Upgrades	**$20,231**	**$2,365**	**8.55**	Public Bidding	Yes
28	Macopin Middle School - Refrigeration Control Upgrades	**$6,561**	**$1,695**	**3.87**	Public Bidding	Yes
29	Macopin Middle School - PPA	**$0**	**$0**	**N/A**	Solar PPA	Yes
30	Macopin Middle School - Plug Load Controls	**$9,446**	**$1,269**	**7.45**	Public Bidding	Yes
31	Macopin Middle School - Destratification Fans	**$16,112**	**$1,259**	**12.80**	Public Bidding	Yes
32	Macopin Middle School - DHW Replacement	**$22,150**	**$1,293**	**17.13**	Public Bidding	Yes
33	Macopin Middle School - Unit Ventilator Refurbishment	**$232,978**	**$531**	**438.85**	Public Bidding	Yes
34	Macopin Middle School - Pipe and Valve Insulation	**$19,629**	**$2,085**	**9.41**	Public Bidding	Yes
35	Macopin Middle School - Upgrade HVAC Controls to DDC-MER	**$70,661**	**$1,482**	**47.68**	Public Bidding	Yes
36	Macopin Middle School - Upgrade HVAC Controls to DDC-HVAC	**$90,592**	**$1,947**	**46.54**	Public Bidding	Yes
37	Macopin Middle School - Pay for Performance	**$29,239**	**$0**	**N/A**	P4P	Yes
	Maple Road Elementary School					
38	Maple Road Elementary School - Kitchen Hood Control Upgrades	**$12,309**	**$224**	**54.92**	Public Bidding	Yes
39	Maple Road Elementary School - Fuel Economizer	**$11,666**	**$990**	**11.79**	Public Bidding	Yes
40	Maple Road Elementary School - Retro-Commissioning	**$12,173**	**$901**	**13.51**	Public Bidding	Yes
41	Maple Road Elementary School - Building Envelope Upgrades	**$29,265**	**$2,638**	**11.10**	Public Bidding	Yes
42	Maple Road Elementary School - Refrigeration Control Upgrades	**$6,561**	**$834**	**7.87**	Public Bidding	Yes
43	Maple Road Elementary School - PPA	**$0**	**$0**	**N/A**	Solar PPA	Yes
44	Maple Road Elementary School - Plug Load Controls	**$4,838**	**$447**	**10.82**	Public Bidding	Yes
45	Maple Road Elementary School - Destratification Fans	**$8,081**	**$579**	**13.96**	Public Bidding	Yes
46	Maple Road Elementary School - Unit Ventilator Refurbishment	**$155,825**	**$170**	**918.75**	Public Bidding	Yes
47	Maple Road Elementary School - Pipe and Valve Insulation	**$6,371**	**$583**	**10.93**	Public Bidding	Yes
48	Maple Road Elementary School - Upgrade HVAC Controls to DDC-MER	**$32,918**	**$1,011**	**32.57**	Public Bidding	Yes
49	Maple Road Elementary School - Upgrade HVAC Controls to DDC-HVAC	**$8,674**	**$677**	**12.82**	Public Bidding	Yes
50	Maple Road Elementary School - Direct Install	**$36,383**	**$14,732**	**2.47**	Direct Install	Yes
	Marshall Hill Elementary School					
51	Marshall Hill Elementary School - Kitchen Hood Control Upgrades	**$14,738**	**$735**	**20.05**	Public Bidding	Yes
52	Marshall Hill Elementary School - Boiler Replacements	**$116,639**	**$1,950**	**59.82**	Public Bidding	Yes
53	Marshall Hill Elementary School - Retro-Commissioning	**$11,198**	**$1,257**	**8.91**	Public Bidding	Yes
54	Marshall Hill Elementary School - Building Envelope Upgrades	**$9,331**	**$1,057**	**8.83**	Public Bidding	Yes
55	Marshall Hill Elementary School - Refrigeration Control Upgrades	**$4,986**	**$486**	**10.25**	Public Bidding	Yes
56	Marshall Hill Elementary School - Plug Load Controls	**$4,838**	**$885**	**5.47**	Public Bidding	Yes
57	Marshall Hill Elementary School - Unit Ventilator Refurbishment	**$122,842**	**$220**	**557.75**	Public Bidding	Yes
58	Marshall Hill Elementary School - Pipe and Valve Insulation	**$8,545**	**$813**	**10.51**	Public Bidding	Yes
59	Marshall Hill Elementary School - Upgrade HVAC Controls to DDC-MER	**$38,254**	**$1,628**	**23.50**	Public Bidding	Yes

ECM ID	Energy Conservation Measure	ECM Hard Costs	Total Savings, $/yr	Simple Payback	Installation Plan	Recommend for Installation
60	Marshall Hill Elementary School - Upgrade HVAC Controls to DDC-HVAC	**$13,937**	**$733**	**19.02**	Public Bidding	Yes
61	Marshall Hill Elementary School - Direct Install	**$48,898**	**$9,906**	**4.94**	Direct Install	Yes
Paradise Knoll Elementary School						
62	Paradise Knoll Elementary School - HVAC Armor-Refurbish Condensing Units	**$2,334**	**$158**	**14.74**	Public Bidding	Yes
63	Paradise Knoll Elementary School - Retro-Commissioning	**$8,802**	**$1,054**	**8.35**	Public Bidding	Yes
64	Paradise Knoll Elementary School - Building Envelope Upgrades	**$20,343**	**$1,805**	**11.27**	Public Bidding	Yes
65	Paradise Knoll Elementary School - Refrigeration Control Upgrades	**$7,349**	**$905**	**8.12**	Public Bidding	Yes
66	Paradise Knoll Elementary School - PPA	**$0**	**$0**	**N/A**	Solar PPA	Yes
67	Paradise Knoll Elementary School - Plug Load Controls	**$3,456**	**$275**	**12.57**	Public Bidding	Yes
68	Paradise Knoll Elementary School - Unit Ventilator Refurbishment	**$39,485**	**$175**	**225.26**	Public Bidding	Yes
69	Paradise Knoll Elementary School - Pipe and Valve Insulation	**$10,549**	**$883**	**11.94**	Public Bidding	Yes
70	Paradise Knoll Elementary School - Upgrade HVAC Controls to DDC-MER	**$35,038**	**$1,495**	**23.44**	Public Bidding	Yes
71	Paradise Knoll Elementary School - Upgrade HVAC Controls to DDC-HVAC	**$46,344**	**$1,200**	**38.62**	Public Bidding	Yes
72	Paradise Knoll Elementary School - Direct Install	**$73,293**	**$7,682**	**9.54**	Direct Install	Yes
Upper Greenwood Lake Elementary School						
73	Upper Greenwood Lake Elementary School - Lighting Upgrades - LED	**$99,130**	**$7,682**	**12.90**	Public Bidding	Yes
74	Upper Greenwood Lake Elementary School - Fuel Economizer	**$11,666**	**$1,527**	**7.64**	Public Bidding	Yes
75	Upper Greenwood Lake Elementary School - Retro-Commissioning	**$11,003**	**$1,058**	**10.40**	Public Bidding	Yes
76	Upper Greenwood Lake Elementary School - Building Envelope Upgrades	**$26,374**	**$2,752**	**9.58**	Public Bidding	Yes
77	Upper Greenwood Lake Elementary School - Refrigeration Control Upgrades	**$5,774**	**$764**	**7.56**	Public Bidding	Yes
78	Upper Greenwood Lake Elementary School - PPA	**$0**	**$0**	**N/A**	Solar PPA	Yes
79	Upper Greenwood Lake Elementary School - Plug Load Controls	**$4,608**	**$513**	**8.99**	Public Bidding	Yes
80	Upper Greenwood Lake Elementary School - Destratification Fans	**$10,465**	**$1,766**	**5.93**	Public Bidding	Yes
81	Upper Greenwood Lake Elementary School - Unit Ventilator Refurbishment	**$128,327**	**$225**	**569.74**	Public Bidding	Yes
82	Upper Greenwood Lake Elementary School - Pipe and Valve Insulation	**$3,643**	**$356**	**10.23**	Public Bidding	Yes
83	Upper Greenwood Lake Elementary School - Upgrade HVAC Controls to DDC-MER	**$38,254**	**$2,189**	**17.48**	Public Bidding	Yes
84	Upper Greenwood Lake Elementary School - Upgrade HVAC Controls to DDC-HVAC	**$6,969**	**$1,459**	**4.78**	Public Bidding	Yes
West Milford High School						
85	West Milford High School - Lighting Upgrades - LED	**$341,360**	**$32,661**	**10.45**	Public Bidding	Yes
86	West Milford High School - Stage Lighting Upgrades - LED	**$145,495**	**$5,394**	**26.97**	Public Bidding	Yes
86	West Milford High School - Kitchen Hood Control Upgrades	**$19,467**	**$535**	**36.35**	Public Bidding	Yes
87	West Milford High School - Transformer Upgrades	**$159,836**	**$14,767**	**10.82**	Public Bidding	Yes
88	West Milford High School - Cooling Tower Fan - VFD	**$19,493**	**$333**	**58.56**		
89	West Milford High School - Refurbish Cooling Tower	**$56,468**	**$2,447**	**23.08**	Public Bidding	Yes
90	West Milford High School - HVAC Armor-Refurbish Condensing Units	**$4,116**	**$314**	**13.12**	Public Bidding	Yes
91	West Milford High School - Fuel Economizer	**$23,333**	**$3,610**	**6.46**	Public Bidding	Yes
92	West Milford High School - Retro-Commissioning	**$59,043**	**$7,460**	**7.91**	Public Bidding	Yes

ECM ID	Energy Conservation Measure	ECM Hard Costs	Total Savings, $/yr	Simple Payback	Installation Plan	Recommend for Installation
93	West Milford High School - Building Envelope Upgrades	$95,641	$8,801	10.87	Public Bidding	Yes
94	West Milford High School - Refrigeration Control Upgrades	$6,561	$1,695	3.87	Solar PPA	Yes
95	West Milford High School - PPA	$0	$0	N/A	Public Bidding	Yes
96	West Milford High School - Plug Load Controls	$9,446	$1,935	4.88	Public Bidding	Yes
97	West Milford High School - Destratification Fans	$31,973	$2,922	10.94	Public Bidding	Yes
98	West Milford High School - Cogeneration (CHP)	$121,298	$1,985	61.10	Public Bidding	Yes
99	West Milford High School - Unit Ventilator Refurbishment	$274,985	$516	532.46	Public Bidding	Yes
100	West Milford High School - Pipe and Valve Insulation	$17,268	$1,634	10.57	Public Bidding	Yes
101	West Milford High School - Upgrade HVAC Controls to DDC-MER	$69,978	$5,336	13.11	Public Bidding	Yes
102	West Milford High School - Upgrade HVAC Controls to DDC-Unitary	$179,454	$3,423	52.43	Public Bidding	Yes
103	West Milford High School - Upgrade HVAC Controls to DDC-HVAC	$90,592	$9,648	9.39	Public Bidding	Yes
Westbrook Elementary School						
105	Westbrook Elementary School - Lighting Upgrades - LED	$73,057	$5,644	12.94	Public Bidding	Yes
106	Westbrook Elementary School - Transformer Upgrades	$36,094	$2,745	13.15	Public Bidding	Yes
107	Westbrook Elementary School - HVAC Armor-Refurbish Condensing Units	$13,904	$1,365	10.19	Public Bidding	Yes
108	Westbrook Elementary School - Retro-Commissioning	$11,763	$1,050	11.20	Public Bidding	Yes
109	Westbrook Elementary School - Building Envelope Upgrades	$10,709	$1,356	7.90	Public Bidding	Yes
110	Westbrook Elementary School - Refrigeration Control Upgrades	$5,774	$1,487	3.88	Public Bidding	Yes
111	Westbrook Elementary School - Plug Load Controls	$2,189	$160	13.68	Public Bidding	Yes
112	Westbrook Elementary School - Unit Ventilator Refurbishment	$32,082	$114	280.49	Public Bidding	Yes
113	Westbrook Elementary School - Pipe and Valve Insulation	$10,162	$936	10.86	Public Bidding	Yes
114	Westbrook Elementary School - Upgrade HVAC Controls to DDC-MER	$24,658	$1,245	19.81	Public Bidding	Yes
115	Westbrook Elementary School - Upgrade HVAC Controls to DDC-HVAC	$27,485	$3,486	7.88	Public Bidding	Yes
		$5,373,079	$275,367	19.51		

Operational Savings Estimates

The lighting retrofits recommended for this project will reduce the amount of lamps that need to be replaced each year due to the longer lasting lamps and new technology fixtures. The LED lighting recommended for the exterior fixtures will last much longer than the current high intensity discharge (HID) lighting and will generate material cost savings.

A brief description of the operational savings estimated for this project is included below. Energy Systems Group has worked with the District to quantify the exact sources of savings by going through past invoices and expenses. The operational savings will not be escalated.

Operational Savings for Financial Model	
ECM Description	**Annual Savings**
LED Lighting Upgrades – District Wide	$39,908
HVAC Upgrades / Equipment Replacement	$72,500
Totals	**$112,408**

Potential Revenue Generation Estimates

As part of the Energy Savings Plan for the West Milford Township Public Schools, several avenues for obtaining rebates and incentives have been investigated which include:

- NJ Smart Start Equipment Incentives
- Pay for Performance
- Combined Heat and Power Incentive
- Demand Response Energy Efficiency Credit

The estimated incentive amount for each program is listed below. Upon final selection of project scope and award of subcontractor bids, the incentive applications will be filed.

NJ Smart Start Equipment Incentives

The NJ Smart Start Equipment Incentives provide prescriptive rebates for defined retrofits. Incentives are applied on a unit-by-unit basis for making energy efficiency upgrades. The table below summarizes the equipment incentives, which will be applied for at West Milford Township Public Schools:

NJ Clean Energy Rebates	
Energy Conservation Measure	**Energy Rebate/ Incentives**
West Milford High School - Lighting Upgrades - LED	$29,334
Upper Greenwood Lake Elementary School - Lighting Upgrades - LED	$7,744
Westbrook Elementary School - Lighting Upgrades - LED	$4,951
West Milford High School - Kitchen Hood Control Upgrades	$1,800
Maple Road Elementary School - Kitchen Hood Control Upgrades	$900
Marshall Hill Elementary School - Kitchen Hood Control Upgrades	$900
West Milford High School - Cooling Tower Fan - VFD	$1,300
West Milford High School - Refrigeration Control Upgrades	$200
Apshawa Elementary School - Refrigeration Control Upgrades	$200
Maple Road Elementary School - Refrigeration Control Upgrades	$200
Marshall Hill Elementary School - Refrigeration Control Upgrades	$100
Paradise Knoll Elementary School - Refrigeration Control Upgrades	$250
Upper Greenwood Lake Elementary School - Refrigeration Control Upgrades	$150
Westbrook Elementary School - Refrigeration Control Upgrades	$150
West Milford High School - Unit Ventilator Refurbishment	$954
Apshawa Elementary School - Unit Ventilator Refurbishment	$58
Maple Road Elementary School - Unit Ventilator Refurbishment	$299
Marshall Hill Elementary School - Unit Ventilator Refurbishment	$409
Paradise Knoll Elementary School - Unit Ventilator Refurbishment	$345
Upper Greenwood Lake Elementary School - Unit Ventilator Refurbishment	$58
Westbrook Elementary School - Unit Ventilator Refurbishment	$205
Totals	**$50,507**

Pay for Performance Incentives

Pay for Performance incentives are awarded upon the satisfactory completion of three milestones:

Incentive Structure

Incentive #1: Energy Reduction Plan		
Incentive Amount:	$0.15	per sq ft
Minimum Incentive:	$7,500	
Maximum Incentive:	$50,000	or 50% of facility annual energy cost

This incentive is designed to offset some or all of the cost of services associated with the development of the Energy Reduction Plan (ERP) and is paid upon ERP approval. Incentive is contingent on implementation of recommended measures outlined in the ERP. If installation does not commence within the required timeframe, Incentive #1 may be required to be returned to the program. In the event the project is cancelled and Incentive #1 is not returned, the project may reapply to the program in the future but another Incentive #1 will not be paid.

Incentive #2: Installation of Recommended Measures			
	Minimum Performance Target:	**15%**	
Electric Incentives	Base Incentive based on 15% savings:	$0.09	per projected kWh saved
	For each % over 15% add:	$0.005	
	Maximum Incentive:	$0.11	
Gas Incentives	Base Incentive based on 15 % savings:	$0.90	per projected Therm saved
	For each % over 15% add:	$0.05	
	Maximum Incentive:	$1.25	
	Incentive Cap:	**25%**	**of total project cost**

This incentive is based on projected energy savings outlined in the ERP. Incentive is paid upon successful installation of recommended measures.

Incentive #3: Post-Construction Benchmarking Report			
	Minimum Performance Target:	**15%**	
Electric Incentives	Base Incentive based on 15% savings:	$0.09	per projected kWh saved
	For each % over 15% add:	$0.005	
	Maximum Incentive:	$0.11	
Gas Incentives	Base Incentive based on 15% savings:	$0.90	per projected Therm saved
	For each % over 15% add:	$0.05	
	Maximum Incentive:	$1.25	
	Incentive Cap:	**25%**	**of total project cost**

This incentive will be released upon submittal of a Post-Construction Benchmarking Report that verifies that the level of savings actually achieved by the installed measures meets or exceeds the minimum performance threshold. Total value of Incentive #2 and Incentive #3 may not exceed 50% of the total project cost. Incentive Caps apply.

Building	Estimated Incentive #1	Estimated Incentive #2	Estimated Incentive #3	Estimated Total
Pay for Performance - Macopin Middle School	$12,000	$25,510	$25,510	$63,021
Totals	**$12,000**	**$25,510**	**$25,510**	**$63,021**

Cogeneration Incentives

Cogeneration Incentives

This project will not utilize Cogeneration Incentives because the minimum Effective Full Load Run Hours will not be met.

Demand Response Energy Efficiency Credit

The LED Lighting Upgrades recommended for the District will be eligible for the Energy Efficiency Credit available through PJM. The Energy Efficiency Credit pays consumers based on the permanent load reduction through the installation of energy efficiency measures. The following table summarizes the available Demand Response Incentives available due to the lighting upgrades to be performed in the District.

Demand Response Energy – Emergency Capacity Credit		
PJM Payment Year	Approved Load (kW)	Annual Customer Capacity Benefit
2020/2021	127.5 kW	$5,234
2021/2022	127.5 kW	$4,618
2022/2023	127.5 kW	$3,848
2023/2024	127.5 kW	$3,848
Totals		**$17,548**

Incentive Breakout for Recommended Project

Year	DR EE Credit	NJ Clean Energy Rebates	Pay for Performance	CHP	Total
1	$5,234	$50,507	$12,000	$0	$67,741
2	$4,618	$0	$25,510	$0	$30,128
3	$3,848	$0	$25,510	$0	$29,358
4	$3,848	$0	$0	$0	$3,848
TOTAL	**$17,548**	**$50,507**	**$63,021**	**$0**	**$131,076**

Business Case for Recommended Project

FORM VI - ENERGY SAVINGS PLAN

ESCO's PRELIMINARY ENERGY SAVINGS PLAN (ESP):
ESCO's PRELIMINARY ANNUAL CASH FLOW ANALYSIS FORM
West Milford Township School District
ENERGY SAVINGS IMPROVEMENT PROGRAM

ESCO Name: ENERGY SYSTEMS GROUP **Project Scenario 1** Solar PPA (Exludes roof restoration)

Note: Respondents must use the following assumptions in all financial calculations:

(a) The cost of all types of energy should be assumed to inflate at 2.4% gas, 2.2% electric per year; and

1. Term of Agreement: 19 years
2. Construction period² (months): 12
3. Cash Flow Analysis Format:

Total ESG Project Cost [1] $ 7,256,015
Capital Contribution $ 125,000
Total Financed Amount[4] $ 7,181,015

Interest Rate to be used for Proposal Purposes: 2.70%

	Annual Energy Savings	Annual Operational Savings	Energy Rebates/ Incentives	Solar PPA	Total Annual Savings	Annual Project Costs	Board Costs	Annual Service Costs	Net Cash-Flow to client	Cumulative Cash Flow
Installation[3]	$ 169,575	$ -	$ -	$ -	$ 169,575	$ -	$ -	$ -	$ 169,575	$ 169,575
1	$ 451,200	$ 112,408	$ 67,741	$ 121,191	$ 752,540	$ 724,365	$ 750,290	$ 25,925	$ 2,250	$ 171,825
2	$ 288,026	$ 112,408	$ 30,128	$ 123,857	$ 554,419	$ 552,169	$ 552,169	$ -	$ 2,250	$ 174,075
3	$ 294,573	$ 39,908	$ 29,358	$ 126,582	$ 490,421	$ 488,171	$ 488,171	$ -	$ 2,250	$ 176,325
4	$ 301,268	$ 39,908	$ 3,848	$ 129,366	$ 474,391	$ 472,141	$ 472,141	$ -	$ 2,250	$ 178,575
5	$ 308,116	$ 39,908	$ -	$ 132,212	$ 480,237	$ 477,987	$ 477,987	$ -	$ 2,250	$ 180,825
6	$ 315,120	$ -	$ -	$ 135,121	$ 450,241	$ 447,991	$ 447,991	$ -	$ 2,250	$ 183,075
7	$ 322,284	$ -	$ -	$ 138,094	$ 460,378	$ 458,128	$ 458,128	$ -	$ 2,250	$ 185,325
8	$ 329,610	$ -	$ -	$ 141,132	$ 470,742	$ 468,492	$ 468,492	$ -	$ 2,250	$ 187,575
9	$ 337,104	$ -	$ -	$ 144,237	$ 481,341	$ 479,091	$ 479,091	$ -	$ 2,250	$ 189,825
10	$ 344,768	$ -	$ -	$ 147,410	$ 492,178	$ 489,928	$ 489,928	$ -	$ 2,250	$ 192,075
11	$ 352,607	$ -	$ -	$ 150,653	$ 503,260	$ 501,010	$ 501,010	$ -	$ 2,250	$ 194,325
12	$ 360,624	$ -	$ -	$ 153,967	$ 514,591	$ 512,341	$ 512,341	$ -	$ 2,250	$ 196,575
13	$ 368,824	$ -	$ -	$ 157,355	$ 526,178	$ 523,928	$ 523,928	$ -	$ 2,250	$ 198,825
14	$ 377,210	$ -	$ -	$ 160,816	$ 538,027	$ 535,777	$ 535,777	$ -	$ 2,250	$ 201,075
15	$ 385,788	$ -	$ -	$ 164,354	$ 550,142	$ 547,892	$ 547,892	$ -	$ 2,250	$ 203,325
16	$ 394,561	$ -	$ -	$ -	$ 394,561	$ 392,311	$ 392,311	$ -	$ 2,250	$ 205,575
17	$ 403,534	$ -	$ -	$ -	$ 403,534	$ 401,284	$ 401,284	$ -	$ 2,250	$ 207,825
18	$ 412,712	$ -	$ -	$ -	$ 412,712	$ 410,462	$ 410,462	$ -	$ 2,250	$ 210,075
19	$ 422,098	$ -	$ -	$ -	$ 422,098	$ 414,689	$ 414,689	$ -	$ 7,409	$ 217,484
20	$ -	$ -	$ -	$ -		$ -	$ -	$ -	$ -	$ -
Totals	**$ 6,770,027**	**$ 344,540**	**$ 131,076**	**$ 2,126,347**	**$ 9,371,990**	**$ 9,298,156**	**$ 9,324,081**	**$ 25,925**	**$ 47,909**	**$ 217,484**

NOTES:

1 **Includes: Hard costs and project service fees defined in ESCO's PROPOSED 'FORM V"**
2 **No payments are made by the Board during the construction period.**
3 **Installation period savings for Energy Savings and Operational Savings are guaranteed. These savings will be used in addition to the first loan payment.**
4 **Total Financed Cost includes all Fees and project costs.**
5 **Interest rate is indicative rate only. Final rate will vary with market conditions at time of closing.**
6 **ESG is an energy services and engineering company, not a financial advisor.**
7 **ESG is not a financial advisor and the presented cash flow proforma is for information only**
8 **The cash flow shown is for illustration purposes, and is not intended as financial advice.**
9 **Loan repayment includes interest accumulation in the construction period**
10 **Loan repayment assumes that the 1st repayment starts immediately after construction**
11 **The annual energy 2.27% and labor .% escalation are in accordance with the RFP**
12 **The utility incentive amount shown is typical expected and is not indicative of the actual amount as project timing, changes to utility program and availability of funds affect the outcome**

Greenhouse Gas Reductions

The project's reduced emissions would be equivalent to:

The project's reduced emissions would be equivalent to:

CO_2 sequestered by	34,233	tree seedlings grown for 10 years in an urban scenario
CO_2 sequestered by	285	acres of pine or fir forests
CO_2 emissions from	255	passenger vehicles
CO_2 emissions from	3,105	barrels of oil consumed
CO_2 emissions from the *energy* use of	114	homes for one year
CO_2 emissions from burning	7	coal railcars

Source:
All carbon equivalencies extracted directly from the EPA website.
"Greenhouse Gas Equivalencies Calculator." Clean Energy. U.S. Environmental Protection Agency. <www.epa.gov/cleanenergy/energy-resources/refs.html> (Jan. 24,2011).

AVOIDED EMISSIONS	Total Electric Savings	Total Natural Gas Savings	Total Annual Avoided Emissions
Annual Unit Savings	**1,326,283 kWh**	**95,652 Therms**	
NO_X	1472 lbs	880 lbs	2,352 lbs
SO_2	1300 lbs	0 lbs	1300lbs
CO_2	1,822,314 lbs	1,119,123 lbs	2,941,436 lbs

Factors Used in Calculations:

CO_2 Electric Emissions:	1,374 lbs. per MWh saved
CO_2 Gas Emissions:	11.7 lbs. per therm saved
NO_X Electric Emissions:	1.11 lbs. per MWh saved
NO_X Gas Emissions:	0.0092 lbs. per therm saved
SO_2 Electric Emissions:	0.98 lbs. per MWh saved

SECTION 4. ENERGY CONSERVATION MEASURES

Comprehensive LED Lighting Upgrades

ECM Summary

West Milford High School Light Fixtures

Lighting Retrofit and Replacement: Most of the lighting fixtures throughout West Milford Public Schools utilize older technologies that can be upgraded. Improvements to lighting will reduce electrical consumption and improve lighting levels. The costs of material to maintain the current systems will also be reduced since these renovations replace items (i.e., lamps and ballasts) that are near the end of their life cycle and/or considered environmentally hazardous.

Where appropriate, lighting levels will be adjusted to meet Illumination Engineering Society (IES) standards.

Lighting Levels: Our proposed lighting system improvements will maximize savings while maintaining or improving existing light levels in each area. All installations will comply with IES standards. Post-retrofit light levels are typically increased because of the improved design and installation of newer equipment, but areas that are currently over lit will be adjusted to maintain IES recommended light level. Before and after sample light level reading will be performed to confirm expected results.

Exterior Lighting: In an effort to reduce electricity consumption and provide better security for West Milford Public Schools buildings, ESG is proposing to retrofit the existing outside lighting on the buildings with newer, LED technology with photo cells for automatic control. In addition, every effort will be made to standardize the installed components for equipment uniformity and maintenance simplicity. Typical LED lighting system exhibit the following characteristics:

- Extremely Long Life – up to 50,000+ hours
- Highly efficient with very low wattage consumption
- Solid state lighting technology ensures that the fixtures are highly durable

Lighting Controls: Lighting controls are effective in areas where lighting is left on unnecessarily, mainly because it is a common area or due to the inconvenience to manually switch lights off when a room is left or on when a room is first occupied. This is common in rooms that are occupied for only short periods and only a few times per day. Lighting controls come in many forms. Sometimes an additional switch is adequate to provide reduced lighting levels when full light output is not needed.

Occupancy sensors detect motion and will switch the lights on when the room is occupied. Occupancy sensors can either be mounted in place of a current wall switch, or on the ceiling to cover large areas. Lighting controls will be installed in various offices, break rooms, restrooms, and other locations where appropriate. In the next phase, ESG will perform detailed sample measurements to determine coincident lighting room occupancy and overall lighting level information to accurately determine and identify spaces suitable for lighting controls throughout each facility.

Facilities Recommended for this Measure

- West Milford High School (includes stage lighting)
- Macopion Middle School
- Upper Greenwood Lake Elementary School
- Westbrook Elementary School

Scope of Work

- Verify availability of ambient light through detailed light level readings in the spaces
- Safely disconnect the existing lighting fixture from live circuit
- Remove existing Fluorescent Lamps
- Where necessary remove existing receptacles in the fixtures
- Install the retrofit kit and install 10.5 watt LED line voltage tubes
- Reconnect all the wiring
- Test for operation
- Clean-up work area
- Properly dispose of removed material
- Provide training to staff on operation of new lighting system
- Refer to Line by Line inventory included in Appendix #6.

Savings Methodology

In general, savings calculations for lighting retrofits are calculated using the following methodology:

Savings Calculation Method		
Baseline Energy Usage (kWh / yr)	=	Existing Fixture Watts x Operating Hours / yr x 1 kW / 1000 Watts
Estimated Energy Usage (kWh / yr)	=	Proposed Fixture Watts x Op. Hours/yr x 1 kW / 1000 Watts
Energy Savings (kWh / yr)	=	Baseline Energy Usage – Estimated Energy Usage
Baseline Demand (kW)	=	Existing Fixture Watts / 1000 Watts
Retrofit Demand (kW)	=	Proposed Fixture Watts / 1000 Watts
Energy Savings (kW)	=	(Existing Fixture Watts – Proposed Fixture Watts) x 1 kW / 1000 Watts

Sample Calculation for 1st Floor Main Area (Administration Building)

Current Hours = 2000

Current Total Watts = 3491.84

Current kWh = Hours * Watts / 1000 = 6983.68 kWh

Proposed Hours = 2000

Proposed Total Watts = 1116

Proposed kWh = Hours * Watts / 1000 = 2232 kWh

kWh Savings = Current kWh – Proposed kWh = 6983.68 kWh – 2232 kWh = 4751.68 kWh

kW Savings = (Current Watts – Proposed Watts)/1000 = (3491.84 W – 1116 W)/1000 = 2.38 kW

Maintenance

Lighting will need to be routine maintenance to ensure that devices/fixtures a clean and in working condition.

Benefits

- Electrical energy savings
- Improved exterior light quality
- Reduction in maintenance of exterior lighting system
- Improved safety around school perimeter
- Reduced lamp replacement for 5 to 10 years for LEDs

Install Kitchen Hood Controls

ECM Summary

In this measure we examined optimizing kitchen hood operation through TEL Kitchen Control System (or equal) control system. The proposed system is designed for commercial kitchen ventilation systems and can save fan energy by improving the efficiency of the hoods.

This measure includes converting the existing Constant Air Volume (CAV) kitchen hood systems to a Demand Control Ventilation (DCV), Variable Air Volume (VAV) system. This will be accomplished through the installation of TEL microprocessor based kitchen control system on the exhaust fan that serves the exhaust hoods in the kitchen. The TEL controls system utilizes temperature and IR sensors automatically regulate exhaust fan speed (via new VFD) based on cooking load, smoke dispersion, time of day and hood temperature.

Facilities Considered for this Measure

- West Milford High School
- Maple Road Elementary School
- Marshall Hill Elementary School

Scope of Work

Maple Road Elementary School

- Provide and install the following:
  - (1) Single hood controller, 1 duct temp sensor, 1 room temp sensors, 1 IR kits, 1 controllers, 1- 7 day time clocks, 1 pre-wired terminal rails, relays, power supplies, 1 - 6A circuit breaker, 1 - door mounted display / configuration units, 1 – door mounted live indicators, 1 - door interlocked isolator, ABS enclosure and UL listed.
  - (1) 1 hp VFD – for Exhaust Fan – ABB - ACS 310 with smart key pad and NEMA 1
- Provide project engineering, project management, start-up, commissioning and O&Ms

Marshall Hill Elementary School

- Provide and install the following:
  - (1) Single hood controller, 1 duct temp sensor, 1 room temp sensors, 1 IR kits, 1 controllers, 1- 7 day time clocks, 1 pre-wired terminal rails, relays, power supplies, 1 - 6A circuit breaker, 1 - door mounted display / configuration units, 1 – door mounted live indicators, 1 - door interlocked isolator, ABS enclosure and UL listed.
  - (1) 1 hp VFD – for Exhaust Fan – ABB - ACS 310 with smart key pad and NEMA 1 enclosure
- Provide project engineering, project management, start-up, commissioning and O&Ms

West Milford High School

- Provide and install the following:
  - (1) Single hood controller, 1 duct temp sensor, 1 room temp sensors, 1 IR kits, 1 controllers, 1- 7 day time clocks, 1 pre-wired terminal rails, relays, power supplies, 1 - 6A circuit breaker, 1 - door mounted display / configuration units, 1 – door mounted live indicators, 1 - door interlocked isolator, ABS enclosure and UL listed.

  - (2) 2 hp VFD – for Exhaust Fan – ABB - ACS 310 with smart key pad and NEMA 1 enclosure
- Provide project engineering, project management, start-up, commissioning and O&Ms

Clarifications:

- All wire below ceiling will be housed in conduit.
- All low voltage wire above ceiling will be plenum rated and not housed in conduit.
- Assumes all motor starters are within 50' of kitchen and VFD's can be mounted indoors.
- Assumes existing motors are inverter duty rated
- Payment and Performance Bond are not included
- Hazardous Materials abatement not included
- Sales Tax not included
- Stamped Drawings not included

Savings Methodology

Energy Savings for a Kitchen Hood Demand Controlled Ventilation (KDCV) System are estimated with an hourly simulation of the air handling systems serving the space. Local weather is simulated by using hourly data from the Typical Meteorological Year (TMY3) weather file from the closest, or most representative location. Operation of the air conditioning process is then simulated, step by step through the system, until the air is exhausted from the space.

The calculation models each "system" independently, and models the Pre- and Post- scenarios separately. The exact makeup of a system can vary, but it's typically effective to consider a system to be all the equipment associated with either a single supply fan, or a single exhaust fan, or a single space.

In general the savings calculations are as follows:

Annual Energy Saved

$$=1.08 \times \Sigma\ [\{(CFM_{existing} \times (Ti - To)_{existing} / (HV \times \eta_H)_{exostomg}) - (CFM_{proposed} \times (Ti - To)_{propose} / (HV \times \eta_H)_{proposed})\} \times H]$$

Where, Ti – Indoor air temperature
To – Outdoor air temperature
H – Bin Hours at To
η_H – Heating system efficiency
HV – BTU to therm conversion factor

Maintenance

Periodically the equipment should be checked to ensure proper operation.

Benefits

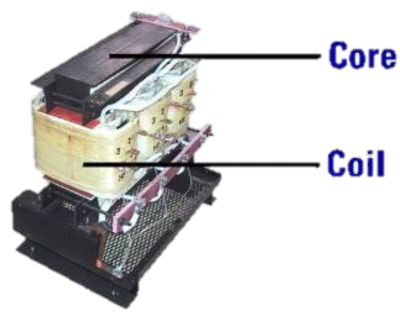
- Electrical, Natural Gas and Fuel Oil energy savings
- Quieter operation
- Reduced HVAC equipment maintenance
- Decreased grease entrapment

Transformer Upgrades

ECM Summary

The primary goal of this ECM is increased energy savings through replacement of old, inefficient transformers with new, ultra-high efficient transformers. While facilities can be unique, electrical infrastructure is almost always based on U.S. industry standard transformers. Transformers are typically purchased as part of a total electrical distribution package, installed, and forgotten for 40-50 years. The majority of these transformers are operating at a small fraction of their nameplate capacity, resulting in very low efficiency, and are producing large amounts of excess heat, resulting in energy losses and higher utility costs. In addition, half of all existing transformers, according to the Dept. of Energy, are approaching a mean time to failure of 32 years. Replacing these units prior to a sudden end of life, results in lower risk of facility down time.

For a transformer retrofit to deliver real energy savings, the losses of the new transformer must be measurably lower than those of the existing transformer. This may sound obvious, but losses of existing transformers are not widely understood in relation to actual load conditions and load profiles. Given a real world setting, estimating or “stipulating” savings using factory or industry test data/standards for either the existing or typical replacement unit would be significantly flawed.



Transformers are comprised of two major components: a steel core, and windings made of aluminum or copper.

Because transformers are in operation 24-hours/day, 365-days/year, they produce energy losses around the clock. Core losses, also known as no-load-losses, are constant. The core remains energized at all times, regardless of the % load (so losses are always the same). Coil losses, also known as load losses, vary with the load placed upon them, i.e. as load increases, as do the losses.

Code and all published data are based on performance at a 35% linear load. Therefore, almost all transformers are designed for highest efficiency under that load profile. However, this profile does not typically exist in the real world. Linear loads essentially ceased to exist with the advent of computers and VFD’s, and the average load on a transformer in 2016, across almost all verticals, is only about 13%. To reach this extreme percentile, the vast majority must be loaded at lower than 10%! Under this lower load profile, virtually all the losses are found in the core. Through the use of design and manufacturing advances, but more importantly, better materials (i.e. higher grade insulation, copper, aluminum and, most critically, steal in the core), energy efficient transformers lower resistance, producing extremely low no-load-losses and minimized load-losses.

Facilities Recommended for this Measure

- West Milford High School
- Westbrook Elementary School

Scope of Work

The old, inefficient transformers will be removed and replaced with new high-efficient transformers. To the maximum extent practicable, the existing conductors and conduit will be reused. Below is the list of schools and transformer sizes, which are in the scope.

West Milford High School

Location ID	Transformer Size (kVA)	Qty
Auditorium Storage	225	1
Auditorium Storage	75	1
Auditorium Band Storage	30	1
Custodian Closet English Wing	150	1
Custodian Closet English Wing	15	1
Custodian Closet Business Wing	112.5	1
Custodian Closet Business Wing	150	1
MDP across from Gym	30	1
Graphic Arts	75	1
Graphic Arts	75	1
Autoshop	75	1
Boiler Rm	30	1
Boiler Rm	15	1
Kitchen	225	1
Girls Locker	15	1
Photography	30	1
Photography	75	1
Total		**17**

Westbrook Elementary School

Location ID	Transformer Size (kVA)	Qty
Storage by Rm 13	75	1
Storage by Rm 13	15	1
Storage by Rm 13	15	1
MDP	30	1
Storage by Stage	30	1
Kitchen	30	1
Total		**6**

Savings Methodology

Savings are calculated using the following methodology for all the transformers:

Savings Calculation Methodology		
Baseline Annual losses from Transformers (kWh/yr)	=	(Baseline Transformer kW Losses (Normal Operation) x Equipment Operating hrs/ day x Equipment Operating days/yr) + Baseline Transformer kW Losses (Outside Op. hrs) x (24 x 365 - Equipment Operating hrs/ day x Equipment Operating days/yr)
Powersmith Annual losses from Transformers (kWh/yr)	=	(Powersmiths Transformer kW Losses (Normal Operation) x Equipment Operating hrs/ day x Equipment Operating days/yr) + Powersmiths Transformer kW Losses (Outside Op. hrs) x (24 x 365 - Equipment Operating hrs/ day x Equipment Operating days/yr)
Electrical Savings (kWh/yr)	=	Baseline Annual losses from Transformers – Powersmith Annual losses from Transformers

Maintenance

Periodically the equipment should be checked to ensure proper operation.

Benefits

Electrical energy savings

Addition of Cooling – RTU for Middle School Auditorium

ECM Summary

The Middle School Auditorium is currently served by a Heating and Ventilating (H&V) Unit and has no cooling. There are frequent events held in the Auditorium and the District requested cooling be added to accommodated additional events during the summer.

ESG evaluated utilizing the existing H&V unit and installing a direct-expansion (DX) cooling coil, a high-efficiency condensing unit (CU) and using the existing hot water coil and piping which currently serves the H&V unit. A new supply fan and motor will also be installed to address the increased pressure drop from the addition of the DX cooling coil.

Facilities Recommended for this Measure

- Macopin Middle School - Auditorium

Scope of Work

The scope of work is as follows:

- Furnish and install the following:
  - New DX cooling coil in the existing H&V unit
  - High-efficiency 25-ton Condensing Unit
  - New supply fan and motor
  - Electrical power and control wiring to new unit(s)
  - Coordinate with new DDC controls
- Provide new unit start-up and commissioning
- Control strategies will be put in place to utilize the exiting unit ventilators for ventilation during summer operation

Savings Methodology

In general, savings calculations for addition of cooling are calculated using the following methodology; however, there are not anticipated savings from this measure as cooling is being added to a space which is not currently cooled.

Savings Calculation Method		
Cooling Savings (kWh)	=	RTU-Size (Tons) x Cooling gradient (%) x (Existing RTU kW/Ton – New RTU kW/Ton) x Bin Hours

Maintenance

Periodically the equipment should be checked to ensure proper operation.

Benefits

- Adding Cooling to Space

Install Variable Frequency Drive (VDF) on Cooling Tower Fan Motor

ECM Summary

We recommend installing VFDs to the High School's cooling tower fan motor. A control signal, integrated with the building management system, will cause the VFD to modulate fan speed to maintain the appropriate design parameters. Energy savings results from reducing fan speed (and power) when there is a reduced load required for the zone. The magnitude of energy savings is based on the estimated amount of time that fan motors operate at partial load.


High School Cooling Tower

The VFDs will include a bypass to allow the motor to operate at full speed in HAND in the event of VFD failure.

Facilities Recommended for this Measure

- West Milford High School

Scope of Work

- Remove existing fan motor starter, and safely disconnect electrical supply
- Where applicable, replace existing motors with new, inverter duty motors
- Properly dispose of all removed equipment and waste materials
- Furnish and install new VFDs. Each VFD to have the following features
    - Open protocol EMS interface card to connect to existing control system
    - Three Contactor Bypass
    - Fusible or Circuit Breaker Disconnect (NEMA rated based on installed location)
- Provide electrical power wiring from the main electrical panel to each new VFD.
- Reuse existing electrical wiring where possible
- Modify electrical power wiring distribution panel as needed
- Extend communication bus to/from each VFD to/from existing Building Management System
- Perform any required programming and graphics modifications
- Start-up and commissioning of VFDs

Savings Methodology

Savings Calculation Method		
Energy Savings (kWh)	=	HP * ESF
Demand Savings (kW)	=	**HP * DSF**

Maintenance

Periodically the equipment should be checked to ensure proper operation.

Benefits

- Electric savings

Refurbish Cooling Tower

ECM Summary

As cooling towers age, their efficiency decreases. Dirt, corrosion, and scale impair heat transfer causing components to work harder. Evaporative losses increase, causing the cooling tower to use more water. Heat transfer is subject to several methods of deterioration. Dirt increases the pressure drop causing the fan to operate at a higher rate. Corrosion and scale build-up reduces he heat transfer coefficient from the water to the air. This reduction causes the pump to push more water and the chiller to operate more inefficiently to maintain cooling. More water is lost from the system due to evaporative cooling losses.

This ECM will restore the equipment's efficiency. Rain, humidity, sunlight, and wind cause the exterior components to corrode. HVAC Armor CT Exterior protects against the natural environment. The interior of the cooling tower is subject to corrosion from the moist environment. HVAC Armor CT Interior restores the heat transfer capabilities by coating the components inside the cooling tower. In conjunction with the coating application, water treatment reduces scale, corrosion, and bacteria build-up. Scale causes an increase in energy, maintenance, and cleaning costs. Corrosion shortens equipment life and increases capital expenses. Bacteria is more insulating than scale and leads to health and safety risks.

Facilities Recommended for this Measure

West Milford High School

Scope of Work

- Clean the exterior and interior of the cooling tower.
- Sandblast interior.
- Repair holes in cooling tower.
- Minor repairs, replace pans (as required), and fix damaged sheet metal.
- Remove and replace fill and drift eliminators.
- Inspect distribution systems.
- Coat the interior and exterior of the tower

Savings Methodology

Refer to Appendix for savings calculations and methodology.

Maintenance

Periodically the equipment should be checked to ensure proper operation.

Benefits

- Improvement in efficiency, and saving energy consumption at the unit.
- Physical protection of coil.
- Extends life of HVAC equipment

Refurbish Condensing Units and Install HVAC Armor

ECM Summary

Condensing unit coils and their performance are key to the efficiency of a unit's energy performance. Coils that have deterioration, scaling, decomposition, or damage due to fin collapse consume more energy than original design.

HVAC Armor is a product and a service. The product is a restorative coating that is impregnated with 65% aluminum in a base of industrial grade polyurethane. This combination provides an impenetrable layer of protection that provides a heat transfer medium thus the energy savings. The service is our stringent application requirements, that clean and strip the coil of dirt, scale and debris prior to our application.

Facilities Recommended for this Measure

- West Milford High School (five units, assumed to be >10 years old)
- Paradise Knoll Elementary School (three units, assumed to be >10 years old)
- Westbrook Elementary School (two units, >15 years old)

Scope of Work

- General cleanup of overall unit and wash-down of coils. Deep clean condenser coils to remove final materials in coils, and corrosion.
- Disassemble equipment to perform deep clean of condenser coils, removing final materials in coils and corrosion.
- Straighten aluminum fins.
- Spray each condenser coil with HVAC Armor from both outside-in and inside-out, applying even coverage.
- Assemble and ensure equipment is operating.

  Anticipated installation time can range from 3 hrs. to 2 days per unit depending on size. Machines will need to be powered down and locked out for the duration of the installation.

Savings Methodology

Refer to Appendix for savings calculations and methodology.

Maintenance

Periodically the equipment should be checked to ensure proper operation.

Benefits

- Improvement in efficiency, and saving energy consumption at the unit.
- Physical protection of coil.
- Extends life of HVAC equipment

Replace Boilers with High Efficiency Boilers

ECM Summary

Macopin Middle School

The building's heating is provided by (5) PK Buderus gas fired, non-modulating, non-condensing hot water boilers. Each boiler has a capacity of approximately 1,615 MBH and a nominal thermal efficiency of 83%. This ECM evaluates the savings associated with replacing the existing gas fired boilers with modulating, condensing hot water boilers. The proposed boilers will operate at an average seasonal efficiency of 92%.

Location	No.	Manufacturer	Model	Capacity MBH	Utility
Boiler Room	5	AERCO	BMK-2000	2000 Each	Nat-Gas

Marshall Hill Elementary School

The building is heated by a hot water system which includes three (3) gas-fired, 1,740 MBH non-condensing hot water boilers. The boilers are fully modulating, are in fair condition and installed about 17 years ago, and are well maintained. The boilers have a nominal combustion efficiency of 79%. This ECM evaluates the savings associated with replacing the existing gas fired boilers with modulating, condensing hot water boilers. The proposed boilers will operate at an average seasonal efficiency of 92%.

Location	No.	Manufacturer	Model	Capacity MBH	Utility
Boiler Room	3	AERCO	BMK-2000	2000 Each	Nat-Gas

Facilities Recommended for this Measure

- Macopin Middle School
- Marshall Hill Elementary School

Scope of Work

Demolition and Removal Work

- Demolish and Remove existing boiler(s) and two, secondary hot water distribution pumps and motors (Middle School only). Cut and cap existing piping for future connection during proposed work.
- Disconnect, remove and properly dispose of hot water supply and return piping for boilers to nearest isolation valves or as required for new installation.
- Disconnect, remove and properly dispose of gas flue for boilers as required.
- Disconnect all electric, controls, gas piping, water lines, pressure reliefs and drains.

New Installation Work

- Furnish and Install (F&I) new Aerco BMK-2000 high-efficiency gas boiler with integral burner set on concrete pad.
- F&I two new hot water distribution pumps and motors at Middle School.

Details of installation to include the following:

- F&I Qty. (5/3) new AERCO BMK-2000 condensing hot water boilers.
- F&I new hot water supply and return piping from new boilers to existing piping capped during proposed work.
- F&I new boiler drains, pressure reliefs piped to floor drains, water supply, blow down drains piped over to existing floor drains.
- F&I new 2" fiberglass insulation on all new and existing hot water piping 'that has no insulation', drain lines, piping in boiler room.
- F&I new AL29-4C single wall stainless steel flue pipe to connect from each new boiler to existing main flue in boiler room.
- F&I proper pipe suspensions for all piping.
- F&I pipe identification and tags for all pipe, valves, etc.
- Reconnect existing line voltage electrical circuits to new boilers.
- Provide factory startup; assist during start up and testing of new boilers.
- Final Boiler sizing will be based on an updated heat loss and gain calculation.

Savings Methodology

In general, savings calculations for boiler replacement are calculated using the following methodology:

Boiler Replacement

$E_E \quad = \sum_{i=1}^{8760} (Q_i \div \eta_E)$

$E_P \quad = \sum_{i=1}^{8760} (Q_i \div \eta_P)$

$E_S \quad = E_E - E_P$

$C_S \quad = E_S \text{ x FUR}$

Where,

E_E = Annual energy (fuel) use of existing system

E_P = Annual energy use of proposed system

E_S = Annual energy savings

C_S = Annual cost savings

Q_i = Hourly heating demand, modeled as a linear fit of OA DBT (dry-bulb temperature), with a cut-off temperature above which there is no heating

η = Combustion efficiency of heating system based on field data, manufacturer's rating or snap-

Maintenance

Follow manufacturers' recommendations for preventative maintenance.

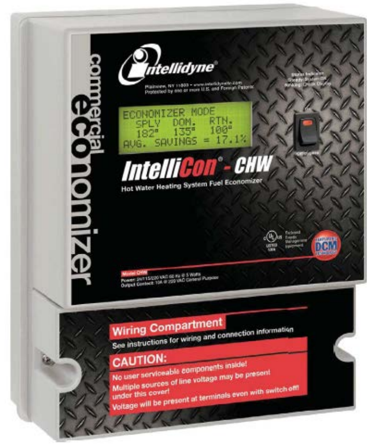
Benefits

- Natural Gas savings
- Operational savings through new equipment and preventative maintenance plan

Fuel-Use Economizers (Boilers)

ECM Summary

A heating system must be able to provide acceptable comfort at the lowest anticipated outdoor temperature. Most residential boilers have a heat capacity 1.5 to 2 times larger than needed to maintain space temperature on extreme days. Due to this oversizing of the boiler, the burner will cycle on and off to prevent overheating of the system water during any call for heat.



Intellidyne Heating System Economizers increase system efficiency. Thus, the heating system uses less fuel to generate the same amount of heat. This is done by dynamically changing the aquastat's effective dead-band based on the measured heating load. This causes the average water temperature to be varied (depending on the measured load) and is accomplished by extending the burner's off-time. Extending the off-time also results in longer, more efficient burns and a reduction in burner cycling. Just as computer control has increased the gas mileage of automobiles, Intellidyne Heating System Economizers improve the fuel utilization of heating systems by supplementing the antiquated on/off control action of the aquastat with the analysis and control capabilities of a computer.

Intellidyne Heating System Economizers reduce fuel consumption 10% to 20% and decrease burner cycling by 30% or more.

Facilities Recommended for this Measure

- Apshawa Elementary School
- Maple Road Elementary School
- Upper Greenwood Lake Elementary School
- West Milford High School

Scope of Work

- Furnish and install one (1) Hot Water Fuel Use Economizer for each boiler at the facilities listed above
- Provide start up and warranty.
- Provide training for maintenance personnel.

Savings Methodology

Energy savings will result from reducing the compressor cycling. In general, ESG uses the following approach to determine savings for this specific measure:

Savings Calculation Method		
Total Existing Boiler Natural Gas Usage (Therms)	=	Therms
Savings (% of Total)	=	13%*
Factor of Safety	=	50%
Total Natural Gas Savings (Therms)	=	(Existing Usage)*(Savings %)*(Factor of Safety)

- The savings estimate (%) matches the value stipulated by the New Jersey Board of Public Utilities New Jersey Clean Energy Program Protocols to Measure Resource Savings. ESG has also applied a 30% factor of safety to lower the estimated savings.

Maintenance

Periodically the equipment should be checked to ensure proper operation.

Benefits

- Natural Gas energy savings

Retro-commissioning Study & HVAC Improvements

ECM Summary

Due to the complexity of today's HVAC systems and controls, it is likely for systems to be operating incorrectly or not as efficiently as they could be. Retro-commissioning studies reveal hidden deficiencies and highlights operational & maintenance (O&M) issues that could have been avoided as well as exposes hidden control system problems. There are valuable benefits to retro-commissioning in existing buildings. It is a detailed and specialized process that reviews how an HVAC system is controlled and designed to operate. Applying retro-commissioning to existing facilities includes planning, discovering root causes of inefficiencies, development of a cost-effective project delivery and a focus on optimizing value to the building owner. The study includes functional system testing under various modes, such as heating or cooling loads, occupied and unoccupied modes, varying outside air temperature and space temperatures.

This is a systematic process to ensure that the building energy systems perform interactively according to the original design intent and the current operational needs of the facility. Retro-commissioning is a common practice recommended by the American Society of Heating Refrigeration and Energy (ASHRAE) to be revisited every couple of years. We recommend that an engineering firm who specializes in energy control systems and retro-commissioning be contacted for a detailed evaluation and implementation costs. Facility operations personnel would work with the engineers to develop goals and objectives. During on-site testing, the qualified personnel conducting the study would immediately make any no/low cost improvements as identified. Furthermore, any suggested corrective actions which require the purchase of material, a contractor who specializes in that scope of work would be contacted to implement the remaining improvements.

Facilities Recommended for this Measure

- Administration Building
- Apshawa Elementary School
- Macopin Middle School
- Maple Road Elementary School
- Marshall Hill Elementary School
- Paradise Knoll School
- Upper Greenwood Lake Elementary School
- Westbrook Elementary School
- West Milford High School
- Bus Garage

Scope of Work

<u>Task 1: Site Visit to define RCx plan</u>
This Task will include a kick-off meeting on site with all parties to review project scope, deliverables, schedule, required information and safety/ security procedures.
Following the Kick-off meeting each school bill be visised (based on a mutually agreed upon schedule) and become familiar with the operations and maintenance of the existing HVAC equipment and controls. This will be accomplished by observing controls operation, staff interviews and review of any original design documentation available.

Upon completion of the site investigations, a Retro-Commissioning plan will be written outlining the recommended changes needed to correct noted deficiencies and to bring existing equipment and controls to the original design operating sequences. This task would include providing a budget estimate for the recommended repairs and estimated energy savings.

Deliverables
• Kick-Off Meeting Minutes.
• Retro-Commissioning Plan- Existing Equipment – PDF Format.

Task 2: Retro-Commissioning of Existing Equipment
This will include the actual retro-commissioning activities of the deficiencies identified in Task 1. General activities will include point-to-point controls verification and calibration adjustments, adjustments to current sequences and schedules to optimize equipment performance, and identification of broken valves, belts, damper actuators, damper linkages, clogged coils and filters. This task may require Testing and Balancing of air and water flows, which would be additional services.

Deliverables
• Retro-Commissioning Deficiencies Log (Interactive- Excel based).
• Cost Estimate.

Task 3: Prepare Commissioning Plan for New Equipment
This task would include developing a Commissioning Plan for the proposed equipment and controls. Specifically, the plan would include the Owner's Project Requirements (OPR), identify all responsible parties and their roles in the commissioning process, pre-functional checklists and functional checklists. This plan would also identify maintenance and operations procedures and required staff training. The Commissioning plan is based upon the Engineered Design documents, OPR and approved submittals, including the Temperature Controls Sequence of Operations. The plan is to be part of the contact documents that are to be used for bidding/ procuring. This Plan would include the following pieces of equipment:
• New Temperature Controls Systems.
• Combined Heat and Power Unit (CHP unit).
• Boilers (Replaced Only).
• Additional Cooling Equipment and accessories at:
    ➢ Middle School.

Deliverables
• Commissioning Plan – New Equipment- PDF Format.

Task 4: Commissioning of New Equipment
This task will include the actual Commissioning of the new equipment. General activities include review of approved submittals, documenting start-up procedures, witnessing the demonstration of the new equipment and controls and verifying that the equipment and controls function in accordance with the approved Engineered Designs. The installing contractor(s) shall be responsible for completing and submitting the pre-functional checklists and any manufacture's start-up checklists. All operational deficiencies will be compiled and distributed to the responsible parties using a living document (Excel based) until all deficiencies are either verified as corrected or resolved.

Deliverables
• Commissioning Deficiencies Log (Interactive- Excel based).

Task 5: Prepare Final Reports
This Task includes the preparation of final RCx and Cx reports. The reports table of contents typically includes:
• Executive Summary
• Project Summary
• RCx and Cx Plans
• Deficiency logs
• Operations and Maintenance requirements

• Training Requirements
• Recommendation for Improvements
• Appendices (Site Photos, correspondence, Cost Estimates and Energy Savings Calculations Completed Pre-Functional checklists, Competed Start-up Reports Completed Functional Checklists)

Deliverables
• Final Commissioning and Retro-Commissioning Report, PDF format.

Assumptions
1) RCx and Cx Tasks will not include:
- Lighting and lighting controls.
- Building Envelop.
- Kitchen Equipment.
- Water Consuming Equipment.
- Computer / plug load management.

2) RCx Task 2 scope of work and fee will be re-evaluated after Task 1 is complete.
3) Provide functional testing for 30% of each type of HVAC equipment for RCx tasks.
4) Provide functional testing for 100% of each type of HVAC equipment and controls for Cx tasks.
5) Building equipment access will be granted during scheduled RCx/Cx tasks and CHA employees will have escorts as needed.
6) Retro-commissioning will use original design criteria as a benchmark for final operation.
7) Building Energy Management Controls vendors and/or School Personnel knowledgeable in the operation and manipulation of the controls systems will be present during scheduled RCx/ Cx Tasks.
8) New HVAC equipment and controls will be fully operational and fully tested by the installing contractors prior to Cx (point to point verification by others).
9) Existing HVAC equipment to receive RCx testing will be operational to the fullest extent possible.

Savings Methodology

Savings Calculation Method		
Cooling Savings (kWh)	=	Stipulated Savings % * Total Annual Electrical Usage
Heating Savings (Therm)	=	Stipulated Savings % * Total Annual Natural Gas Usage

Maintenance

Periodically the equipment should be checked to ensure proper operation.

Benefits

- Electric and Natural Gas savings

Building Envelope Upgrades

ECM Summary

Infiltration drives energy costs higher by allowing unconditioned outside air to enter the building, thus adding to the building load and causing additional unnecessary heating and cooling loads. All West Milford School buildings were surveyed in order to identify potential improvements for outside air infiltration reduction. The main observations are listed below:

- Most entrance doors need weather stripping, sweeps or the closure or strike plate adjusted;
- Sealant is recommended around the perimeter of several windows;
- Numerous penetrations were observed that need to be sealed.

These deficiencies mostly reflect the skin of the buildings, which either have existed since original construction of the building, were added during some retrofit periods, or were caused by deterioration.

Facilities Recommended for this Measure

- Administration Building
- Apshawa Elementary School
- Macopin Middle School
- Maple Road Elementary School
- Marshall Hill Elementary School
- Paradise Knoll School
- Upper Greenwood Lake Elementary School
- Westbrook Elementary School
- West Milford High School
- Bus Garage

Scope of Work

A building envelope audit was performed for the entire district. The results of the audit were the identification of several areas of envelope deficiency. The deficient areas were tabulated and their savings potential calculated. Building Envelope Scope drawings are listed in the Appendix.

<u>Assumptions & Exclusions</u>

- Asbestos in the Work Area – it is assumed that no comprehensive asbestos remediation project is planned; as a result, it is assumed that all of the areas of asbestos insulation that were found during BER's on-site inspections will remain in place. Under these assumptions, work areas that are directly adjacent to likely asbestos-containing material cannot be included in the scope of work because installing the retrofit insulation would disrupt potentially hazardous material. Any work areas that are directly adjacent to likely asbestos-containing material or would potentially disrupt asbestos-containing material are excluded from the scope of work.
- Electrical Hazards – testing and/ or repair of hazardous electrical components (knob and tube wiring, open junction boxes, etc) that are encountered are excluded from the B|E Retrofit scope of work and pricing. Others are responsible for testing and/ or repair of electrical hazards.
- Hazardous Materials – testing, remediation and/ or removal of any potentially hazardous material that is encountered is excluded from the B|E Retrofit scope of work and pricing. Others are responsible for testing, remediation and/ or removal of potentially hazardous material.

Savings Methodology

The energy savings derived from this measure are a result of the heating and cooling systems (DX cooling and boilers) not having to work as hard to achieve the desired environmental conditions. The amount of savings is dependent on the existing building conditions and the amount of air leakage under the current operating conditions.

Energy savings are based on the ASHRAE crack method calculations. If the process reveals any variation in the as-built conditions, then savings will be adjusted accordingly. Determination of air current air leakage rates is based on many factors, including:

- Linear feet of cracks
- Square feet of openings
- Stack coefficient
- Shield class
- Average wind speed
- Heating or cooling set point
- Average seasonal ambient temperatures

Savings due to infiltration reduction:
The following equation is based on the ASHRAE crack method:

Heat loss per hour: $\dot{q}$ = 1.08 x Q x ΔT

Where Q represents the airflow in cubic feet per minute (CFM) and is calculated in the following manner:

$$Q = A_{crack} \times \sqrt{(C_s \Delta T + C_w V^2}$$

In this equation, A_{crack} represents the crack area in square inches to be reduced. The other values in the equation are standard for these buildings and are based on shelter class, height, and local wind speed.

Cw = wind coefficient = 0.0104 average

V = wind speed = 8.8 average mph

Cs = stack coefficient = 0.0299 (two-story typical)

ΔT = temperature difference = Tout – Tin

ΔT is calculated by subtracting the average outdoor air temperature per hour from the indoor temperature, using 24 data points per month to accurately account for weather variances, and subsequently calculating airflow and heat loss for each set of data. Therefore, 288 data points are used, and Δt is the number of hours each data point represents. The total heat loss is calculated as follows:

$$q = \sum_{x=1}^{288} 1.08 \times A_{crack} \times \sqrt{C_s\left(T_{out} - T_{in}\right) + C_w V^2} \times \left(T_{out} - T_{in}\right) \times \Delta t$$

Maintenance

After the building envelopes have been improved, operations and maintenance should be reduced, due to improved space conditions and lower humidity during the cooling season. The maintenance staff should maintain the newly installed equipment per manufacturers' recommendations. The manufacturer specification sheets will be provided for exact maintenance requirements.

Benefits

- Electrical energy savings
- Fuel energy savings
- Increased thermal comfort

Refrigeration Control Upgrades

ECM Summary

Many of the schools at West Milford Public Schools contain walk-in freezers, walk-in coolers, reach-in freezers and reach-in coolers. These units are controlled by a dry bulb temperature and as a result run continuously throughout the year. Installing an **eTemp** control retrofit was assessed. The refrigeration systems usually monitor circulating air temperature in order to decide when to switch on and off. The circulating air temperature tends to rise far more quickly than the food temperature, and as result, the refrigeration unit works harder than necessary to maintain stored products at the right temperature. This, in turn, leads to excessive electricity consumption and undue wear and tear on the equipment. With **eTemp**, the thermostat regulates the refrigeration temperature based upon product temperature rather than air temperature, thereby maintaining product at the proper temperature. Savings is a result of reduced frequency of the compressor cycles, which are now based on food temperature rather than volatile air temperature. The equipment present in the middle school are shown in the table below.

Facilities Recommended for this Measure

- West Milford High School: (1) Walk-in Cooler; (1) Walk-in Freezer; (2) Reach-in Coolers
- Macopin Middle School: (1) Walk-in Cooler; (1) Walk-in Freezer; (2) Reach-in Coolers
- Apshawa Elementary School: (4) Reach-in Coolers
- Maple Road Elementary School: (4) Reach-in Coolers
- Marshall Hill Elementary School: (1) Reach-in Cooler; (1) Reach-in Freezer
- Paradise Knoll Elementary School: (3) Reach-in Cooler; (2) Reach-in Freezers
- Upper Greenwood Lake Elementary School: (1) Reach-in Cooler; (2) Reach-in Freezers
- Westbrook Elementary School: (1) Walk-in Cooler; (1) Walk-in Freezer; (1) Reach-in Cooler

Scope of Work

- Furnish and install one (1) eTemp per type.
- Fit eTemp to the thermostat sensor that controls the compressor.
- Provide start up and warranty.
- Provide training for maintenance personnel.

Building	Type	Quantity
All Schools	Walk-In Freezer	3
	Walk-In Cooler	3
	Reach-in Cooler	18
	Reach-in Freezer	5

Savings Methodology

Savings are calculated using the following methodology:

Energy savings will result from reducing the compressor cycling. In general, ESG uses the following approach to determine savings for this specific measure:

Savings Calculation Method		
Pre - kW	=	Compressor (HP) x 0.746 x Pre Cycles/hr
Post - kW	=	Compressor (HP) x 0.746 x Post Cycles/hr
Summer Season Hrs (Hs)	=	Total Hrs/yr x 55%
Winter Season Hrs (Hw)	=	Total Hrs/yr x 45%
Compressor Summer Cycling (% On) (Cs)	=	55%
Compressor Winter Cycling (% On) (Cw)	=	45%
Compressor Summer Operating (Hrs)	=	Hs x Cs
Compressor Winter Operating (Hrs)	=	Hw x Cw
Savings (kW)	=	Pre – Post (KW)
Savings (kWh)	=	(Compressor Summer Operating (Hrs)+ Compressor Winter Operating (Hrs)) x (Pre – Post (KW))

Maintenance

Periodically the equipment should be checked to ensure proper operation.

Benefits

- Electrical energy savings

Plug Load Controls

ECM Summary

Office equipment is regularly left in the ‘on’ state at all times allowing the individual machine to revert to the ‘Sleep’ mode based on an internal timer. This measure will plug the office equipment into a networkable device that will allow for scheduling of the plugged in equipment.

Facilities Recommended for this Measure

- Administration Building
- Apshawa Elementary School
- Macopin Middle School
- Maple Road Elementary School
- Marshall Hill Elementary School
- Paradise Knoll School
- Upper Greenwood Lake Elementary School
- Westbrook Elementary School
- West Milford High School

Scope of Work

Energy Systems Group recommends utilizing specialty wall sockets from BERT that have software to track real-time electrical usage of your appliances. The software also allows you to use your web browser to view this usage and automatically turn on/off any and all appliances plugged into these outlets.

Administration Building

Device Type:	Baseline Hours ON:	# of Berts
Medium Printer	8760	2
Soda Vending	8760	1
H/C Water Dispenser	8760	1
AC - 110 (15A)	8760	1
TOTAL		**5**

Apshawa Elementary School

Device Type:	Baseline Hours ON:	# of Berts
Projector	8760	22
Charging Cart	8760	7
Large Printer/Copier (110 only)	8760	1
H/C Water Dispenser	8760	1
AC - 110 (15A)	8760	3
TOTAL		**34**

Macopin Middle School

Device Type:	Baseline Hours ON:	# of Berts
Projector	8760	30
Projector/Smartboard Combo	8760	2
Charging Cart	8760	9
Medium Printer	8760	4
TV/LCD/Smart TV	8760	2
Snack Vending	8760	1
Soda Vending	8760	2
H/C Water Dispenser	8760	3
AC - 110 (15A)	8760	27
AC - 110 (20A)	8760	2
TOTAL		**82**

Maple Road Elementary School

Device Type:	Baseline Hours ON:	# of Berts
Projector	8760	19
Projector/Smartboard Combo	8760	1
Charging Cart	8760	3
Medium Printer	8760	7
TV/LCD/Smart TV	8760	3
H/C Water Dispenser	8760	2
AC - 110 (15A)	8760	4
AC - 110 (20A)	8760	3
TOTAL		**42**

Marshall Hill Elementary School

Device Type:	Baseline Hours ON:	# of Berts
Projector	8760	23
Projector/Smartboard Combo	8760	2
Medium Printer	8760	5
Large Printer/Copier (110 only)	8760	1
Soda Vending	8760	2
H/C Water Dispenser	8760	2
AC - 110 (15A)	8760	3
AC - 110 (20A)	8760	4
TOTAL		**42**

Paradise Knoll School

Device Type:	Baseline Hours ON:	# of Berts
Projector	8760	18
Charging Cart	8760	2
Medium Printer	8760	4
Large Printer/Copier (110 only)	8760	1
H/C Water Dispenser	8760	2
AC - 110 (15A)	8760	3
TOTAL		**30**

Upper Greenwood Lake Elementary School

Device Type:	Baseline Hours ON:	# of Berts
Projector	8760	23
Medium Printer	8760	10
H/C Water Dispenser	8760	5
AC - 110 (15A)	8760	2
TOTAL		**40**

Westbrook Elementary School

Device Type:	Baseline Hours ON:	# of Berts
Projector	8760	16
Charging Cart	8760	2
TV/LCD/Smart TV	8760	1
TOTAL		**19**

West Milford High School

Device Type:	Baseline Hours ON:	# of Berts
Projector	8760	46
Charging Cart	8760	9
Medium Printer	8760	10
Large Printer/Copier (110 only)	8760	2
Snack Vending	8760	2
Soda Vending	8760	5
H/C Water Dispenser	8760	2
AC - 110 (15A)	8760	1
AC - 110 (20A)	8760	5
TOTAL		**82**

Savings Methodology

Savings are calculated using the following methodology for all devices plugged in:

Savings Calculation Methodology		
Baseline Energy Usage (kWh / yr)	=	Average kW x Baseline Weekly Hours x 4.348 wks/mo. x Months/yr
Proposed Energy Usage (kWh/ yr)	=	Average kW x Proposed Weekly Hours x 4.348 wks/mo. x Months/yr
Electrical Savings (kWh/ yr)	=	Baseline Energy Usage – Proposed Energy Usage

Maintenance

Periodically the equipment should be checked to ensure proper operation.

Benefits

- Electrical energy savings

Destratification Fans

ECM Summary

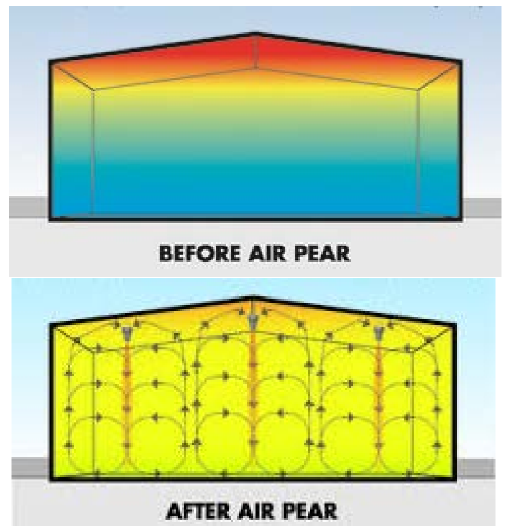
In this measure we examined installing destratification fans for equipment that serves large assembly areas such as gyms. In high ceiling areas, rising hot air produces layers of stratified air. Thermal Destratification is the process of mixing the internal air to eliminate stratified layers and achieve temperature equalization throughout the building envelope.

The design of the Air Pear will address the issue of temperature differences in high ceiling areas by efficiently moving hot air to the ground and homogenizing the air throughout the space.

When air has little opportunity to move, dramatic temperature differences occur. Hot air rises pushing cooler air near the floor. This temperature difference can be as much as one degree per foot of height. Items such as lighting and ventilation ducts can increase this effect. Since people and thermostats are located near the floor it is imperative to even out this temperature difference.

Air Pear fans get air moving. Their energy efficient motors operate quietly to eliminate hot and cold spots throughout a space. After installation, there is significant energy reduction. The result is a more comfortable space with reduced utility and maintenance costs.

Multiple fans can be connected to a single variable speed controller. Air Pears' optional wireless Fan Center Manager controller can operate up to 100 fans using an easy web based interface. Fans can be ordered in white, black, grey, or custom colored to match any area.



Typical airflow and heat distribution before and after installing a destratification fan system

Facilities Recommended for this Measure

- West Milford High School
- Macopin Middle School
- Apshawa Elementary School
- Maple Road Elementary School
- Upper Greenwood Lake Elementary School

Scope of Work

Location	Fan Type	Quantity
West Milford High School Gym	E-125SP	12
Upper Greenwood Lake Elementary School Gym	E-125SP	4
Macopin Middle School Gym	E-125SP	6
Maple Road Elementary School Gym	E-125SP	3
Apshawa Elementary Gym	E-125SP	3

Savings Methodology

Savings are calculated using the following methodology for all devices:

Savings Calculation Methodology		
Electric Energy Penalty (kWh)	=	(Fan Motor HP) x (hour/year) x 0.746 kW/HP
Heating Savings (Therms)	=	(Peak Heating Load Reduction in MMBTU) x (Hours) / System Efficiency

Maintenance

Periodically the equipment should be checked to ensure proper operation.

Benefits

- Natural gas savings

Cogeneration (CHP)

ECM Summary

Energy Systems Group proposes to install one (1) 10 kW cogeneration machine at West Milford High School to supply electricity and heat to the building, which will offset a portion of the boiler load. The recovered heat will be rejected into the boiler hot water heating system.

Location: There is ample space in the boiler room where the unit will be installed. The radiator, which will reject the excess heat, will be installed in roof or outside the boiler room. The radiator location must be verified and agreed upon with West Milford Township Public Schools.

Facilities Recommended for this Measure

- West Milford High School

Scope of Work

New YANMAR 10 kW system will be located next to existing boilers on concrete pad with module, etc.

<u>New Installation Work:</u>

Furnish & Install (1) Yanmar Model CP10WN (10kW) using natural gas. The high-efficiency generator provides 10kW of electrical power. The engine heat is captured and heats water at a rated temperature of 158°F for immediate use or storage in your facility. Excess electricity production may be sold back onto the grid in certain states, creating a credit on your electric bill.

- Natural gas fired CHP unit with heat rejection system located on outside wall of boiler room mounted in existing combustion air louver converted for radiator and fan. New CHP location will be in basement and set on new concrete housekeeping pad.
- F&I new gas piping to CHP unit from main gas meter bank.
- F&I new insulated hot water piping overhead from Yanmar CHP pump module to heating hot water system piping and heat rejection system.
- F&I new electrical power from Yanmar CHP unit to building electrical main switchgear.
- New exhaust vent piping to go through exterior wall and onto the roof

Savings Methodology

In general, savings calculations for lighting retrofits are calculated using the following methodology:

Savings Calculation Method	
Energy:	10 kW/module x 1 module(s) x 1 net after "parasitic losses"
	= 10 net kW output x $/kWh avg. displaced energy x run hours
Demand :	10 kW/module x 1 module(s) available x 1 net after "parasitic losses"
When Heat Used to Displace Boiler Gas Use:	$\frac{\left(\frac{Th}{hr\ module}\right)\ x}{boiler\ efficiency}\ x\ 1\ modules\ x\ \$/\text{Th boiler gas rate}$

Maintenance

Follow manufacturers' recommendations for preventative maintenance. In order to be eligible for New Jersey Clean Energy incentives, West Milford Public Schools must demonstrate that they have contracted for an extended maintenance agreement to service the cogeneration units. This maintenance agreement will be conducted outside of the Energy Savings Improvement Program, as required by law.

Benefits

- The installation of a cogeneration unit will result in significant economic benefits to the overall ESIP program. These benefits include:
    - Up to 20-year financing term.
    - Additional funding from FEMA grants and other local, state, and national incentives.

DHW Replacement

ECM Summary

The existing domestic water heater at Macopin Middle School nearing the end of its useful life. As existing DHW tanks age, they typically experience a loss in efficiency due to fouling and scaling on the internal heat exchange components, as well as an increase in maintenance costs. This measure will include replacing these units with new high-efficiency domestic water heating systems.

The existing domestic hot water heaters are standard efficiency models that operate at a nameplate value of around 80% thermal efficiency. This measure will include the installation of new hot water heaters to replace these aging, lower efficiency ones. New condensing water heaters are available that operate at efficiencies up to 98%.

Typical Domestic Water Heater

Facilities Recommended for this Measure

- Macopin Middle School

Scope of Work

Demolition and Removal Work

- Drain, disconnect hot water piping, gas piping, electrical and metal flue venting for removing and properly disposing of existing gas fired domestic hot water heater.

New Installation Work

- Furnish and Install (F&I) Qty. (1) AO Smith Model #BTH-120 gas fired domestic hot water heater.
- F&I new copper pipe, fittings, valves and insulation to reconnect existing hot water piping to new water heater.
- Reconnect existing into existing chimney.
- Reconnect existing gas piping to new water heater.
- Reconnect existing electric to new water heater.
- Provide factory-authorized start-up with written combustion report.
- All existing piping, supply pumps and check valve to remain.
- Set new heater on existing concrete housekeeping pad.

Savings Methodology

Savings Calculation Methodology		
Existing DHWH Efficiency	=	Existing Heat Production/ Existing Fuel Input
Proposed DHWH Efficiency	=	Proposed Heat Production/ Proposed Fuel Input
Energy Savings	=	Heating Production (Proposed Efficiency – Existing Efficiency)

Maintenance

Periodically the equipment should be checked to ensure proper operation.

Benefits

- Natural gas savings

Unit Ventilator Refurbishment

ECM Summary

We recommend refurbishing the existing unit ventilators with new fan decks, cleaning the existing units and coils and insatllation of updated valve and gear linkages. Based on discussions with facility personnel and the inspection of existing unit ventilators throughout the building, they are several units in poor condition and can benefit from complete unit ventilator refurbishment including installation of replacement fan decks.

Although this measure results in a very poor payback period, it is recommended based on the poor condition of the existing units, improved occupant comfort with slight potential energy savings. This ECM is included in the base case financial scenario presented in our proposal as this ECM is a cost effective way of achieving energy efficiency as well as extending the life of the equipment.

Facilities Recommended for this Measure

- West Milford High School
- Macopin Middle School
- Apshawa Elementary School
- Maple Road Elementary School
- Marshall Hill Elementary School
- Paradise Knoll Elementary School
- Upper Greenwood Lake Elementary School
- Westbrook Elementary School

Scope of Work

- Demolition, removal and disposal of existing unit ventilators fan decks
- Furnish and install the following:
    - New fan decks
    - Valve and damper actuators and linkages
    - Electrical control wiring to new unit(s)
- Provide new unit start-up and commissioning

Savings Methodology

Savings Calculation Method		
Electric Usage Savings (kWh)	=	(# of Unit Ventilators) x (Unit Ventilator Motor HP) x (Run Hours) x (0.746) x (Existing Motor Load Factor – New Motor Load Factor) / (Old Motor Efficiency – New Motor Efficiency)
Heating Savings (Therm)	=	Stipulated Savings % * Total Annual Natural Gas Usage

Maintenance

Periodically the equipment should be checked to ensure proper operation.

Benefits

- Electric and Natural gas savings

Valve and Pipe Insulation

ECM Summary

Non-insulated pipelines and associated valves and fittings carrying thermal fluids because heat loss where not intended and result in excess fuel consumption, as well as discomfort in occupied areas. Valves and fittings without insulation were observed throughout the buildings and installation of new insulation is recommended. Installation of the proper amount of insulation will not only conserve energy but will also improve safety by reducing the chance for burns on hot piping or slipping due to condensate on a pipe.

Facilities Recommended for this Measure

- Apshawa Elementary School
- Macopin Middle School
- Maple Road Elementary School
- Marshall Hill Elementary School
- Paradise Knoll School
- Upper Greenwood Lake Elementary School
- Westbrook Elementary School
- West Milford High School

Scope of Work

Findings

- Pipe Insulation – un-insulated pipes in the heating hot water systems are leading to unnecessary distribution losses and wasted energy. While all the assessed boiler rooms in West Milford have bare straight pipes, this weakness is greatest at Apshawa Elementary School, where there are long straight runs of pipe that are un-insulated. These long runs amplify the amount of heat (energy) that is lost as fluids pass through the heating system.
- Valve & Fitting Insulation – valves and fittings are difficult components of a mechanical system to insulate and as a result are frequently left un-insulated. The following components were found un-insulated at the respective locations in West Milford: Bonnets, Butterfly valves, Centrifugal pumps, Check valves, Control valves, End Caps, Flanges, Flex fittings, Gate valves, In-Line pumps, Strainers, Suction Diffusers, T-intersections, 90 degree elbows, and 45 degree elbows. Leaving these components of the distribution system in their current condition is leading to unnecessary distribution losses and wasted energy.
- Tank Insulation – tanks are difficult components of a mechanical system to insulate and as a result are frequently left un-insulated. Un-insulated tanks have the same temperature fluids passing through them as the pipes that are more likely to be insulated. In West Milford, these tanks are present in the form of Air Separator Tanks; these un-insulated tanks were found at Apshawa Elementary School, Macopin Middle School, Maple Road Elementary School, Paradise Knoll Elementary School, Westbrook Elementary School, and West Milford High School. Because these tanks have such a large surface area, distribution (energy) losses are amplified by continuing to operate the buildings' heating system in their current un-insulated state.

Schools	Pipe Insulation (LF)	Valve & Fitting Insulation (Units)	Tank Insulation (Units)
Apshawa Elementary Total	102	50	1
Macopin Middle School	9	94	1
Maple Road Elementary School	4	44	1
Marshall Hill Elementary School	9	69	0
Paradise Knoll Elementary School	10	62	1
Upper Greenwood Lake Elementary School	0	24	0
West Milford High School	3	76	1
Westbrook Elementary School	2	51	1
Total	**139**	**470**	**6**

<u>Apshawa Elementary School</u>

Equipment/Pipe	Fluid Type	Pipe Dia (") or Tank Surface Area(SF)*	Quantity/Length	Insulation Type/ Thickness
90 Degree Elbow	MTHW	1.25	3	1.5" Cellular Glass
Control Valve	MTHW	1.25	1	1.5" Removable Blanket
Straight Pipe	MTHW	1.25	4	1.5" Cellular Glass
90 Degree Elbow	MTHW	2	3	2" Cellular Glass
Straight Pipe	MTHW	2	5	2" Cellular Glass
Butterfly Valve	MTHW	3	4	1.5" Removable Blanket
Centrifugal Pump	MTHW	3	2	1.5" Removable Blanket
Check Valve	MTHW	3	1	1.5" Removable Blanket
Check Valve	MTHW	3	2	1.5" Removable Blanket
Flange	MTHW	3	2	1.5" Removable Blanket
Flange	MTHW	3	3	1.5" Removable Blanket
Flange	MTHW	3	4	1.5" Removable Blanket
Flange	MTHW	3	10	1.5" Removable Blanket
Flange	MTHW	3	3	2" Cellular Glass
Flex Fitting	MTHW	3	1	1.5" Removable Blanket
Flex Fitting	MTHW	3	2	1.5" Removable Blanket
Gate Valve	MTHW	3	1	1.5" Removable Blanket
Gate Valve	MTHW	3	3	1.5" Removable Blanket
Gate Valve	MTHW	3	4	1.5" Removable Blanket
Straight Pipe	MTHW	3	12	2" Cellular Glass
Straight Pipe	MTHW	3	43	2" Cellular Glass
Straight Pipe	MTHW	3	14	2" Cellular Glass
Straight Pipe	MTHW	3	24	2" Cellular Glass
T Intersection	MTHW	3	1	2" Cellular Glass
Air Seperator Tank	MTHW	17.6625	1	2" Cellular Glass

Macopin Middle School

Equipment/Pipe	Fluid Type	Pipe Dia (") or Tank Surface Area(SF)*	Quantity/Length	Insulation Type/ Thickness
In-line Pump	MTHW	1.5	1	1.5" Removable Blanket
Butterfly Valve	MTHW	3	1	1.5" Removable Blanket
Butterfly Valve	MTHW	3	5	1.5" Removable Blanket
Butterfly Valve	MTHW	3	5	2" Cellular Glass
Control Valve	MTHW	3	2	1.5" Removable Blanket
Flange	MTHW	3	1	1.5" Removable Blanket
Flange	MTHW	3	2	1.5" Removable Blanket
Flange	MTHW	3	4	1.5" Removable Blanket
Flange	MTHW	3	5	1.5" Removable Blanket
Flange	MTHW	3	5	2" Cellular Glass
Gate Valve	MTHW	3	1	1.5" Removable Blanket
In-line Pump	MTHW	3	1	1.5" Removable Blanket
In-line Pump	MTHW	3	2	1.5" Removable Blanket
In-line Pump	MTHW	3	5	1.5" Removable Blanket
Straight Pipe	MTHW	3	2	2" Cellular Glass
Straight Pipe	MTHW	3	5	2" Cellular Glass
Strainer	MTHW	3	5	1.5" Removable Blanket
Centrifugal Pump	MTHW	4	2	1.5" Removable Blanket
Check Valve	MTHW	4	2	1.5" Removable Blanket
Control Valve	MTHW	4	2	1.5" Removable Blanket
Flange	MTHW	4	1	1.5" Removable Blanket
Flange	MTHW	4	2	1.5" Removable Blanket
Flange	MTHW	4	4	1.5" Removable Blanket
Flange	MTHW	4	20	1.5" Removable Blanket
Gate Valve	MTHW	4	8	1.5" Removable Blanket
Strainer	MTHW	4	1	1.5" Removable Blanket
Check Valve	MTHW	6	1	1.5" Removable Blanket
Flange	MTHW	6	3	1.5" Removable Blanket
End Cap	MTHW	8	1	2" Cellular Glass
Flange	MTHW	8	2	2" Cellular Glass
Straight Pipe	MTHW	8	2	2" Cellular Glass
Air Seperator Tank	MTHW	85.1725	1	2" Cellular Glass

Maple Road Elementary School

Equipment/Pipe	Fluid Type	Pipe Dia (") or Tank Surface Area(SF)*	Quantity/Length	Insulation Type/ Thickness
Butterfly Valve	MTHW	3	2	1.5" Removable Blanket
Centrifugal Pump	MTHW	3	2	1.5" Removable Blanket
Check Valve	MTHW	3	1	1.5" Removable Blanket
Check Valve	MTHW	3	2	1.5" Removable Blanket
Flange	MTHW	3	2	1.5" Removable Blanket

Flange	MTHW	3	4	1.5" Removable Blanket
Flange	MTHW	3	6	1.5" Removable Blanket
Flange	MTHW	3	12	1.5" Removable Blanket
Flange	MTHW	3	1	2" Cellular Glass
Flex Fitting	MTHW	3	4	1.5" Removable Blanket
Gate Valve	MTHW	3	3	1.5" Removable Blanket
Gate Valve	MTHW	3	5	1.5" Removable Blanket
Straight Pipe	MTHW	3	4	2" Cellular Glass
Air Seperator Tank	MTHW	15.3075	1	2" Cellular Glass

Marshall Hill Elementary School

Equipment/Pipe	Fluid Type	Pipe Dia (") or Tank Surface Area(SF)*	Quantity/Length	Insulation Type/ Thickness
90 Degree Elbow	MTHW	1.5	3	2" Cellular Glass
Straight Pipe	MTHW	1.5	2	2" Cellular Glass
90 Degree Elbow	MTHW	2	2	2" Cellular Glass
Butterfly Valve	MTHW	2	6	1.5" Removable Blanket
Centrifugal Pump	MTHW	2	1	1.5" Removable Blanket
Check Valve	MTHW	2	3	1.5" Removable Blanket
Control Valve	MTHW	2	3	1.5" Removable Blanket
Flange	MTHW	2	9	1.5" Removable Blanket
Straight Pipe	MTHW	2	2	2" Cellular Glass
Straight Pipe	MTHW	2	3	2" Cellular Glass
45 Degree Elbow	MTHW	2.5	1	2" Cellular Glass
90 Degree Elbow	MTHW	2.5	2	2" Cellular Glass
Straight Pipe	MTHW	2.5	2	2" Cellular Glass
Bonnet	MTHW	3	1	1.5" Removable Blanket
Bonnet	MTHW	3	7	1.5" Removable Blanket
Butterfly Valve	MTHW	3	1	1.5" Removable Blanket
Centrifugal Pump	MTHW	3	2	1.5" Removable Blanket
Check Valve	MTHW	3	1	1.5" Removable Blanket
End Cap	MTHW	3	1	2" Cellular Glass
Flange	MTHW	3	1	1.5" Removable Blanket
Flange	MTHW	3	2	1.5" Removable Blanket
Flange	MTHW	3	3	1.5" Removable Blanket
Flange	MTHW	3	6	1.5" Removable Blanket
Flex Fitting	MTHW	3	1	1.5" Removable Blanket
In-line Pump	MTHW	3	3	1.5" Removable Blanket
Strainer	MTHW	3	3	1.5" Removable Blanket
Butterfly Valve	MTHW	4	1	1.5" Removable Blanket
Control Valve	MTHW	4	1	1.5" Removable Blanket
Flange	MTHW	4	1	1.5" Removable Blanket
Flange	MTHW	4	3	1.5" Removable Blanket
Strainer	MTHW	4	1	1.5" Removable Blanket

Paradise Knoll Elemenetary School

Equipment/Pipe	Fluid Type	Pipe Dia (") or Tank Surface Area(SF)*	Quantity/Length	Insulation Type/ Thickness
Centrifugal Pump	MTHW	2	4	1.5" Removable Blanket
Check Valve	MTHW	2	2	1.5" Removable Blanket
Flange	MTHW	2	2	1.5" Removable Blanket
Flange	MTHW	2	4	1.5" Removable Blanket
Flange	MTHW	2	8	1.5" Removable Blanket
Flex Fitting	MTHW	2	2	1.5" Removable Blanket
Flex Fitting	MTHW	2	4	1.5" Removable Blanket
Straight Pipe	MTHW	2	2	2" Cellular Glass
Strainer	MTHW	2	2	1.5" Removable Blanket
Suction Diffuser	MTHW	2	2	1.5" Removable Blanket
45 Degree Elbow	MTHW	3	1	2" Cellular Glass
90 Degree Elbow	MTHW	3	1	2" Cellular Glass
Flex Fitting	MTHW	3	2	1.5" Removable Blanket
Straight Pipe	MTHW	3	4	2" Cellular Glass
Suction Diffuser	MTHW	3	2	1.5" Removable Blanket
Butterfly Valve	MTHW	4	2	1.5" Removable Blanket
Check Valve	MTHW	4	1	1.5" Removable Blanket
End Cap	MTHW	4	1	2" Cellular Glass
Flange	MTHW	4	2	1.5" Removable Blanket
Flange	MTHW	4	4	1.5" Removable Blanket
Flange	MTHW	4	8	1.5" Removable Blanket
Flange	MTHW	4	2	2" Cellular Glass
Gate Valve	MTHW	4	2	1.5" Removable Blanket
Straight Pipe	MTHW	4	4	2" Cellular Glass
Strainer	MTHW	4	4	1.5" Removable Blanket
Air Seperator Tank	MTHW	37.2875	1	2" Cellular Glass

Upper Greenwood Elementary School

Equipment/Pipe	Fluid Type	Pipe Dia (") or Tank Surface Area(SF)*	Quantity/Length	Insulation Type/ Thickness
Bonnet	MTHW	2	2	1.5" Removable Blanket
Bonnet	MTHW	2	4	1.5" Removable Blanket
Check Valve	MTHW	2	1	1.5" Removable Blanket
Control Valve	MTHW	2	1	1.5" Removable Blanket
Flange	MTHW	2	3	1.5" Removable Blanket
Bonnet	MTHW	3	4	1.5" Removable Blanket
Bonnet	MTHW	3	6	1.5" Removable Blanket
Centrifugal Pump	MTHW	3	2	1.5" Removable Blanket
Check Valve	MTHW	3		1.5" Removable Blanket
Flange	MTHW	3	1	1.5" Removable Blanket

Westbrook Elementary School

Equipment/Pipe	Fluid Type	Pipe Dia (") or Tank Surface Area(SF)*	Quantity/Length	Insulation Type/ Thickness
Centrifugal Pump	MTHW	3	2	1.5" Removable Blanket
Control Valve	MTHW	3	2	1.5" Removable Blanket
Flange	MTHW	3	2	1.5" Removable Blanket
Flange	MTHW	3	4	1.5" Removable Blanket
Flange	MTHW	3	6	1.5" Removable Blanket
Flex Fitting	MTHW	3	2	1.5" Removable Blanket
Suction Diffuser	MTHW	3	2	1.5" Removable Blanket
Bonnet	MTHW	4	2	1.5" Removable Blanket
Butterfly Valve	MTHW	4	2	1.5" Removable Blanket
Check Valve	MTHW	4	2	1.5" Removable Blanket
Control Valve	MTHW	4	2	1.5" Removable Blanket
End Cap	MTHW	4	1	2" Cellular Glass
Flange	MTHW	4	2	1.5" Removable Blanket
Flange	MTHW	4	4	1.5" Removable Blanket
Flange	MTHW	4	6	1.5" Removable Blanket
Flange	MTHW	4	5	1.5" Removable Blanket
Flange	MTHW	4	1	2" Cellular Glass
Gate Valve	MTHW	4	2	1.5" Removable Blanket
Straight Pipe	MTHW	4	2	2" Cellular Glass
Strainer	MTHW	4	2	1.5" Removable Blanket
Air Seperator Tank	MTHW	20.0175	1	2" Cellular Glass

West Milford High School

Equipment/Pipe	Fluid Type	Pipe Dia (") or Tank Surface Area(SF)*	Quantity/Length	Insulation Type/ Thickness
Centrifugal Pump	MTHW	2.5	2	1.5" Removable Blanket
Control Valve	MTHW	2.5	2	1.5" Removable Blanket
Flange	MTHW	2.5	10	1.5" Removable Blanket
Flex Fitting	MTHW	2.5	2	1.5" Removable Blanket
Gate Valve	MTHW	2.5	2	1.5" Removable Blanket
Strainer	MTHW	2.5	2	1.5" Removable Blanket
Suction Diffuser	MTHW	2.5	2	1.5" Removable Blanket
Butterfly Valve	MTHW	6	2	1.5" Removable Blanket
Centrifugal Pump	MTHW	6	2	1.5" Removable Blanket
Control Valve	MTHW	6	2	1.5" Removable Blanket
Control Valve	MTHW	6	4	1.5" Removable Blanket
Flange	MTHW	6	4	1.5" Removable Blanket
Flange	MTHW	6	8	1.5" Removable Blanket
Flange	MTHW	6	6	2" Cellular Glass
Flange	MTHW	6	8	2" Cellular Glass
Gate Valve	MTHW	6	2	1.5" Removable Blanket

In-line Pump	MTHW	6	4	1.5" Removable Blanket
Strainer	MTHW	6	2	1.5" Removable Blanket
Suction Diffuser	MTHW	6	2	1.5" Removable Blanket
Flange	MTHW	8	4	1.5" Removable Blanket
Flange	MTHW	8	2	2" Cellular Glass
Gate Valve	MTHW	8	2	1.5" Removable Blanket
Straight Pipe	MTHW	8	3	2" Cellular Glass
Air Seperator Tank	MTHW	50.24	1	2" Cellular Glass

Savings Methodology

Mechanical Insulation Savings Calculations

This section describes our methodology for calculating energy savings. We use standard heat transfer methods to compute heat loss from bare and insulated mechanical systems (piping, valves, fittings, tanks and ductwork). The difference in heat loss is the energy savings, as follows:

Energy Savings = [Existing Heat Loss] – [Insulated Heat Loss]

Methodology

We use standard heat transfer methods to compute radiation, convection, and conduction heat loss from

(Alternatively, gain to, for cold systems) bare and insulated systems. Key parameters that affect the heat transfer rate include: temperature of fluid (e.g. steam, hot water, chilled water, etc.); surface temperature of the component (e.g. pipe, fitting, tank, ductwork); temperature of environment; emissivity of surface; average wind speed where applicable; percentage of existing component covered with insulation; and condition of existing insulation, where applicable.

Energy Use

Existing and proposed energy use are computed as follows:

Pipes & Fittings
Heat Loss (Btu/h) = (Heat Loss / lin.ft. bare pipe) * (lin.ft. of pipe) * [1 – (%insulated)] +
(Heat Loss / lin.ft. insulated pipe) * (lin.ft. of pipe) * (%insulated)
Fuel Loss (MMBTU/yr) = (Heat Loss Btu/h) * (heating hrs/year) ÷ (efficiency)
Electric Loss (kWh/yr) = (Heat Loss Btu/h) * (cooling hrs/year) ÷ (12,000 Btu/ton-hr) x (cooling kW/ton)

Tanks, Plates, & Ductwork

Existing and proposed heat loss for tanks, plates, and ductwork are calculated as follows:
Heat Loss (Btu/h) = (Heat Loss / sq.ft.) * (sq.ft. of component) * (qty) * [1 – (%insulated)] +
(Heat Loss / sq.ft. insulated) * (qty) * (sq.ft. of component) * (%insulated)
Fuel Loss (MMBTU/yr) = (Heat Loss Btu/h) * (heating hrs/year) ÷ (efficiency)
Electric Loss (kWh/yr) = (Heat Loss Btu/h) * (cooling hrs/year) ÷ (12,000 Btu/ton-hr) x (cooling kW/ton)

Energy Savings

Energy savings are the difference between existing and proposed heat loss:

Fuel Savings (MMBTU/yr) = (Existing Fuel Loss) – (Proposed Fuel Loss)
Electric Savings (MMBTU/yr) = (Existing Electric Loss) – (Proposed Electric Loss)
Cost Savings ($/yr) = (Fuel Savings MMBTU/yr) * (Fuel Rate $/MMBTU) +
(Electric Savings kWh/yr) * (Electric Rate $/kWh)

Heat Transfer: Bare Systems

Bare systems are subject to convection and radiation heat transfer. We ignore conductive heat transfer through the pipe/fitting material (e.g. steel, copper, PVC etc.) as this is negligible as compared to heat transfer through insulation and air convection.

Pipes & Fittings

This section describes the heat transfer calculations for pipes and fittings for indoor systems subject to natural convection (no wind). The calculations for outdoor systems subject to forced convection (wind) are similar except that the formulas are more complicated. These methods are presented following this section.

For fittings (valves, elbows, strainers, etc.), we estimate heat loss based on equivalent length of straight pipe, which is the ratio of the area of the fitting to the area of 1 linear foot of pipe of the same size (fitting equivalent length = Area of fitting, ft^2 / Area of pipe of equivalent diameter, ft^2).

$$q_{pipe} = \frac{2 * \pi * \Delta T}{\frac{1}{h * \left({D_{outer}}/{2}\right)}}$$

Where:
q_{pipe} = *heat loss per linear foot = Btu/h/lin.ft.*

$$h = total\ convective\ heat\ transfer\ factor = h_{convection} + h_{radiation}$$

$$h_{convection} = 0.213 * \left(\frac{\Delta T}{D}\right)^{\left(\frac{1}{4}\right)} \qquad \text{[ASHRAE 2005, Ch. 3, Eq. T10.16]}$$

$\square T = T_{surface} - T_{air}$
$\Delta T = T_{surface} - T_{air}$
D = Outer diameter

$$h_{radiation} = \varepsilon * \sigma * {\left(T_{surface}^4 - T_{air}^4\right)}\Big/{\left(T_{surface} - T_{air}\right)}$$

e = emissivity of surface
s = Stefan-Boltzmann constant = 0.1714 x 10-8 Btu / (hr-ft^2-°R^4)
$T_{surface} = Temperature\ of\ surface$
$T_{air} = Average\ ambient\ air\ temperature$

Heat Transfer: Insulated Systems

Insulated systems are subject to convection, radiation, and conductive heat transfer. We ignore conductive heat transfer through the pipe/fitting material (e.g. steel, copper, PVC etc.) as this is negligible when compared to heat transfer through insulation and air convection.

$$q_{pipe} = \frac{2 * \pi * \Delta T}{\frac{ln\left(D_{outer}/D_{inner}\right)}{k} + \frac{1}{h * \left(D_{outer}/2\right)}}$$

Where:

q_{pipe} = *heat loss per linear foot = Btu/h/lin.ft.*

$$h_{convection} = 0.213 * \left(\frac{\Delta T}{D}\right)^{\left(\frac{1}{4}\right)}$$ [ASHRAE 2005, Ch. 3, Eq. T10.16]

□T = $T_{surface} - T_{air}$

$\Delta T = T_{surface} - T_{air}$

D = Outer diameter

$$h_{radiation} = \varepsilon * \sigma * \left(T_{surface}^4 - T_{air}^4\right) / \left(T_{surface} - T_{air}\right)$$

e = emissivity of surface

s = Stefan-Boltzmann constant = 0.1714 x 10-8 Btu / (hr-ft^2-°R^4)

$T_{surface}$ = *Temperature of surface*

T_{air} = *Average ambient air temperature*

L = Pipe length or fitting equivalent length

Heat Transfer for Outdoor Systems

The methods for computing heat loss for outdoor systems subject to forced convection (wind) are identical to the methods for indoors systems described above except that the formulas to compute the convective heat transfer coefficient h is more complicated. These methods are described below:

Pipes & Fittings: Outdoor Systems

The convection heat transfer coefficient is:

$$h_{convection} = Nu * k \,/ D_{outer}$$

$$Nu = Nussault\ number = 0.3 + \frac{0.62 * Re^{\left(\frac{1}{2}\right)} * Pr^{\left(\frac{1}{3}\right)}}{\left[1 + \left(\frac{0.4}{Pr}\right)^{\left(\frac{2}{3}\right)}\right]^{\left(\frac{1}{4}\right)}} * \left[1 + \left(\frac{Re}{282{,}000}\right)^{\left(\frac{5}{8}\right)}\right]^{\left(\frac{4}{5}\right)}$$

$$Re = Reynolds\ number = \frac{V * D_{outer}}{v}$$

$\mathrm{Pr} = Prandtl\ number = 0.7\ (for\ air)$
$v = kinematic\ viscosity\ of\ air$
$V = wind\ speed$
$D_{outer} = outer\ pipe\ diameter$

Plates, Tanks, Ductwork: Outdoor Systems

The convection heat transfer coefficient for flat surfaces is estimated as follows

$$h_{convection} = Nu * k \,/ D_{outer}$$

$$Nu = Nussault\ number = 0.415 * Re^{\left(\frac{1}{2}\right)} * Pr^{\left(\frac{1}{3}\right)}$$

$$Re = Reynolds\ number = \frac{V * L}{v}$$

$\mathrm{Pr} = Prandtl\ number = 0.7\ (for\ air)$
$v = kinematic\ viscosity\ of\ air$
$V = wind\ speed$
$L = width\ or\ diameter\ of\ component$

Maintenance

The maintenance staff should maintain the newly installed equipment per manufacturers' recommendations. The manufacturer specification sheets will be provided for exact maintenance requirements.

Benefits

- Fuel energy savings

Upgrade HVAC Controls to DDC

ECM Summary

The currently installed Building Management Systems is a mostly an antiquated pneumatic system with a spattering collection of various manufacturers, operating independently from one another. Due to the incompatibility of the various systems to interact with one another, a Unified Open Protocol Control System utilizing the Niagara Platform communicating with the BACnet Protocol is proposed.

This ECM includes modernization of the District's current control system for the HVAC equipment to a DDC system. With the communication between the control devices and the new updated digital interface/software, the District will be able to take advantage of scheduling for occupied and unoccupied periods based on the actual occupancy of each space in the facility. The DDC system will also aid in the response time to service / maintenance issues when the facility is not under normal maintenance supervision, i.e. after-hours.

Facilities Recommended for this Measure

- Administration Building
- Apshawa Elementary School
- Macopin Middle School
- Maple Road Elementary School
- Marshall Hill Elementary School
- Paradise Knoll School
- Upper Greenwood Lake Elementary School
- Westbrook Elementary School
- West Milford High School
- Bus Garage

Scope of Work (General)

District BMS Infrastructure

A. BMS Archival Data Server
   1. Centralized Alarming
   2. Open Protocol Control System (BACnet)
   3. Open Source Control System
   4. Energy Usage Collection and archiving from the district's schools,

5. Web-based accessibility

B. Common Items for each school, unless otherwise noted.
1. Performance functionality and sequencing testing of devices which are to remain, including enclosures, control valves, transformers, relays, sensors wiring, etc
2. Provide Report of any non-operable device to District for remediation consideration.
3. Web-Based Open Source/Open System Building Network Communication bus (BACnet) to each DDC controller, plenum rated.
4. The District to provide TCP/IP drop at each Network Controller to their WAN.
5. (1) Operator Workstation with Web-based Graphics
6. (1) Central Dashboard Display of Buildings Historical and Current Utility Demands.
7. Utility meters provided by others, or existing.
8. Institute Energy Reduction Strategies, including but not limited to:
   a) Demand Control Ventilation
   b) Centralized Synchronized Scheduling
9. Equipment not within DDC control:
   a) Cabinet Unit Heaters (Local control)
   b) Kitchen Makeup Air Units (Local Control)
   c) Domestic Hot Water (Local Control)
   d) Emergency Generators, including fuel oil systems (Local Control)
   e) Building Sumps (Local Control)
   f) Lighting Controls (furnished by others)
   g) Window AC Unit Controls (Local Control)

Scope of Work (Administration Building)

A. District Building Management System Infrastructure
1. Provide a centralized Archival server for collection of the district's individual building data.
2. Provide a Niagara Supervisor for coordinating the multiple districts Building Management Systems.
3. Provide two portable web graphical user interface devices.
4. Provide web-based 3-dimensional web-based graphic interface.
5. Provide alarming, trending of the district's connected Niagara sites.

B. Provide control of the Single Zone Air Handling Unit (NG/DX) and condensing unit with the following devices:
1. A new Honeywell CIPer (WEBs) Building Level DDC controller with NEMA 1 enclosureand control transformer.
2. New discharge air, mixed air and return air temperature sensors.
3. A new Smart Space Temperature sensor.
4. New Outside air and Return air dampers actuators.
5. Fan status current sensors.
6. Control of the Natural Gas heating.
7. Control of the Direct Expansion Cooling.

Scope of Work (Apshawa Elementary School)

A. Provide a new Honeywell (WEBs-8000) Supervisory Network Controller with NEMA 1 enclosure and control power transformer.

B. Provide control of the Central Heating Plant system Hot Water boilers, Hot Water Pumps and control valve with the following devices:
1. A new Honeywell (WEBs) Building Level DDC controller with NEMA 1 enclosure and control

power transformer
2. New Hot Water Boiler enable control
3. A new Hot Water Loop mixing control valve.
4. A new Outside Air Temperature sensor with sun shield
5. New Hot Water Loop supply and Return temperature sensors.
6. New Hot Water pump start/stop control with pump status
7. New Hot Water pump speed control, as applicable.
8. A new Hot Water Pressure Bypass valve.
9. A new Hot Water Loop differential pressure sensor.

C. Provide control of the two H&V units (Ceiling) Multipurpose room with the following devices:
1. A new Honeywell (WEBs) Application Specific Controller with NEMA 1 enclosure, control power transformer and network communications wiring.
2. A new Unit Fan Start/Stop relay.
3. A new Unit Fan status current sensors.
4. A new Smart Space Temperature sensor.
5. New Unit discharge air, mixed air and return air temperature sensors.
6. A new outside air damper actuator (modulating 0-10vdc, spring return N.C.).
7. A new Unit HW coil low-limit temperature safety switch.
8. A new Unit HW control valve (2-way, modulating 0-10vdc, spring return N.O., 24VAC).
9. A new perimeter Fintube radiation control valve (2-way, 2-position, spring return N.O., 24VAC).
10. A new Return Air CO2 sensor for Demand Control Ventilation.

D. Provide new network communications wiring between ddc controllers.

Scope of Work (Macopin Middle School)

A. Provide a new Honeywell (WEBs-8000) Supervisory Network Controller with NEMA 1 enclosure and control power transformer.

B. Provide control of the Central Heating Plant system Hot Water boilers, Hot Water Pumps and control valve with the following devices:
1. A new Honeywell (WEBs) Building Level DDC controller with NEMA 1 enclosure and control power transformer
2. New Hot Water Boiler enable control
3. A new Hot Water Loop mixing control valve.
4. A new Outside Air Temperature sensor with sun shield
5. New Hot Water Loop supply and Return temperature sensors.
6. New Hot Water pump start/stop control with pump status
7. New Hot Water pump speed control, as applicable.
8. New Hot Water Pressure Bypass valve (3).
9. New Hot Water Loop differential pressure sensor (3)

C. Provide control of the 13 H&V units serving the locker rooms, gymnasium, auditorium
1. A new Honeywell (WEBs) Application Specific Controller with NEMA 1 enclosure, control power transformer and network communications wiring.
2. A new Unit Fan Start/Stop relay.
3. A new Unit Fan status current sensors.
4. A new Smart Space Temperature sensor.

5. New Unit discharge air, mixed air and return air temperature sensors.
6. A new outside air damper actuator (modulating 0-10vdc, spring return N.C.).
7. A new Unit HW coil low-limit temperature safety switch.
8. A new Unit HW control valve (2-way, modulating 0-10vdc, spring return N.O., 24VAC).
9. A new Return Air CO2 sensor for Demand Control Ventilation.

D. Provide control of the Roof Top Unit (NG/DX) serving the office area with the following devices:
1. A new Honeywell (WEBs) Application Specific Controller with control power transformer and network communications wiring.
2. New discharge air, mixed air and return air temperature sensors.
3. A new Smart Space Temperature sensor.
4. New Outside air and Return air dampers actuators.
5. A new Unit Fan Start/Stop relay.
6. A new Unit Fan status current sensors.
7. Control of the Natural Gas heating.
8. Control of the Direct Expansion Cooling.

Scope of Work (Maple Road Elementary School)

A. Provide a new Honeywell (WEBs-8000) Supervisory Network Controller with NEMA 1 enclosure and control power transformer.

B. Provide control of the Central Heating Plant system Hot Water boilers, Hot Water Pumps and control valve with the following devices:
1. A new Honeywell (WEBs) Building Level DDC controller with NEMA 1 enclosure and control power transformer
2. New Hot Water Boiler enable control
3. A new Hot Water Loop mixing control valve.
4. A new Outside Air Temperature sensor with sun shield
5. New Hot Water Loop supply and Return temperature sensors.
6. New Hot Water pump start/stop control with pump status
7. New Hot Water pump speed control, as applicable.
8. New Hot Water Pressure Bypass valve.
9. New Hot Water Loop differential pressure sensor

C. Provide control of the one H&V units serving the Multi-Purpose room with the following devices:
1. A new Honeywell (WEBs) Application Specific Controller with NEMA 1 enclosure, control power transformer and network communications wiring.
2. A new Unit Fan Start/Stop relay.
3. A new Unit Fan status current sensors.
4. A new Smart Space Temperature sensor.
5. New Unit discharge air, mixed air and return air temperature sensors.
6. A new outside air damper actuator (modulating 0-10vdc, spring return N.C.).
7. A new Unit HW coil low-limit temperature safety switch.
8. A new Unit HW control valve (2-way, modulating 0-10vdc, spring return N.O., 24VAC).
9. A new Return Air CO2 sensor for Demand Control Ventilation.

D. Provide control of the one mini-split air conditioning units which serve local cooling loads. (Math Labs/IT Rms) with the following devices:
1. New BMS DDC Space Thermostats.

2. Interface relays.

E. Provide new network communications wiring between ddc controllers.

Scope of Work (Marshall Hill Elementary School)

A. Provide a new Honeywell (WEBs-8000) Supervisory Network Controller with NEMA 1 enclosure and control power transformer.

B. Provide control of the Central Heating Plant system Hot Water boilers, Hot Water Pumps and control valve with the following devices:
1. A new Honeywell (WEBs) Building Level DDC controller with NEMA 1 enclosure and control power transformer
2. New Hot Water Boiler enable control
3. A new Hot Water Loop mixing control valve.
4. A new Outside Air Temperature sensor with sun shield
5. New Hot Water Loop supply and Return temperature sensors.
6. New Hot Water pump start/stop control with pump status
7. New Hot Water pump speed control, as applicable.
8. New Hot Water Pressure Bypass valve.
9. New Hot Water Loop differential pressure sensor

C. Provide control of the two H&V units serving the Multi-Purpose room with the following devices:
1. A new Honeywell (WEBs) Application Specific Controller with NEMA 1 enclosure, control power transformer and network communications wiring.
2. A new Unit Fan Start/Stop relay.
3. A new Unit Fan status current sensors.
4. A new Smart Space Temperature sensor.
5. New Unit discharge air, mixed air and return air temperature sensors.
6. A new outside air damper actuator (modulating 0-10vdc, spring return N.C.).
7. A new Unit HW coil low-limit temperature safety switch.
8. A new Unit HW control valve (2-way, modulating 0-10vdc, spring return N.O., 24VAC).
9. A new Return Air CO2 sensor for Demand Control Ventilation.

D. Provide new network communications wiring between ddc controllers.

Scope of Work (Paradise Knoll School)

A. Provide a new Honeywell (WEBs-8000) Supervisory Network Controller with NEMA 1 enclosure and control power transformer.

B. Provide control of the Central Heating Plant system Hot Water boilers, Hot Water Pumps and control valve with the following devices:
1. A new Honeywell (WEBs) Building Level DDC controller with NEMA 1 enclosure and control power transformer
2. New Hot Water pump speed control, as applicable.
3. Reutilize the existing devices to the greatest extent:
    a. Outside Air Temperature sensor with sun shield
    b. Hot Water Loop supply and Return temperature sensors.
    c. Hot Water Boiler enable control
    d. Hot Water Pressure Bypass valve.

   e. Hot Water pump start/stop control with pump status
   f. Hot Water Loop differential pressure sensor

C. Provide control of one Roof Multi-Zone Unit which serves 16 zones (Front of Building) with the following devices:
   1. A new Honeywell CIPer (WEBs) Building Level Controller with control power transformer and network communications wiring.
   2. New Space Temperature sensors.
   3. Reutilize the existing devices to the greatest extent, , or replace in kind, including:
      a. Unit Fan Start/Stop relays.
      b. Unit Fan status current sensors.
      c. Unit Hot Deck, Cold Deck, discharge air, mixed air and return air temperature sensors.
      d. Outside air and Return air damper actuators
      e. Zone Damper Actuators
      f. Hot Deck Control
      g. Cold Deck Control

D. Provide control of three Roof Multi-Zone Unit which serve the library/media/ and 5 classrooms with the following devices:
   1. A new Honeywell (WEBs) Application Specific Controller with control power transformer and network communications wiring.
   2. New Space Temperature sensors.
   3. New Unit Fan Start/Stop relays.
   4. New Unit Fan status current sensors.
   5. New discharge air, mixed air and return air temperature sensors.
   6. New Outside air and Return air damper actuators
   7. Control of the Natural Gas Heating
   8. Control of the Direct Expansion Cooling

E. Provide control of the two H&V units serving the Multi-Purpose room with the following devices:
   1. A new Honeywell (WEBs) Application Specific Controller with NEMA 1 enclosure, control power transformer and network communications wiring.
   2. A new Unit Fan Start/Stop relay.
   3. A new Unit Fan status current sensors.
   4. A new Smart Space Temperature sensor.
   5. New Unit discharge air, mixed air and return air temperature sensors.
   6. A new outside air damper actuator (modulating 0-10vdc, spring return N.C.).
   7. A new Unit HW coil low-limit temperature safety switch.
   8. A new Unit HW control valve (2-way, modulating 0-10vdc, spring return N.O., 24VAC).
   9. A new Return Air CO2 sensor for Demand Control Ventilation.

F. Provide new network communications wiring between ddc controllers.

Scope of Work (Upper Greenwood Lake Elementary School)

A. Provide a new Honeywell (WEBs-8000) Supervisory Network Controller with NEMA 1 enclosure and control power transformer.

B. Provide control of the Central Heating Plant system Hot Water boilers, Hot Water Pumps and control valve with the following devices:

1. A new Honeywell (WEBs) Building Level DDC controller with NEMA 1 enclosure and control power transformer
2. New Hot Water pump speed control, as applicable.
3. Reutilize the existing devices to the greatest extent:
   a. Outside Air Temperature sensor with sun shield
   b. Hot Water Loop supply and Return temperature sensors.
   c. Hot Water Boiler enable control
   d. Hot Water Pressure Bypass valve.
   e. Hot Water pump start/stop control with pump status
   f. Hot Water Loop differential pressure sensor

C. Provide control of the one H&V unit serving the Multi-Purpose room with the following devices:
1. A new Honeywell (WEBs) Application Specific Controller with NEMA 1 enclosure, control power transformer and network communications wiring.
2. A new Unit Fan Start/Stop relay.
3. A new Unit Fan status current sensors.
4. A new Smart Space Temperature sensor.
5. New Unit discharge air, mixed air and return air temperature sensors.
6. A new outside air damper actuator (modulating 0-10vdc, spring return N.C.).
7. A new Unit HW coil low-limit temperature safety switch.
8. A new Unit HW control valve (2-way, modulating 0-10vdc, spring return N.O., 24VAC).
9. A new Return Air CO2 sensor for Demand Control Ventilation.

D. Provide new network communications wiring between ddc controllers.

Scope of Work (Westbrook Elementary School)

A. Provide control of the Central Heating Plant system Hot Water boilers, Hot Water Pumps and control valve with the following devices:
1. A new Honeywell (WEBs) Building Level DDC controller with NEMA 1 enclosure and control power transformer
2. New Hot Water pump speed control, as applicable.
3. Reutilize the existing devices to the greatest extent:
   a. Outside Air Temperature sensor with sun shield
   b. Hot Water Loop supply and Return temperature sensors.
   c. Hot Water Boiler enable control
   d. Hot Water Pressure Bypass valve.
   e. Hot Water pump start/stop control with pump status
   f. Hot Water Loop differential pressure sensor

B. Provide control of the three H&V unit serving the Multi-Purpose room with the following devices:
1. A new Honeywell (WEBs) Application Specific Controller with NEMA 1 enclosure, control power transformer and network communications wiring.
2. A new Unit Fan Start/Stop relay.
3. A new Unit Fan status current sensors.
4. A new Smart Space Temperature sensor.
5. New Unit discharge air, mixed air and return air temperature sensors.
6. A new outside air damper actuator (modulating 0-10vdc, spring return N.C.).
7. A new Unit HW coil low-limit temperature safety switch.
8. A new Unit HW control valve (2-way, modulating 0-10vdc, spring return N.O., 24VAC).
9. A new Return Air CO2 sensor for Demand Control Ventilation.

C. Provide control of one Roof Multi-Zone Unit which serves 5 zones with the following devices:
1. A new Honeywell CIPer (WEBs) Building Level Controller with control power transformer and network communications wiring.
2. New Space Temperature sensors.
3. Reutilize the existing devices to the greatest extent, , or replace in kind, including:
   a. Unit Fan Start/Stop relays.
   b. Unit Fan status current sensors.
   c. Unit Hot Deck, Cold Deck, discharge air, mixed air and return air temperature sensors.
   d. Outside air and Return air damper actuators
   e. Zone Damper Actuators
   f. Hot Deck Control
   g. Cold Deck Control

D. Provide new network communications wiring between ddc controllers.

Scope of Work (West Milford High School)

A. Provide a new Honeywell (WEBs-8000) Supervisory Network Controller with NEMA 1 enclosure and control power transformer.

B. Provide control of the Central Heating Plant system Hot Water boilers, Hot Water Pumps and control valve with the following devices:
1. A new Honeywell (WEBs) Building Level DDC controller with NEMA 1 enclosure and control power transformer
2. New Hot Water Boiler enable control
3. A new Hot Water Loop mixing control valve.
4. A new Outside Air Temperature sensor with sun shield
5. New Hot Water Loop supply and Return temperature sensors.
6. New Hot Water pump start/stop control with pump status
7. New Hot Water pump speed control, as applicable.
8. New Hot Water Pressure Bypass valve (4).
9. New Hot Water Loop differential pressure sensor (4)

C. Provide control of the Central Cooling Plant system Chiller, Cooling Tower, Chilled/Condenser Water Pumps and Tower control valve with the following devices:
1. A new Honeywell (WEBs) Building Level DDC controller with NEMA 1 enclosure and control power transformer
2. New Chiller enable control and status.
3. New Chiller Interface, as applicable.
4. Control of existing tower mixing control valve.
5. New Chilled Water Loop supply and Return temperature sensors.
6. New Chilled Water pump start/stop control with pump status
7. New Chilled Water pump speed control, as applicable.
8. New Condenser Water Loop supply and Return temperature sensors.
9. New Condenser Water pump start/stop control with pump status
10. New Condenser Water pump speed control, as applicable.
11. New Cooling Tower enable control and status
12. New Cooling Tower fan speed control, as applicable
13. Reconnect the existing Chilled Water and Condenser Water flow sensors.

D. Provide control of the 60 classrooms Unit Ventilators and Fintube Radiation with the following devices:
1. A new Honeywell (WEBs) Application Specific Controller with control power transformer and network communications wiring.
2. A new Unit Fan Start/Stop relay.
3. A new Unit Fan status current sensors.
4. A new Smart Space Temperature sensor.
5. A new Unit discharge air temperature sensor.
6. A new outside air damper actuator (modulating 0-10vdc, spring return N.C.).
7. A new Unit HW coil low-limit temperature safety switch.
8. A new Unit HW control valve (2-way, modulating 0-10vdc, spring return N.O., 24VAC).
9. A new Unit Fintube radiation control valve (2-way, 2-position, spring return N.O., 24VAC)

E. Provide control of the eight HVAC units located in the east/west wing penthouses which serve the 1st/2nd Floor core areas, attendance offices, library, cafeteria with the following devices:
1. A new Honeywell (WEBs) Application Specific Controller with NEMA 1 enclosure, control power transformer and network communications wiring.
2. A new Unit Fan Start/Stop relay.
3. A new Unit Fan status current sensors.
4. A new Smart Space Temperature sensor.
5. New Unit discharge air, mixed air and return air temperature sensors.
6. A new outside air damper actuator (modulating 0-10vdc, spring return N.C.).
7. A new Unit HW coil low-limit temperature safety switch.
8. A new Unit HW control valve (2-way, modulating 0-10vdc, spring return N.O., 24VAC).
9. A new Unit CHW control valve (2-way, modulating 0-10vdc, spring return N.C., 24VAC).
10. A new Return Air CO2 sensor for Demand Control Ventilation.

F. Provide control of the four H&V units located in the shop areas (C-2/4/6/8)which serve the same spaces, with the following devices:
1. A new Honeywell (WEBs) Application Specific Controller with NEMA 1 enclosure, control power transformer and network communications wiring.
2. A new Unit Fan Start/Stop relay.
3. A new Unit Fan status current sensors.
4. A new Smart Space Temperature sensor.
5. New Unit discharge air, mixed air and return air temperature sensors.
6. A new outside air damper actuator (modulating 0-10vdc, spring return N.C.).
7. A new Unit HW coil low-limit temperature safety switch.
8. A new Unit HW control valve (2-way, modulating 0-10vdc, spring return N.O., 24VAC).
9. A new Return Air CO2 sensor for Demand Control Ventilation.

G. Provide control of the nine mini-split air conditioning units which serve local cooling loads. (Math Labs/IT Rms) with the following devices:
1. New BMS DDC Space Thermostats.
2. Interface relays.

H. Provide control of the approximately 40 exhaust fans serving the building with the following devices:
1. Exhaust Fan Start/Stop Interface relays.
2. Exhaust Fan Status current switch.

3. Control from the nearest BMS ddc control panel or consolidated to an area ddc panel

I. Provide new network communications wiring between ddc controllers.

Scope of Work (Bus Garage)

A. Provide a new Honeywell CIPer (WEBs) Building Level DDC controller with NEMA 1 enclosure and control transformer.

B. Provide control of the Hot Water boiler with the following devices:
1. Hot Water Boiler enable control
2. New Hot Water Loop supply and Return temperature sensors.
3. New Outside Air Temperature sensor with sun shield

C. Provide monitoring of the space temperature, 2 locations.

Savings Methodology

See savings calculations provided in Appendix.

Maintenance

The maintenance staff should maintain the newly installed equipment per manufacturers' recommendations. The manufacturer specification sheets will be provided for exact maintenance requirements.

Benefits

- Electric and fuel energy savings

Direct Install Program (Lighting, Controls, HVAC)

ECM Summary

Existing small to mid-sized commercial and industrial facilities with a peak electric demand that did not exceed 200 kW in any of the preceding 12 months are eligible to participate in Direct Install. Applicants will submit the last 12 months of electric utility bills indicating that they are below the demand threshold and have occupied the building during that time. Buildings must be located in New Jersey and served by one of the state's public, regulated electric or natural gas utility companies. Created specifically for existing small to medium-sized facilities, Direct Install is a turnkey solution that makes it easy and affordable to upgrade to high efficiency equipment. The program pays up to 70% of retrofit costs, dramatically improving your payback on the project.

Facilities Available for Direct Install

- Apshawa Elementary School
- Maple Road Elementary School
- Marshall Hill Elementary School
- Paradise Knoll Elementary School
- Administration Building
- Bus Garage

Scope of Work

- ESG worked closely with one of the program partners to evaluate the Direct Install Program
- The systems and equipment addressed by the program are
    - Lighting at all facilities listed above
    - Fuel Use Economizers at Administration Building, Apshawa Elementary School, Maple Road Elementary School and Paradise Knoll Elementary School
    - Programmable thermostat at Administration Building
    - Two Packaged Rooftop units at Paradise Knoll Elementary School
    - Three hot water boilers at Marshall Hill Elementary School
    - Low-flow aerators at Administration Building, Apshawa Elementary School, Bus Garage, Maple Road Elementary School, Marshall Hill Elementary School and Paradise Knoll Elementary School
    - Pipe wrap insulation for domestic water piping at Apshawa Elementary School, Bus Garage and Paradise Knoll Elementary School

Savings Methodology

See savings calculations provided in Appendix.

Maintenance

Periodically the equipment should be checked to ensure proper operation.

Benefits

- Reduced installation cost utilizing Direct Install Incentive Program.
- Electric and fuel energy savings

Pay for Performance

ECM Summary

Energy Systems Group is a partner in the New Jersey Pay for Performance Program. This program allows schools district to obtain rebate for energy savings project above and beyond the standard NJ Smart program when energy savings exceeds 15% of the baseline usage for each school. We expect that Macopin Middle School will be eligible for this rebate program

The Pay for Performance for Existing Buildings Program takes a comprehensive, whole-building approach to saving energy in existing facilities through incentives that are directly linked to savings. Pay for Performance program relies on a network of partners who provide technical services under direct contract to you. Acting as your energy expert, your partner will develop an energy reduction plan for each project with a whole-building technical component of a traditional energy audit, a financial plan for funding the energy efficient measures and a construction schedule for installation.

At the same time, ESG feels the knowledge of the Pay for Performance Program allows us to be reasonable in our incentive estimates during the RFP Response and create a realistic expectation for West Milford Public Schools.

Facilities Recommended for this Measure

- Macopin Middle School

Scope of Work

The following services will be provided during the development of the ESP for the District:

- Coordinate with the District to complete and submit the Pay for Performance Application
- Develop and submit Energy Reduction Plan to Pay for Performance Case Manager
- Complete and submit Request for Incentive #1
- Conduct necessary reviews with Pay for Performance Case Manager

During and after installation of measures is complete, the following services will be provided:

- Complete and submit request for Incentive #2
- Conduct necessary reviews with Pay for Performance Case Manager to ensure equipment has been installed according to scope of work submitted in ERP and ESIP

After year 1 of performance period:

- Complete post-construction benchmarking report
- Complete and submit with request for Incentive #3
- Conduct necessary reviews for Incentive #3

Benefits

- Source of revenue throughout the first several years of project development and implementation.
- Public acknowledgement of District's efforts toward energy responsibility.

Solar Power Purchase Agreement (PPA)

ECM Summary

The entire district was evaluated for the potential to install rooftop photovoltaic (PV) solar panels for power generation. The locations of solar panel installation were agreed upon with the district. Present technology incorporates the use of solar cell arrays that produce direct current (DC) electricity. The DC current is converted to alternating current (AC) with the use of an electrical device known as an inverter. The amount of available roof area and ground space determines how large of a solar array can be installed on any given location.

The proposed system layouts can be found on the next pages.

Facilities Recommended for this Measure

- West Milford High School
- High School Parking Lot-Carport (Macopin Middle School is interconnection site)
- Apshawa Elementary School
- Maple Road Elementary School
- Paradise Knoll Elementary School
- Upper Greenwood Lake Elementary School
- Bus Garage/Maintenance

Scope of Work

West Milford High School – 751.88 kW-DC

Macopin Middle School - Carport in High School Parking Lot - 234 kW-DC

Apshawa Elementary School 73.68 kW-DC

Maple Road Elementary School 91.13 kW-DC

Paradise Knoll Elementary School 119.53 kW-DC

Upper Greenwood Lake Elementary School 85.5 kW-DC

Bus Garage/Maintenance 85.5 kW-DC

SECTION 5. MEASUREMENT AND VERIFICATION

Measurement & Verification (M&V) Methodologies

This section contains a description of the types of Measurement and Verification (M&V) methodologies that Energy Systems Group will use to guarantee the performance of this project.

They have been developed and defined by two independent authorities:

- International Performance Measurement and Verification Protocol (IPMVP)
- Federal Energy Management Program (FEMP)

There are four guarantee options that may be used to measure and verify the performance of a particular energy conservation measure. Each one is described below.

Option A – Retrofit Isolation: Key Parameter Measurement

Energy savings is determined by field measurement of the key parameters affecting the energy use of the system(s) to which an improvement measure was applied separate from the energy use of the rest of the facility. Measurement frequency ranges from short-term to continuous, depending on the expected variations in the measured parameter, and the length of the reporting period.

Measurement of key parameters means that those parameters not selected for field measurement will be estimated. Estimates can be based on historical data, manufacturer's specifications, or engineering judgment. Documentation of the source or justification of the estimated parameter will be described in the M&V plan in the contract. Energy savings is determined through engineering calculations of the baseline and post-retrofit energy used based on the combination of measured and estimated parameters, along with any routine adjustments.

Option B – Retrofit Isolation: All Parameter Measurement

Like Option A, energy savings is determined by field measurement of the energy use of the systems to which an improvement measure was applied separate from the energy use of the rest of the facility. However, all of the key parameters affecting energy use are measured; there are no estimated parameters used for Option B. Measurement frequency ranges from short-term to continuous, depending on the expected variations in the savings and the length of the reporting period. Energy savings is determined through engineering calculations of the baseline and post-retrofit energy used based on the measured parameters, along with any routine adjustments.

Option C – Whole Building Metering/Utility Bill Comparisons

Option C involves the use of utility meters or whole building sub-meters to assess the energy performance of a total building. Option C assesses the impact of any type of improvement measure, but not individually if more than one is applied to an energy meter. This option determines the collective savings of all improvement measures applied to the part of the facility monitored by the energy meter. In addition, since whole building meters are used, savings reported under Option C include the impact of any other change made in facility energy use (positive or negative).

Option C may be used in cases where there is a high degree of interaction between installed improvement measures or between improvement measures and the rest of the building or the isolation and measurement of individual improvement measures is difficult or too costly.

This Option is intended for projects where savings are expected to be large enough to be discernable from the random or unexplained energy variations that are normally found at the level of the whole facility meter. The larger the savings, or the smaller the unexplained variations in the baseline, the easier it will be to identify savings. In addition, the longer the period of savings analysis after installing the improvement measure, the less significant is the impact of short-term unexplained variations. Typically, savings should be more than 20% of the baseline energy use if they are to be separated from the noise in the baseline data.

Periodic inspections should be made of all equipment and operations in the facility after the improvement measure installation. These inspections will identify changes from baseline conditions or intended operations. Accounting for changes (other than those caused by the improvement measures) is the major challenge associated with Option C-particularly when savings are to be monitored for long periods.

Savings are calculated through analysis of whole facility utility meter or sub-meter data using techniques from simple comparison to regression analysis.

Option D – Calibrated Simulation

Option D involves the use of computer simulation software to predict energy use, most often in cases where baseline data does not exist. Such simulation models must be calibrated so that it predicts an energy use and demand pattern that reasonably matches actual utility consumption and demand data from either the base-year or a post-retrofit year.

Option D may be used to assess the performance of all improvement measures in a facility, akin to Option C. However, different from Option C, multiple runs of the simulation in Option D allow estimates of the savings attributable to each improvement measure within a multiple improvement measure project.

Option D may also be used to assess just the performance of individual systems within a facility, akin to Option A and B. In this case, the system's energy use must be isolated from that of the rest of the facility by appropriate meters.

Savings are calculated using energy use simulation models, calibrated with hourly or monthly utility billing data and/or end-use metering.

Selecting M&V Options for a Specific Project

The tailoring of your specific M&V option is based on the level of M&V precision required to obtain the desired accuracy level in the savings determination and is dependent on:

- The complexity of the Energy Conservation Measure
- The potential for changes in performance
- The measured savings value.

The challenge of the M&V plan is to balance three related elements:

- The cost of the M&V Plan
- Savings certainty
- The benefit of the particular conservation measure.

Savings can also be non-measured. If savings are non-measured, these savings are mutually agreed upon as achieved at substantial completion of the respective facility improvement measure and shall not be measured or monitored during the term of the performance contract. Non-measured energy savings are limited to no more than 10-15% of the overall project savings.

Recommended Performance Verification Methods

Energy Systems Group's performance verification methods are designed to provide the facility's administration with the level of M&V necessary to protect them from an under-performing ECM, yet have a minimal impact on the project's financial success.

The selection of the M&V methods to be used is based on the criteria as detailed by IPMVP and Energy Systems Group's experience with hundreds of successful performance contracts in the K-12, state, and local government sectors. Following is a table illustrating how the savings of the major energy conservation measures proposed for this project will be verified.

ECM Description	Measurement and Verification Method – Summary	Detail of M&V Methodology
Comprehensive LED Lighting Upgrades (Includes NJDI)	Option A: One-time pre and post-retrofit kW measurement. Burn hours agreed upon with school district.	Pre M&V: Lighting power readings will be taken on a sample of lighting fixtures. Lighting burn hours were measured through the use of light loggers. Post M&V: Lighting power readings will be taken on a sample of lighting fixtures. Measurements will occur once at the outset of the agreement. "Occupied" hours logged during the baseline data collection will be used as the post-installation burn hours. Energy Savings: Energy savings will be calculated using the actual measured wattage reduction and measured burn-hours.
Building Envelope & Weatherization	Non-Measured: Existing envelope deficiencies will be documented based on collected field data to provide a baseline for evaluating the effectiveness of the air barrier system. Post-retrofit verifications of improvements will be documented.	Pre M&V: The magnitude of the air infiltration caused by cracks and joint deficiencies was determined by field surveys. Post M&V: The areas identified for weatherization improvements will be verified to be complete through visual inspections and as-built documentation. A one-time infrared survey of the buildings, when seasonally appropriate, will be conducted for the M&V agreement. Energy Savings: Energy savings will be based on the ASHRAE crack method calculations. If the commissioning process reveals any variation in the as-built conditions, then savings will be adjusted accordingly.
Pipe Insulation/Blankets	Option A: Savings are from installing pipe insulation and insulation blankets.	Pre M&V: The surface temperature and the size of the space requiring insulation installation were measured during the field audit. Post M&V: Following installation, the size and the surface temperature of the space where the insulation is installed will be verified. Energy Savings: Savings are from a reduction in heat loss through uninsulated pipes and valves.

Kitchen Hood Control Upgrades	Non-measured: Savings are from the reduced operating hours and slower speed of the equipment.	Pre M&V: Quantity of motors and horsepower were determined in the field survey. Nameplate data was used to determine the total kW of related equipment. Post M&V: Once the installation is complete, the VFD's will be inspected to ensure proper operation. Energy Savings: Savings are from the reduced kW load of the equipment at reduced speed.
Cooling Tower VFD Upgrades	Option A: Savings are from the reduced operating hours of the plugged in equipment.	Pre M&V: Quantity of motors and horsepower were determined in the field survey. Nameplate data was used to determine the total kW of related equipment. Post M&V: Once the installation is complete, the VFD's will be inspected to ensure proper operation. During the guarantee term, actual operating conditions will be downloaded from the BMS to verify motors (and associated fans/pumps are being operated at part load. Energy Savings: Savings are from the reduced kW load of the equipment at reduced speed.
Boiler Replacements	Option A: Baseline energy consumption based on collected field data and combustion efficiency of existing boilers. Post installation energy consumption based on combustion efficiency of new boilers.	Pre M&V: Energy Systems Group will take a combustion efficiency test to verify the efficiency of existing boilers and estimate the fuel consumption of existing boilers based on collected field data and utility bills. Post M&V: Energy Systems Group will take a combustion efficiency test to verify the efficiency of new boilers. Energy Savings: Savings for the new boilers will be determined using the base heating load and the difference in efficiencies between the existing boilers and new boilers.
Walk-In Cooler/Freezer Controls	Non-Measured: Savings are from the reduced electric consumption of freezer and refrigerator.	Pre M&V: Manufacturer's data and operating parameters will be collected on the freezer and refrigerator. Post M&V: Once the installation is completed, the walk-in box control system will be inspected to ensure proper operation. Energy Savings: Savings are from the reduced electric consumption of freezer and refrigerator.
Combined Heat and Power	Option B: Savings are from the electric and heat provided by the cogeneration system.	Pre M&V: The baseline utility bills were analyzed to determine baseline heating and electric loads and the time that the cogeneration system is able to operate per year and the capacity of the cogeneration system. Post M&V: The electric generation output from the cogeneration system will be measured with an electric meter. The heat output from the

		cogeneration system will be determined by measuring the water inlet/outlet temperature and flow rate. The gas input to the cogeneration system will be measured with a gas meter. Combined, these data points will be used to verify the conversion efficiency of the cogeneration system. Energy Savings: Savings are from the electric and heat provided by the cogeneration system.
Building Automation Controls Upgrades - Central Plant	Option A: Savings are from implementing control strategies.	Pre M&V: Accepted engineering practices / building simulations will be used to calculate energy consumption baselines. Operating parameters of the system will be verified through BAS system. Post M&V: Various control points within the building management system will be trended and/or totalized. This data will be used to verify that all control strategies are in place and functioning as intended. Energy Savings: Savings are from implementing control strategies.
Building Automation Controls Upgrades - Primary AHUs	Option A: Savings are from implementing control strategies.	Pre M&V: Accepted engineering practices / building simulations will be used to calculate energy consumption baselines. Operating parameters of the system will be verified through BAS system. Post M&V: Various control points within the building management system will be trended and/or totalized. This data will be used to verify that all control strategies are in place and functioning as intended. Energy Savings: Savings are from implementing control strategies.
Building Automation Controls Upgrades - Terminal Units	Option A: Savings are from implementing control strategies.	Pre M&V: Accepted engineering practices / building simulations will be used to calculate energy consumption baselines. Operating parameters of the system will be verified through BAS system. Post M&V: Various control points within the building management system will be trended and/or totalized. This data will be used to verify that all control strategies are in place and functioning as intended. Energy Savings: Savings are from implementing control strategies.
Boiler Controllers / Fuel Use	Non-Measured: Savings are from the optimized on	Pre M&V: Manufacturer's data and existing operating parameters will be collected on the

Economizers (Includes NJDI)	and off cycles of the burner ignition	boilers. Post M&V: The boiler controllers will be inspected following installation to verify proper operation Energy Savings: Savings are from the optimized on and off cycles of the burner ignition.
Transformer Replacement	Non-Measured: Savings are from installing high efficiency transformers.	Pre M&V: Manufacturer's data and operating parameters will be collected on the existing transformers. The efficiency of the existing transformers will be determined through the test. Post M&V: Once the installation is completed, the new transformers will be inspected to verify if they are working properly. The efficiency of the new transformers will be determined through the test. Energy Savings: Savings are from reduced losses from installing high efficiency transformers.
Domestic Water Heater Replacement	Non-Measured: Savings are from installing high efficiency domestic water heater(s).	Pre M&V: Manufacturer's data and operating parameters will be collected on the existing domestic water heaters (DWH's). The efficiency of the existing DWH's will be determined by a combustion analysis test. Post M&V: Once the installation is completed, the new DWH will be inspected to verify if they are working properly. The efficiency of the new DWH's will be determined through the same test. Energy Savings: Savings are from reduced losses from installing high efficiency DWH's.
Unit Ventilator Refurbishment	Non-Measured: Savings are from replacing the existing unit ventilators with new unit ventilators.	Pre M&V: Manufacturer's data and operating parameters will be collected on the unit ventilators requiring refurbishment. Post M&V: The refurbished unit ventilators will be inspected following installation to verify proper operation. Energy Savings: Savings are from improving the efficiency by refurbishing the existing unit ventilators.
Retro-Commissioning	Non-Measured: Savings are retro-commissioning the HVAC equipment to ensure they are working as expected.	Pre M&V: Accepted engineering practices / building simulations will be used to calculate energy consumption baselines. Operating parameters of the system will be verified through BAS system. Post M&V: Various control points within the building management system will be trended and/or totalized. This data will be used to verify that all control strategies are in place and functioning as intended. Energy Savings: Savings are retro-commissioning the HVAC equipment to ensure they are working as expected.

Plug Load Management	Non-Measured: Savings are from reduced electric consumption by controlling plugged equipment.	Pre M&V: Manufacturer's data of the plug load and the occupancy mode of the affected spaces will be collected during the field audit. Typical plug load is assumed to run 24 hours per day. Post M&V: The occupancy mode is assumed to be same pre and post, so the post retrofit operating hours are determined as the "occupied" hours from the pre- installation. Following the installation, a sample of sensors and correspondent equipment associated with them will be inspected to ensure the sensors are in place and operating. Energy Savings: Savings are from reduced electric consumption by controlling plugged equipment.
HVAC Armor-Refurbish Condensing Units and Cooling Tower	Option A: Savings are from reduced electric consumption by improving efficiency of equipment.	Pre & Post M&V: Measure performance of the unit, with the following test points: • Compressor Inlet Pressure or Evaporator Reference Pressure (refrigerant) • Compressor Discharge Pressure (refrigerant) • Compressor Discharge Temperature (refrigerant). • Condenser Outlet Temperature (refrigerant) • Outdoor Air Temperature or Entering Cooling Water Temperature. • Evaporator Water Inlet Temperature or Evaporator Air Return Temperature.
Destratification Fans	Non-Measured: Savings are from reduced heating energy consumption by maintaining circulation of heated air.	Pre M&V: Manufacturer's data and operating parameters will be collected on the units. Post M&V: The destratification fans will be inspected following installation to verify proper operation. Energy Savings: Savings are from improving the circulation of heated air.

Measurement and Verification Services

Measurement and Verification Services will be provided in association with the guarantee provided by Energy Systems Group. The guarantee will be in effect for each year that the District elects to participate in the Measurement and Verification Services. The cost of the measurement and verification services is included in the business case in the "Annual Services" column as outlined in the table below:

Year	Annual Amount ($/Yr)
1	$25,925
Total	**$25,925**

ESG will provide the M&V Services set forth below in connection with the Assured Performance Guarantee.

- During the Installation Period, an ESG Performance Engineer will track Measured Project Benefits. ESG will report the Measured Project Benefits achieved during the Installation Period, as well as any Non-Measured Project Benefits applicable to the Installation Period, to Customer within 90 days of the commencement of the Guarantee Term.
- Within 90 days of of the commencement of the Guarantee Term, ESG will provide Customer with a one-time report containing:
    - An executive overview of the project's performance and Project Benefits achieved to date;
    - A summary analysis of the Measured Project Benefits accounting; and
    - Depending on the M&V Option, a detailed analysis of the Measured Project Benefits calculations.
- During the Guarantee Term, an ESG Performance Engineer will monitor the on-going performance of the Improvement Measures, as specified in this Agreement, to determine whether anticipated Measured Project Benefits are being achieved. The Performance Engineer will visit Customer regularly and assist Customer on-site or remotely, with respect to the following activities:
    - Review of information furnished by Customer from the facility management system to confirm that control strategies are in place and functioning;
    - Advise Customer's designated personnel of any performance deficiencies based on such information;
    - Coordinate with Customer's designated personnel to address any performance deficiencies that affect the realization of Measured Project Benefits; and
    - Inform Customer of opportunities to further enhance project performance and of opportunities for the implementation of additional Improvement Measures.
    - Track utility bills on a monthly basis to determine current utility rate costs and to identify any billing anomalies.
- For specified Improvement Measures, ESG will:
    - Conduct pre and post installation measurements required under this Agreement;
    - Confirm the building management system employs the control strategies and set points specified in this Agreement; and
    - Analyze actual as-built information and adjust the Baseline and/or Measured Project Benefits to conform to actual installation conditions (e.g., final lighting benefits calculations will be determined from the as-built information to reflect the actual mix of retrofits encountered during installation).
    - Confirm that the appropriate metering and data points required to track the variables associated with the applicable Improvement Measures' benefits calculation formulas are established; and
    - Set up appropriate data capture systems (e.g., trend and totalization data on the facility management system) necessary to track and report Measured Project Benefits for the applicable Improvement Measure.

SECTION 6. CUSTOMER SUPPORT

Maintenance Impacts/ On-Going Service

New pieces of equipment that are installed as part of the ESIP project will be provided with the standard manufacturer warranty. Once installation of the equipment is complete, the remaining warranty period will be transferred to West Milford Township School District; any warranty issues will be handled directly with the equipment manufacturer rather than with Energy Systems Group.

a) ESG subcontractors will warranty the installation for a period of 12 months, beginning at substantial completion.

b) In addition, ESG will facilitate warranty related issues for a period of 12 months, beginning at substantial completion. Extended manufacture warranties beyond the 12 month installation warranty period will be facilitated by the District.

The installation of the recommended measures will reduce the amount of emergency maintenance required by the district through the installation of new equipment; however, preventative maintenance is still required in order to ensure the correct operation of the equipment for the expected lifetime. A service agreement cannot be included as part of this project per the New Jersey Local Finance Notice 2009-11. Once the scope is finalized and bids are received, Energy Systems Group will assist the District in preparing bids for any preventative service agreement that is felt necessary for the new equipment. The service agreement will cover recommended maintenance per each equipment manufacturer. Training on the proper maintenance and operation of each piece of equipment has also been included as part of the ESIP project which will allow the District to complete the majority of maintenance and repair in-house in order to utilize District resources.

In order to ensure the District is fully capable of achieving the energy savings and fully utilizing the new HVAC and Building Automation Systems, Energy Systems Group has included training for district employees.

Energy Systems Group recommends the District go out to bid for the following 3rd party service contracts in order to achieve the continuous savings throughout the term of the Energy Savings Improvement Program:

- Cogeneration Service Agreement to allow for emergency service and preventative maintenance on the new cogeneration systems. In order to receive the incentives for the cogeneration system, a 10-year maintenance contract must be in place.

Services for Lighting, Boiler Replacements, Combined Heat and Power, Plug Load Management, and walk-in freezer controller upgrades, such as filter changes and on-going maintenance can be completed by District staff.

Design and Compliance Issues

West Milford Township School District will work closely with Energy Systems Group and CHA Consulting Inc. (CHA) to oversee and complete all design engineering for the purposes of public bidding of the work as well as completing construction drawings.

As part of the Energy Savings Plan development, Energy Systems Group completed a thorough analysis of the building electrical and mechanical systems including light level readings throughout the spaces. The existing light levels are typically within 10-20% of current Illumination Engineering Society (IES) recommendations, which is reasonable given the varying age of lamps throughout the District. The proposed lighting solution will continue to adhere to current IES and NJ Education Code guidelines for light levels, which in many cases may increase the current light levels to the spaces. At this time, Energy Systems Group did not observe any compliance issues in the development of this Energy Savings Plan.

Customer Risks

Asbestos reports were obtained and reviewed for all schools as part of Energy Systems Group's safety policy. Based on the reports, asbestos materials will have to be abated prior to any work being performed. If any additional asbestos is found during the installation of the measures, Energy Systems Group will stop work and notify the School District. Any work associated with testing or remediation of asbestos containing material will be the responsibility of West Milford Township School District. Based on the asbestos reports provided, we feel this is a low risk item.

The NJ SmartStart and Demand Response Energy Efficiency Credit Incentives outline the anticipated incentive amounts to West Milford Township School District. Energy Systems Group does not guarantee the rebate or state incentive structure. If the programs change or the incentive amounts differ, West Milford Township School District. will be responsible to make up the difference in received incentives for the financing. The difference could result from over performance of energy conservation measures, other rebates/ incentives that may be available, restructuring the loan payment for years 1 and 2, or capital contributions by the District.

Public Engagement and Community Outreach

Student Engagement in ESIP Development: ESG has involved students at all levels in the energy related fields. At West Milford, we plan to expand on interests related to energy conservation throughout the district and would welcome and actively encourage student involvement in various phases of the proposed project. Furthermore, in line with our commitment, and with West Milford's concurrence, we propose to offer presentations to Energy Clubs, including them in the process.

STEM EXPO Sponsorship: ESG has a history of sponsoring STEM programs for many school districts and Universities across the country. If selected, ESG would like to sponsor the West Milford's Annual STEM EXPO and further complement your Engineering/Technology Science curriculum.

Community Outreach Program: ESG is focused on creating a partnership with West Milford Township Public Schools that will extend beyond the scope of this project. Keeping the community informed and involved in the process is key to success. One way this can be achieved is thru a ***Community Scholarship Program.*** At Northern Illinois University (NIU), ESG established The **Energy Systems Group Scholarship Award in Engineering** to underscore our commitment. Established in 2001, ESG and NIU jointly select students for award of this scholarship. To date, we have awarded **$35,000** to NIU engineering students with superior academic excellence. ESG would like to establish a similar program for West Milford Township Public Schools.

ESG will seek to develop and build partnerships between The National Education Foundation (NEF) and the West Milford Township Public Schools. These partnerships were developed by ESG and the NEF, to bring engineering and engineering technology career opportunities to students through the educational programs offered by the University of Salt Lake City Utah. These programs help students who might not otherwise consider careers in these sciences or further expand the knowledge of the children who are participating in such class. In addition, this affords local colleges and Universities the opportunity to recruit future applicants from the local school boards. Some of these programs are listed below:

Student Engagement in ESIP Development: ESG has involved students at all levels in the energy related fields. At West Milford, we plan to expand on interests related to energy conservation throughout the West Milford Distrcit campus and would welcome and actively encourage student involvement in various phases of the proposed project. Furthermore, in line with our commitment, and with West Milford's concurrence, we propose to offer presentations to Energy Clubs, including them in the process.

Solar Photovoltaic Systems at Work Grades 9-12: This program includes learning activities for the secondary levels and a supply kit to investigate solar energy and its uses. Additional instructional materials include the Renewable Energy Sources poster, Energist, the Electrical Generation poster and Energist, the Energy Basics CD, and the Eye Chart poster. The program can stand alone or complement Energy Fun, Energy Fundamentals, Energy Action Technology, or Energy Action Patrol.

Career Exploration, grades 11-12: Provides students with career related work experience while obtaining up to 40 hours of academic credit. The program allows students a superb opportunity to integrate classroom theory into the world of work, as well as providing career option exploration, skill development, work environment exposure, and professional contacts.

SECTION 7: IMPLEMENTATION SCHEDULE

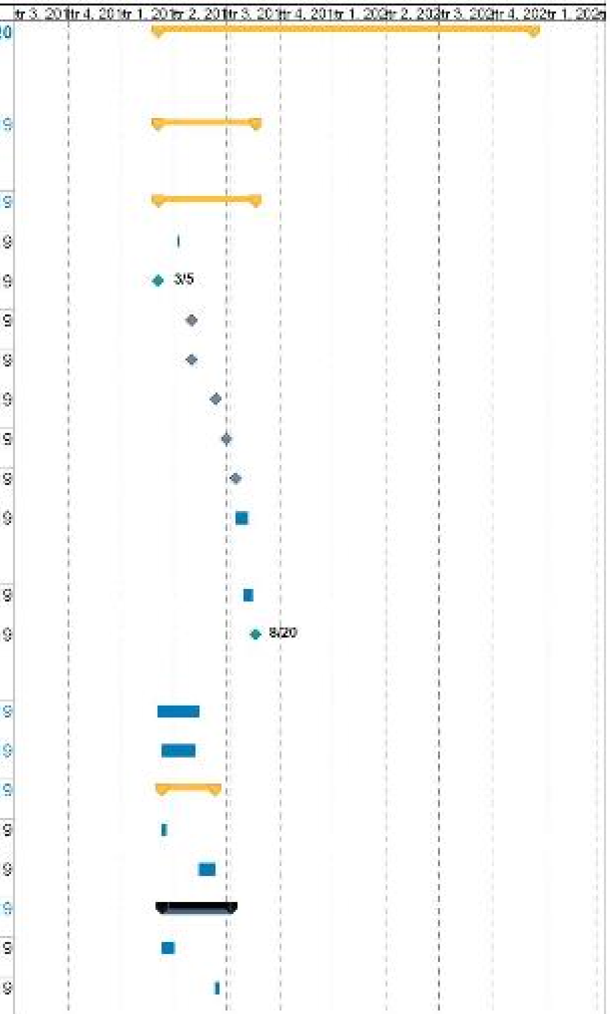
A preliminary installation schedule for the measures implemented as part of the ESP is included below to provide a reasonable expectation for the timeline of construction. Once final bids are received and financing of the project is complete, the installation will be finalized in much greater detail and reviewed with the team from the West Milford Township School District to ensure agreement. A high-level review of the next steps in the process is shown below as well as the estimated time frame to complete each step:

- Accept Energy Savings Plan Pending Necessary Reviews – July 1, 2019
- Complete Third Party Engineering Review of Energy Savings Plan – 2 weeks (July 15 – July 29)
- Complete Board of Public Utilities Review of Energy Savings Plan – 14 days (July 30 – August 13)
- Approval resolution to contract with Energy Systems Group: August 20, 2019
- Financing of project: 21 days (August 20 – October 21)
- Complete 100% design drawings and bid specifications – November 25, 2019
- Public bidding for Sub-Contractors – December 3 – December 31
- Installation – November 2019 - December 2020
- Maintenance: On-going

The project plan on the following page details the Installation Phase schedule.

West Milford Township Public Schools
ESP Development & Installation Schedule

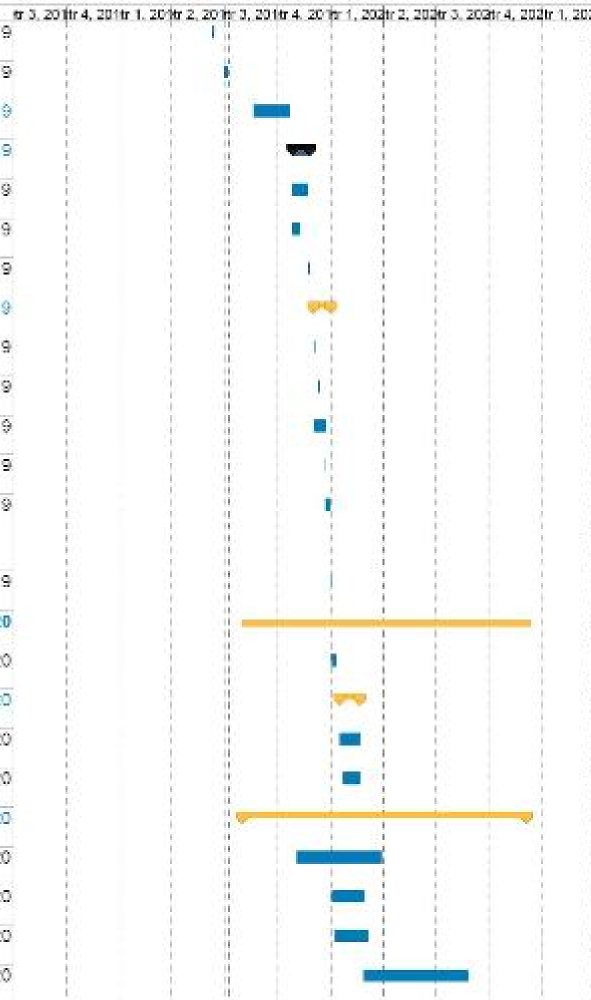
ID	Task Name	Duration	Start	Finish
1	**West Milford Township Public Schools (WMTPS)**	**463 days**	**Tue 3/5/19**	**Thu 12/10/20**
2	Phase 1: Investment Grade Audit/ Energy Savings Plan	121 days	Tue 3/5/19	Tue 8/20/19
3	Major Milestones	121 days	Tue 3/5/19	Tue 8/20/19
4	Signed Investment Grade Audit Agreement	1 day	Mon 4/8/19	Mon 4/8/19
5	Customer Kick-off Workshop	0 days	Tue 3/5/19	Tue 3/5/19
6	ECM Verification Workshop	0 days	Thu 5/2/19	Thu 5/2/19
7	Baseline Utility Workshop	0 days	Thu 5/2/19	Thu 5/2/19
8	Measurement & Verification Workshop	0 days	Thu 6/13/19	Thu 6/13/19
9	Business Case Workshop	0 days	Mon 7/1/19	Mon 7/1/19
10	IGEA Results Presented to WMTPS	0 days	Tue 7/16/19	Tue 7/16/19
11	3rd Party Engineering Review Complete and Comments Addressed	3 wks	Wed 7/17/19	Tue 8/6/19
12	Submit Energy Savings Plan to BPU for Review	10 days	Wed 7/31/19	Tue 8/13/19
13	WMTPS Approval & Acceptance of ESP & ESG Contract	0 days	Tue 8/20/19	Tue 8/20/19
14	Detailed Site Visits	10 wks	Tue 3/5/19	Mon 5/13/19
15	Scope Design & Construction Cost Estimating	8 wks	Tue 3/12/19	Mon 5/6/19
16	Detailed Energy Analysis	65 days	Tue 3/12/19	Mon 6/10/19
17	Update Utility Bills	1 wk	Tue 3/12/19	Mon 3/18/19
18	Energy Saving Calculations	4 wks	Tue 5/14/19	Mon 6/10/19
19	ESP Report Development	85 days	Tue 3/12/19	Mon 7/8/19
20	Detailed Scope Write-up	15 days	Tue 3/12/19	Mon 4/1/19
21	Detailed Energy Savings Analysis	5 days	Tue 6/11/19	Mon 6/17/19



Page 1

West Milford Township Public Schools
ESP Development & Installation Schedule

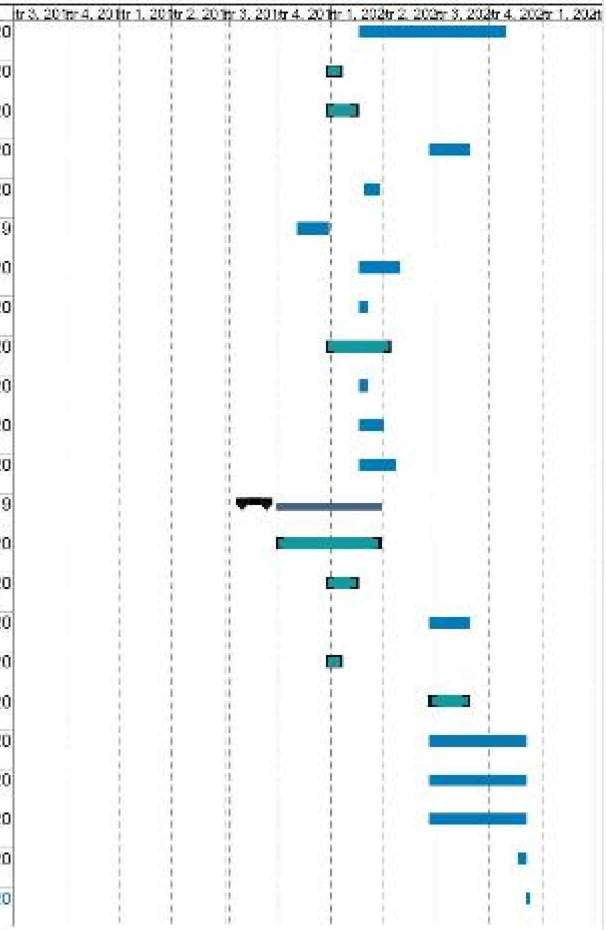
ID	Task Name	Duration	Start	Finish
22	Develop Business Case	3 days	Tue 6/11/19	Thu 6/13/19
23	Energy Savings Plan Appendix	6 days	Mon 7/1/19	Mon 7/8/19
24	Project Financing	45 days	Tue 8/20/19	Mon 10/21/19
25	Phase 2: Design	21 days	Mon 10/28/19	Mon 11/25/19
26	Final Design Engineering	4 wks	Mon 10/28/19	Fri 11/22/19
27	Bid Specification Development	2 wks	Mon 10/28/19	Fri 11/8/19
28	Final Design Review Workshop	1 day	Mon 11/25/19	Mon 11/25/19
29	Phase 3: Procurement	21 days	Tue 12/3/19	Tue 12/31/19
30	Advertise Bids	1 day	Tue 12/3/19	Tue 12/3/19
31	Pre-Proposal Conference & Site Visits	1 day	Wed 12/11/19	Wed 12/11/19
32	Bid Duration for Subcontractors	3 wks	Tue 12/3/19	Mon 12/23/19
33	Opening of Bids	1 hr	Mon 12/23/19	Mon 12/23/19
34	Evaluation of Bids and Confer on Selection of Sub-Contractors	1 wk	Tue 12/24/19	Mon 12/30/19
35	Subcontractor Selection	1 day	Tue 12/31/19	Tue 12/31/19
36	**Phase 4: Construction**	**289 days**	**Mon 11/4/19**	**Thu 12/10/20**
37	Issue Subcontracts	1 wk	Thu 1/2/20	Wed 1/8/20
38	Pre- Construction Activities	25 days	Thu 1/16/20	Wed 2/19/20
39	Planning / Engineering	25 days	Thu 1/16/20	Wed 2/19/20
40	Shop Drawing Approval	20 days	Thu 1/23/20	Wed 2/19/20
41	Installation of Recommended ECMs	351 days	Thu 8/1/19	Thu 12/3/20
42	Direct Install	105 days	Mon 11/4/19	Fri 3/27/20
43	Construction Contingency	40 days	Thu 1/2/20	Wed 2/26/20
44	P4P	40 days	Thu 1/9/20	Wed 3/4/20
45	Boiler Replacements	130 days	Thu 2/27/20	Wed 8/26/20



Page 2

West Milford Township Public Schools
ESP Development & Installation Schedule

ID	Task Name	Duration	Start	Finish
46	Building Envelope Upgrades	180 days	Thu 2/20/20	Wed 10/28/20
47	Cogeneration (CHP)	20 days	Tue 12/24/19	Mon 1/20/20
48	Cooling Tower Fan - VFD	40 days	Tue 12/24/19	Mon 2/17/20
49	Destratification Fans	50 days	Fri 6/19/20	Thu 8/27/20
50	DHW Replacement	20 days	Thu 2/27/20	Wed 3/25/20
51	Fuel Economizer	40 days	Mon 11/4/19	Fri 12/27/19
52	HVAC Armor-Refurbish Condensing Units	50 days	Thu 2/20/20	Wed 4/29/20
53	Kitchen Hood Control Upgrades	10 days	Thu 2/20/20	Wed 3/4/20
54	Lighting Upgrades - LED	80 days	Tue 12/24/19	Mon 4/13/20
55	Motor Upgrades	10 days	Thu 2/20/20	Wed 3/4/20
56	Pipe and Valve Insulation	30 days	Thu 2/20/20	Wed 4/1/20
57	Plug Load Controls	45 days	Thu 2/20/20	Wed 4/22/20
58	Roof Restoration at Upper / Apshawa / PK	30 days	Thu 8/1/19	Wed 9/11/19
59	PPA	130 days	Mon 9/30/19	Fri 3/27/20
60	Refrigeration Control Upgrades	40 days	Tue 12/24/19	Mon 2/17/20
61	Retro-Commissioning	50 days	Fri 6/19/20	Thu 8/27/20
62	Transformer Upgrades	20 days	Tue 12/24/19	Mon 1/20/20
63	Unit Ventilator Refurbishment	50 days	Fri 6/19/20	Thu 8/27/20
64	Upgrade HVAC Controls to DDC-HVAC	120 days	Fri 6/19/20	Thu 12/3/20
65	Upgrade HVAC Controls to DDC-MER	120 days	Fri 6/19/20	Thu 12/3/20
66	Upgrade HVAC Controls to DDC-Unitary	120 days	Fri 6/19/20	Thu 12/3/20
67	System Commissioning	10 days	Fri 11/20/20	Thu 12/3/20
68	Project Close Out	5 days	Fri 12/4/20	Thu 12/10/20



Page 3

SECTION 8. SAMPLE ENERGY PERFORMANCE CONTRACT

A sample Energy Performance Contract has been provided electronically to the District for review.

APPENDIX 1. ENERGY CONSERVATION MEASURES INVESTIGATED BUT NOT RECOMMENDED AT THIS TIME

ECM: Premium Efficiency Motors

ECM Summary

GREENHECK Vari-Green Motor

The District has several motors that have older low-efficiency motors and have exceeded their useful life. Although this measure results in a poor payback period, it is recommended based on the potential for energy savings, improved occupant comfort and safety concerns.

On small motor applications, Electronically Commutated (EC) Motors have the proven potential to generate significant savings. These motors are typically in sizes up to 1 horsepower, and their efficiencies are high compared to the older fractional horsepower motors. Since these motors are without mechanical brushes and the commuter reduces friction losses, they work much like Direct Current (DC) motors. They are programmable and can be used for a wide range of applications.

Facilities Considered for this Measure

- All

ECM: Demand Response Programs

ECM Summary

West Milford Township School District is currently under contract for the Demand Response Program.

Facilities Considered for this Measure

- All Buildings

ECM: Replace Heat Pumps with High Efficiency Heat Pumps

ECM Summary

The District utilizes several heat pump systems that are nearing the end of their useful life. This ECM entails the replacement of the existing heat pump units with high efficiency systems. The proposed systems will reduce heating and cooling costs compared to the existing equipment and will include DDC controls that can be easily integrated into the proposed Building Management System. The new systems will also ensure that all equipment operates with a common, environmentally low-impact refrigerant minimizing the plants ozone depletion potential.

High Efficiency Water Source Heat Pumps

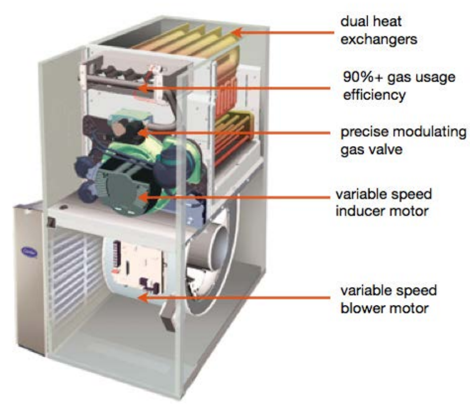
Facilities Considered for this Measure

- All

ECM: Replace AHU and Furnace with High Efficiency Furnace and AHU

ECM Summary

We recommend replacing existing standard efficiency AHUs and furnaces with condensing furnaces and high-efficiency condensing units. Improved combustion technology and heat exchanger design optimize heat recovery from the combustion gases which can significantly improve furnace efficiency. The proposed systems will reduce heating costs compared to the existing equipment and will include DDC controls that can be easily integrated into the proposed Building Management System.



High Efficiency Condensing Furnace

Facilities Considered for this Measure

- Administration Building

ECM: Installation of VRF Systems

ECM Summary

Variable refrigerant flow systems are a multi-split type HVAC system to provide the ability to condition the building and maintain individual zone control in each room, floor and area of the building. This type of system has precise individual controls and technology designed to minimize energy consumption and optimize energy savings above traditional HVAC systems. A modular design of outdoor units with a variety of indoor units allow for specified design and installation. A heat recovery system has a high initial cost, however the potential savings are significant. The system allows for the ability to provide heating and cooling to different spaces at the same time. Heat is essentially transferred to wherever in the system it is needed, without requiring the use of hot water or chilled water to be supplied to the space. Using this type of system requires electric heating and cooling. The coefficient of performance (COP) for heating is greater than 4.0, in comparison to a traditional electric resistance heating COP of 1.0. The integrated energy efficiency rating (IEER) are higher than 24, in comparison to water cooled air conditioners rated at 13.6 IEER as recommended by ASHRAE Standard 90.1-2013.

Per discussions with a representative from the leading manufacturer, the proposed system could utilize ceiling units integrated into the existing drop in ceiling. One of the biggest benefits of installing VRF in a situation like this is that the existing system and infrastructure can remain intact and untouched while VRF is being installed. It can be done where one day the hot water / chilled water is on and the next the VRF is on and the existing is off.

Facilities Recommended for this Measure

- Apshawa Elementary School
- Macopin Middle School
- Maple Road Elementary School
- Marshall Hill Elementary School
- Paradise Knoll School
- Upper Greenwood Lake Elementary School
- Westbrook Elementary School

ECM: Install Low Flow Plumbing Fixtures / Devices

ECM Summary

Bathroom fixtures offer good water saving opportunities because many of these fixtures can be retrofit to reduce the amount of water consumed per flush (toilets and urinals) or per minute of use (sinks and showers). Reducing sink and shower water usage also saves the thermal energy used to make hot water.

Facilities Considered for this Measure

- All buildings.

ECM: PC Power Management

ECM Summary

Energy Systems Group will furnish and install a software utility that measures, manages, and minimizes the energy consumed by the network's PC clients through one centralized interface. It provides IT departments with a powerful approach to automate energy-efficient "best practices" throughout their networks, while it adds new control and flexibility to traditional PC power management.

With the help and cooperation of the District, ESG will install and rapidly deploy PC Power Management software on the District's PC network. A one-day deployment plan will address server and client installation, basic administrative configurations, logical power management profile groupings, and energy consumption reporting. Ongoing technical support and product revisions, with an annual energy audit to ensure maximized energy savings are also included for a period of three years.

Facilities Considered for this Measure

- All buildings.

ECM: Stadium Lighting Upgrade

ECM Summary

Lighting Retrofit and Replacement: The existing Stadium Lighting at the High School utilizes older technologies that can be upgraded. Improvements to the stadium lighting will reduce electrical consumption, improve lighting uniformity and increase foot-candle levels. The system also has flexible dimming capabilities and timer controls for additional security. The cost of materials required to maintain the current fixtures will also be reduced since these renovations replace items that are near the end of their life cycle and/or considered environmentally hazardous.

Facilities Considered for this Measure

- High School

ECM: Window Film – Solar/Security Film

ECM Summary

Security window film mitigates hazards from shattered glass during natural disasters. Helps protect people from flying glass shards, one of the most common causes of blast-related injuries and fatalities. Micro-layered and tear-resistant to help increase security and provide added protection against smash and grab burglaries.

Facilities Considered for this Measure

- West Milford High School
- Macopin Middle School
- Apshawa Elementary School
- Maple Road Elementary School
- Marshall Hill Elementary School
- Paradise Knoll Elementary School
- Upper Greenwood Lake Elementary School
- Westbrook Elementary School
- Administration Building

ECM: Energy Star Refrigerator Replacement

ECM Summary

Energy Star labeled refrigerators are energy efficient refrigerators and should replace existing refrigerators. The replacement of older refrigerators will reduce the energy consumption of the equipment located throughout staff lounges. The refrigerators are a very visible item used by most of the staff throughout the day and will make a positive impact on the teachers by being replaced.

Facilities Considered for this Measure

- West Milford High School
- Macopin Middle School
- Apshawa Elementary School
- Maple Road Elementary School
- Marshall Hill Elementary School
- Paradise Knoll Elementary School
- Upper Greenwood Lake Elementary School
- Westbrook Elementary School

APPENDIX 2. ENERGY SAVINGS CALCULATIONS

Energy Savings

Energy savings were calculated using an Excel based bin calculation workbook developed by Energy Systems Group; all savings calculations and field measurements will be provided electronically.

Operational Savings

New LED Fixtures

Annual operational savings are calculated based on the reduced amount of material needed for replacement of the lighting system. This is calculated by comparing the existing lifetime of the T8, HID and halogen lamps to the new lifetime of LED lighting. The calculations are based on replacements of T8 fixtures every three years, T8 ballasts every 5 years, HID lamps every 5 years and halogen lamps being replaced every 2 years. The table below highlights the various lamp types and associated replacement timing as well as total cost with replacement. These savings do not include any costs for labor to replace the bulbs or additional material needed for replacement such as lifts, replacement fixtures, new sockets, etc.

Material Type	Lifetime	Cost/ Unit
Linear fluorescent (T8)	3 years	$5
Electronic Ballast	5 years	$25
HID Lamp	5 years	$25
HID Ballast	5 years	$75
Halogen, PARs, BRs	2 years	$10
Incandescent, CFLs, MRs	2 years	$2

This methodology is used to determine the annual savings through the replacement of all lamp types with new LED lamps and fixtures. The fixture warranty associated with each of these replacements is 10 years. Operational savings have been claimed for a total of 5 years per the BPU regulations.

Mechanical Upgrades (Boiler Replacement & Controls Upgrades)

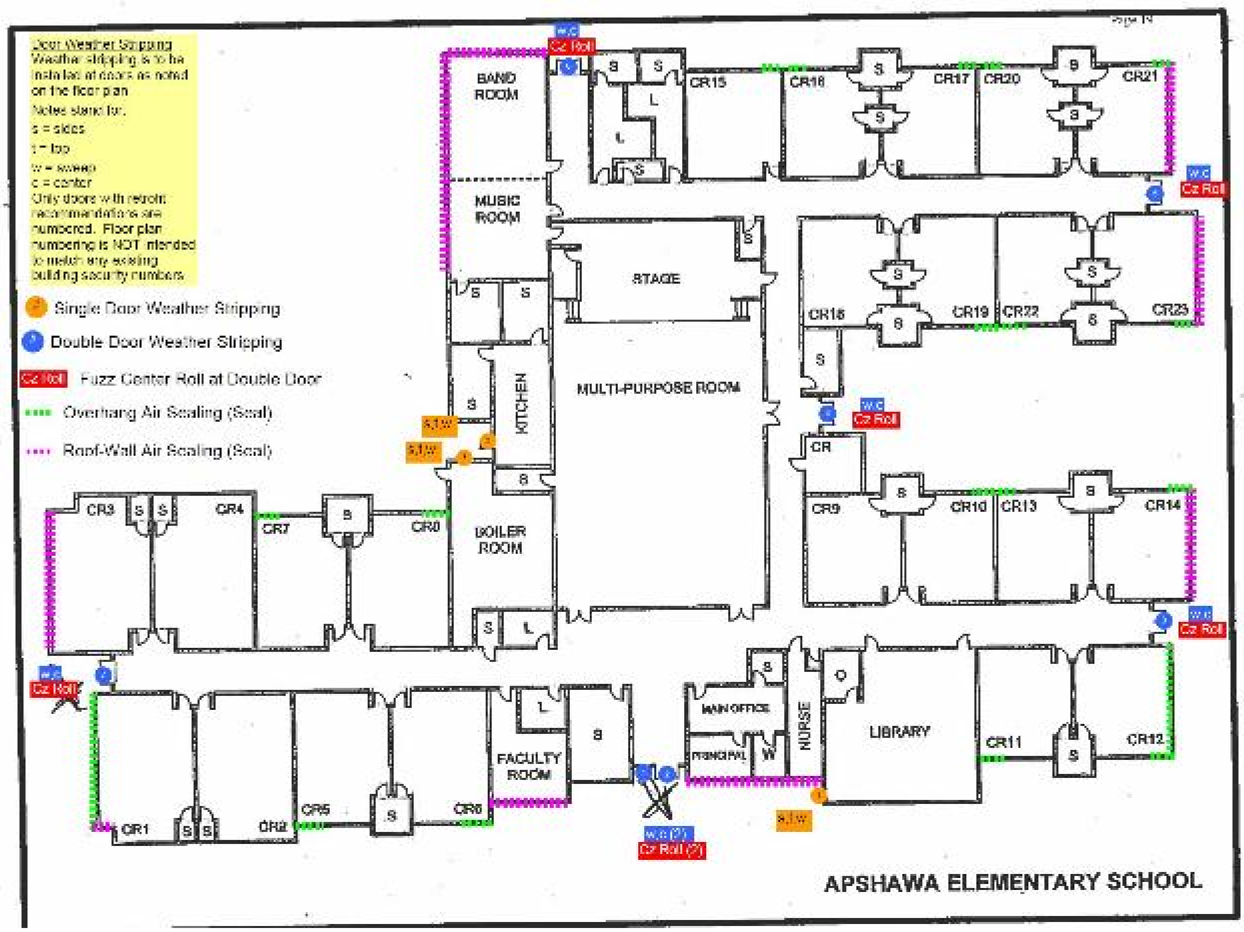
The annual operating expenses for West Milford was provided to Energy Systems Group in order to determine the amount of emergency repair maintenance conducted annually at the District. The installation of new equipment along with manufacturers' warranties will effectively eliminate the need for these emergency repair costs. The operational savings for these measures have been claimed for 2 years per the BPU regulations. A complete breakdown of the operational analysis for the District is included on the following pages.

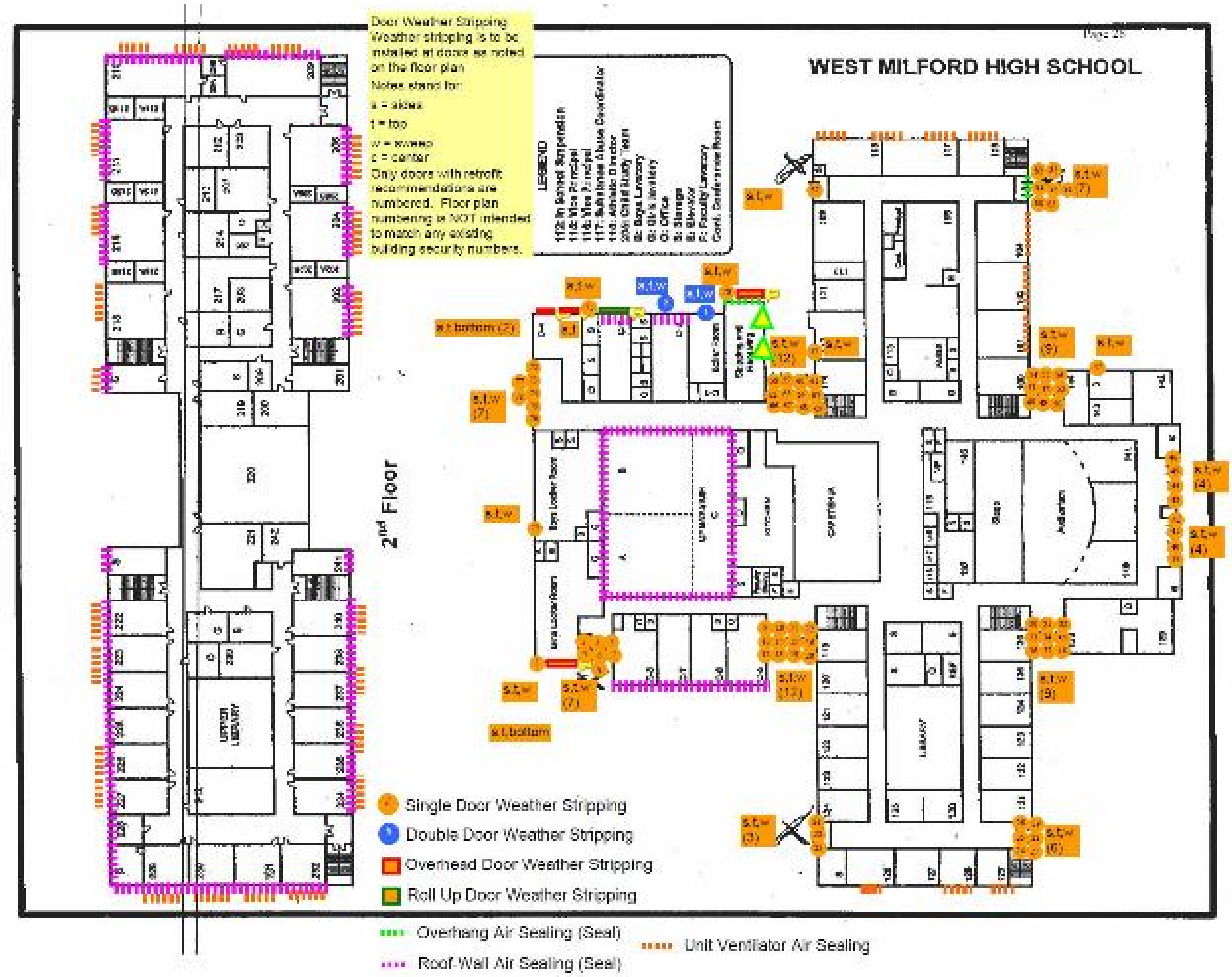
Operational Savings Summary

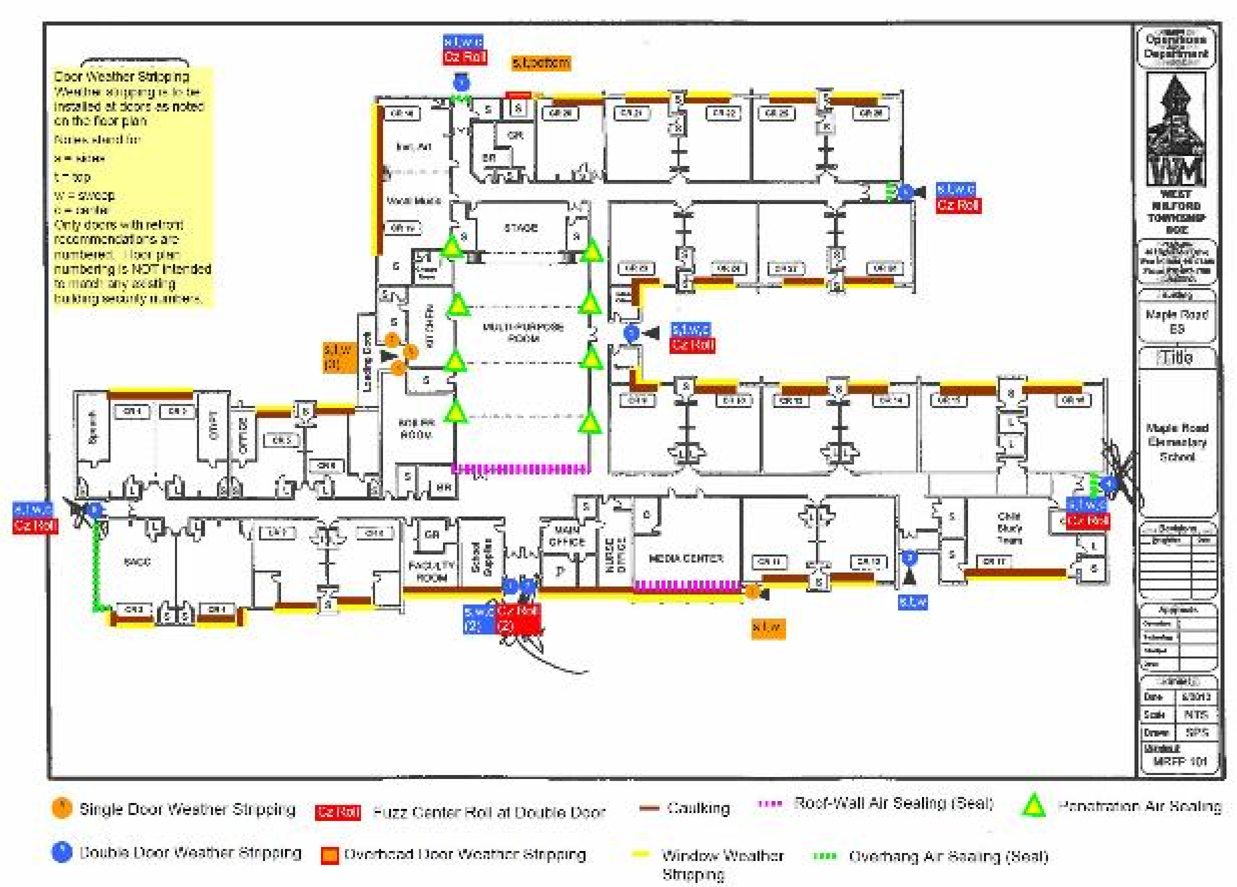
Energy Systems Group has worked with the District to quantify the exact sources of savings by going through past invoices and expenses. The table below summarizes the cost savings estimated from invoices provided by the District; these invoices are summarized only by the applicable ECMs and any non-recurring charge. Any preventative maintenance or service contracts that will remain were not factored into this analysis. The complete list of invoices is provided electronically. The operational savings will not be escalated.

Operational Savings for Financial Model	
ECM Description	**Annual Savings**
LED Lighting Upgrades & Occupancy Sensors – District Wide	$39,908
HVAC Upgrades / Equipment Replacement	$72,500
Totals	$112,408

APPENDIX 3. BUILDING ENVELOPE SCOPE DRAWINGS




Door Weather Stripping
Weather stripping is to be installed at doors as noted on the floor plan
Notes stand for:
s = sides
t = top
w = sweep
c = center
Only doors with retrofit recommendations are numbered. Floor plan numbering is NOT intended to match any existing building security numbers.
WEST MILFORD HIGH SCHOOL
2nd Floor
UPPER LIBRARY
LIBRARY
CAFETERIA
KITCHEN
Stage
Auditorium
Single Door Weather Stripping
Double Door Weather Stripping
Overhead Door Weather Stripping
Roll Up Door Weather Stripping
Overhang Air Sealing (Seal)
Roof-Wall Air Sealing (Seal)
Unit Ventilator Air Sealing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Notes stand for:
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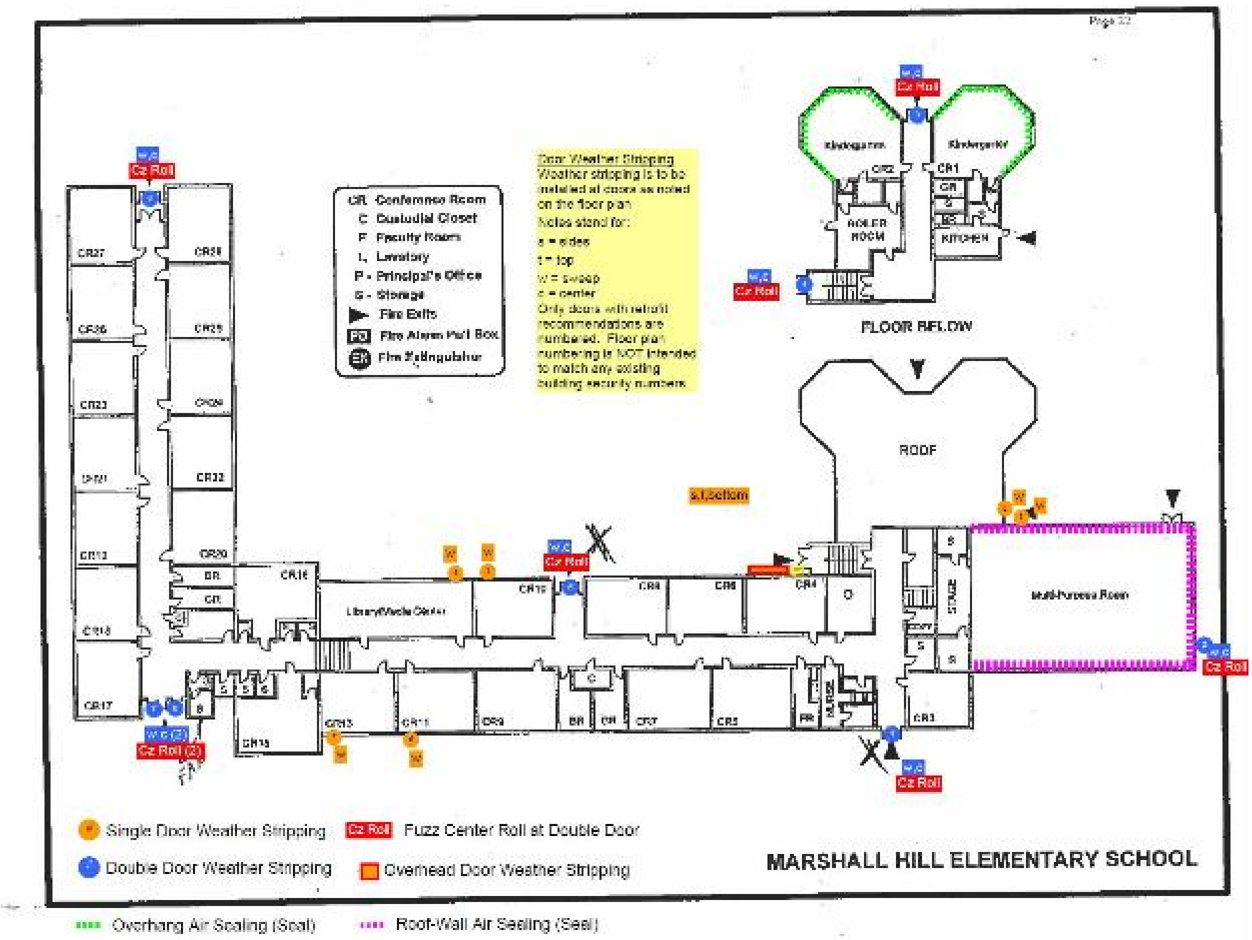
t = top
w = sweep
c = center
Only doors with retrofit recommendations are numbered. Floor plan numbering is NOT intended to match any existing building security numbers.
MULTI-PURPOSE ROOM
STAGE
KITCHEN
BOILER ROOM
MEDIA CENTER
MAIN OFFICE
NURSE OFFICE
FACULTY ROOM
School Supplies
Child Study Team
SACC
Speech
Loading Dock
Maple Road ES
Title
Maple Road Elementary School
MRFP 101
Single Door Weather Stripping
Cz Roll Fuzz Center Roll at Double Door
Caulking
Roof-Wall Air Sealing (Seal)
Penetration Air Sealing
Double Door Weather Stripping
Overhead Door Weather Stripping
Window Weather Stripping
Overhang Air Sealing (Seal)


Door Weather Stripping
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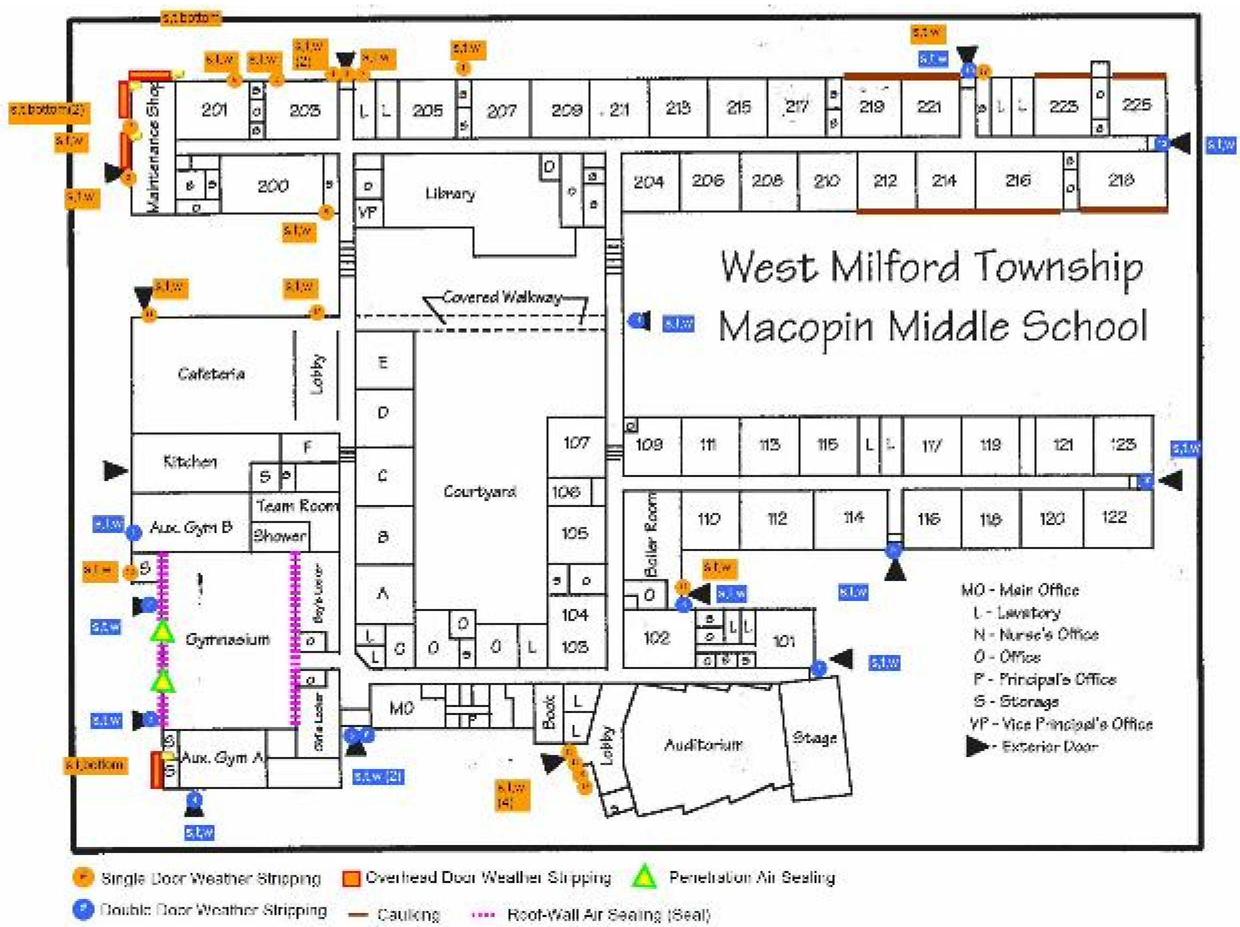
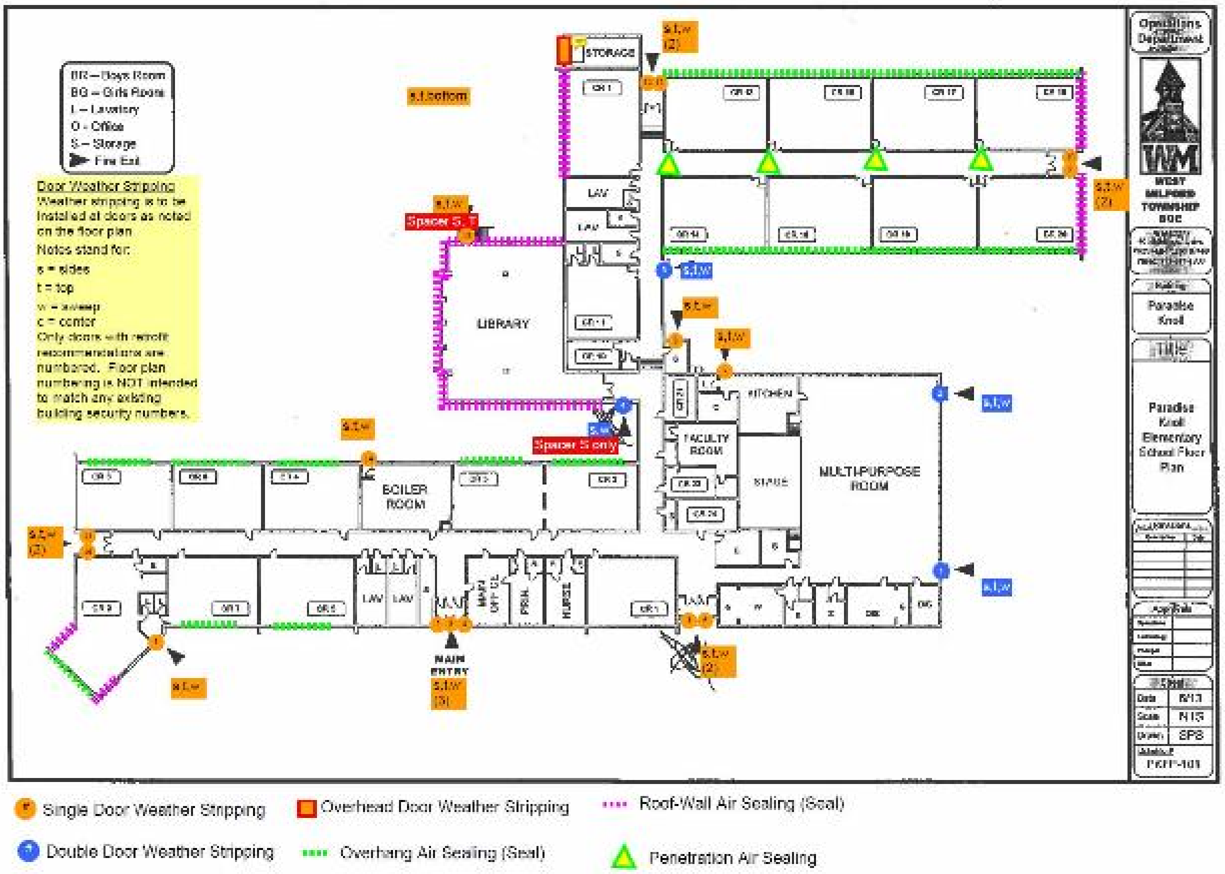
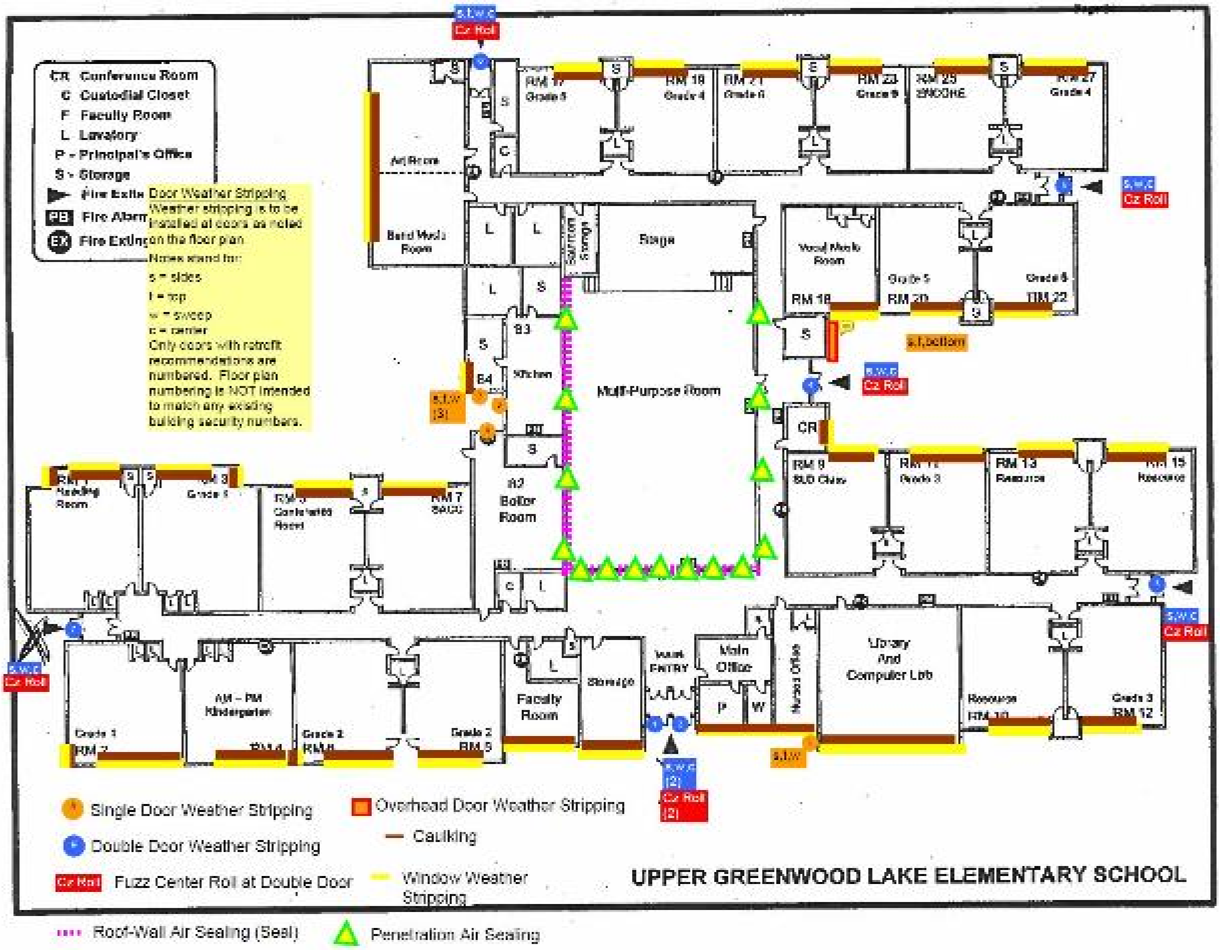
Notes stand for:
s = sides
t = top
w = sweep
c = center
Only doors with retrofit recommendations are numbered. Floor plan numbering is NOT intended to match any existing building security numbers.
CR Conference Room
C Custodial Closet
F Faculty Room
L Lavatory
P - Principal's Office
S - Storage
Fire Exits
FA Fire Alarm Pull Box
Fire Extinguisher
FLOOR BELOW
KITCHEN
ROOF
Multi-Purpose Room
STAGE
Library/Media Center
s,t,bottom
W,C
Cz Roll
W,C (2)
Cz Roll (2)
Single Door Weather Stripping
Double Door Weather Stripping
Fuzz Center Roll at Double Door
Overhead Door Weather Stripping
MARSHALL HILL ELEMENTARY SCHOOL
Overhang Air Sealing (Seal)
Roof-Wall Air Sealing (Seal)


West Milford Township
Macopin Middle School
MO - Main Office
L - Lavatory
N - Nurse's Office
O - Office
P - Principal's Office
S - Storage
VP - Vice Principal's Office
Exterior Door
Single Door Weather Stripping
Overhead Door Weather Stripping
Penetration Air Sealing
Double Door Weather Stripping
Caulking
Roof-Wall Air Sealing (Seal)
Cafeteria
Kitchen
Aux. Gym B
Gymnasium
Aux. Gym A
Library
Courtyard
Covered Walkway
Auditorium
Stage
Boiler Room
Maintenance Shop
Team Room
Shower


BR – Boys Room
BG – Girls Room
L – Lavatory
O – Office
S – Storage
Fire Exit
Door Weather Stripping
Weather stripping is to be installed at doors as noted on the floor plan
Notes stand for:
s = sides
t = top
w = sweep
c = center
Only doors with retrofit recommendations are numbered. Floor plan numbering is NOT intended to match any existing building security numbers.
STORAGE
s,t,bottom
Spacer S, T
Spacer S only
LIBRARY
LAV
KITCHEN
FACULTY ROOM
STAGE
MULTI-PURPOSE ROOM
BOILER ROOM
MAIN OFFICE
PRIN.
NURSE
MAIN ENTRY
s,t,w (2)
s,t,w (3)
Operations Department
WEST MILFORD TOWNSHIP BOE
Paradise Knoll
Paradise Knoll Elementary School Floor Plan
NTS
SPS
Single Door Weather Stripping
Overhead Door Weather Stripping
Roof-Wall Air Sealing (Seal)
Double Door Weather Stripping
Overhang Air Sealing (Seal)
Penetration Air Sealing


UPPER GREENWOOD LAKE ELEMENTARY SCHOOL
Single Door Weather Stripping
Double Door Weather Stripping
Cz Roll Fuzz Center Roll at Double Door
Overhead Door Weather Stripping
Caulking
Window Weather Stripping
Roof-Wall Air Sealing (Seal)
Penetration Air Sealing
Door Weather Stripping
Weather stripping is to be installed at doors as noted on the floor plan
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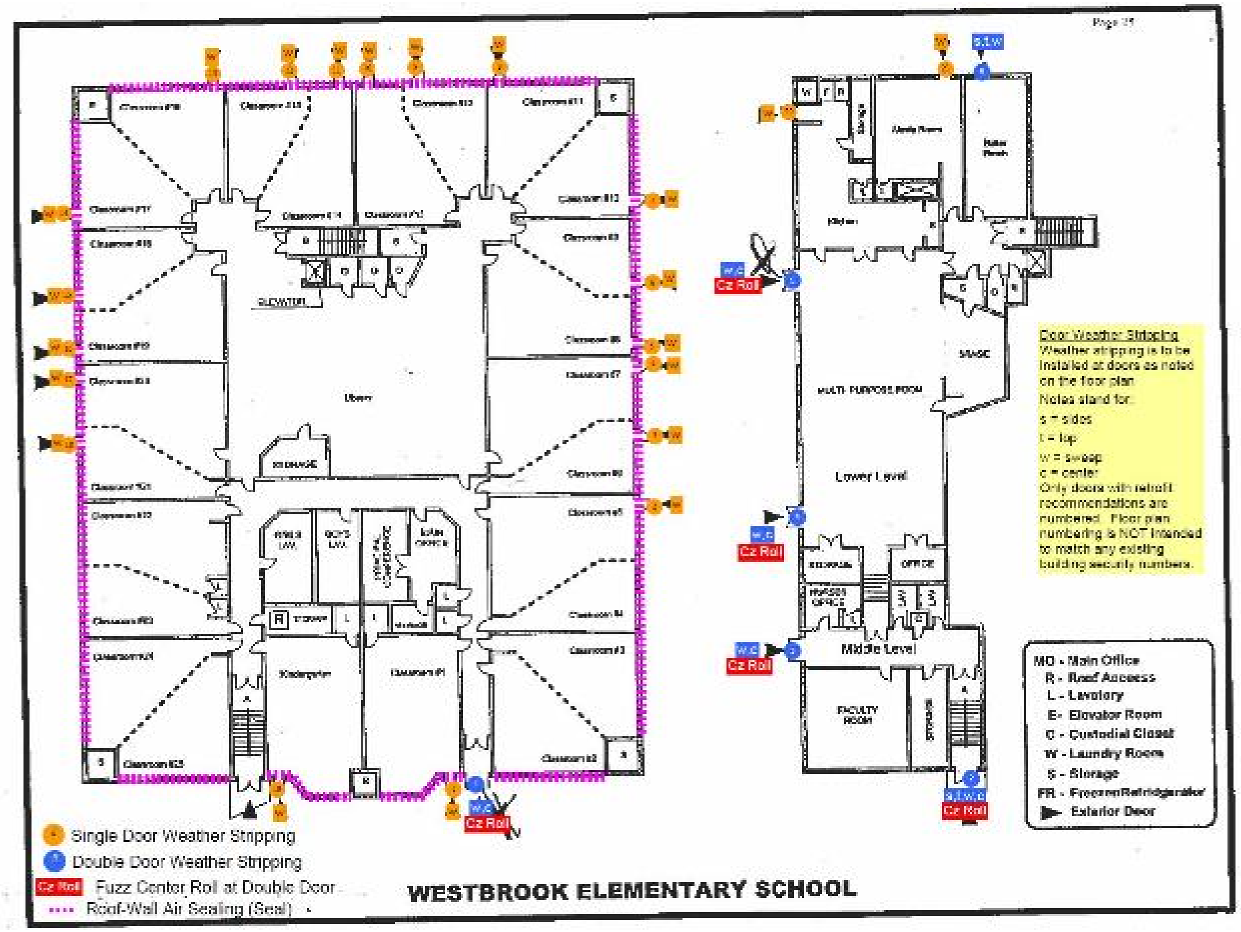
w = sweep
c = center
Only doors with retrofit recommendations are numbered. Floor plan numbering is NOT intended to match any existing building security numbers.
CR Conference Room
C Custodial Closet
F Faculty Room
L Lavatory
P - Principal's Office
S - Storage
Multi-Purpose Room
Stage
Main Office
Library And Computer Lab
Faculty Room
Boiler Room
Kitchen


Door Weather Stripping
Weather stripping is to be installed at doors as noted on the floor plan
Notes stand for:
s = sides
t = top
w = sweep
c = center
Only doors with retrofit recommendations are numbered. Floor plan numbering is NOT intended to match any existing building security numbers.
MO - Main Office
R - Roof Access
L - Lavatory
E - Elevator Room
C - Custodial Closet
W - Laundry Room
S - Storage
FR - Freezer/Refrigerator
Exterior Door
Single Door Weather Stripping
Double Door Weather Stripping
Cz Roll Fuzz Center Roll at Double Door
Roof-Wall Air Sealing (Seal)
WESTBROOK ELEMENTARY SCHOOL
Library
MULTI PURPOSE ROOM
Lower Level
Middle Level
Kitchen
FACULTY ROOM
Kindergarten
Cz Roll

APPENDIX 4. DETAILED SCOPE DESCRIPTIONS

Design Drawings will be available electronically.

APPENDIX 5. RECOMMENDED PROJECT – ESP

ECM ID	Energy Conservation Measure	ECM Hard Costs	Total Savings, $/yr	Simple Payback	Installation Plan	Recommend for Installation
	Administration Building					
1	Administration Building - Retro-Commissioning	$2,147	$288	7.44	Public Bidding	Yes
2	Administration Building - Building Envelope Upgrades	$3,301	$382	8.65	Public Bidding	Yes
3	Administration Building - Plug Load Controls	$576	$325	1.77	Public Bidding	Yes
4	Administration Building - Upgrade HVAC Controls to DDC-MER	$26,802	$334	80.35	Public Bidding	Yes
5	Administration Building - Direct Install	$18,102	$2,986	6.06	Direct Install	Yes
	Apshawa Elementary School					
6	Apshawa Elementary School - Fuel Economizer	$11,666	$1,430	8.16	Public Bidding	Yes
7	Apshawa Elementary School - Retro-Commissioning	$11,138	$977	11.40	Public Bidding	Yes
8	Apshawa Elementary School - Building Envelope Upgrades	$7,469	$1,260	5.93	Public Bidding	Yes
9	Apshawa Elementary School - Refrigeration Control Upgrades	$6,561	$834	7.87	Public Bidding	Yes
10	Apshawa Elementary School - PPA	$0	$0	N/A	Solar PPA	Yes
11	Apshawa Elementary School - Plug Load Controls	$3,917	$425	9.22	Public Bidding	Yes
12	Apshawa Elementary School - Destratification Fans	$8,156	$1,396	5.84	Public Bidding	Yes
13	Apshawa Elementary School - Unit Ventilator Refurbishment	$128,845	$214	601.70	Public Bidding	Yes
14	Apshawa Elementary School - Pipe and Valve Insulation	$10,877	$1,781	6.11	Public Bidding	Yes
15	Apshawa Elementary School - Upgrade HVAC Controls to DDC-MER	$26,559	$2,072	12.82	Public Bidding	Yes
16	Apshawa Elementary School - Upgrade HVAC Controls to DDC-HVAC	$13,450	$1,570	8.57	Public Bidding	Yes
17	Apshawa Elementary School - Direct Install	$12,149	$1,148	10.58	Direct Install	Yes
	Bus Garage/Maintenance					
18	Bus Garage/Maintenance - Retro-Commissioning	$1,342	$730	1.84	Public Bidding	Yes
19	Bus Garage/Maintenance - Building Envelope Upgrades	$4,447	$781	5.69	Public Bidding	Yes
20	Bus Garage/Maintenance - PPA	$0	$0	N/A	Solar PPA	Yes
21	Bus Garage/Maintenance - Upgrade HVAC Controls to DDC-MER	$7,310	$193	37.93	Public Bidding	Yes
22	Bus Garage/Maintenance - Direct Install	$27,952	$4,074	6.86	Public Bidding	Yes
	Macopin Middle School					
23	Macopin Middle School - Lighting Upgrades - LED	$306,988	$26,626	11.53	Public Bidding	Yes
24	Macopin Middle School - Addition of Cooling - RTU at Auditorium	$121,449	$0	N/A	Public Bidding	Yes
25	Macopin Middle School - Boiler Replacements	$570,726	$3,877	147.20	Public Bidding	Yes
26	Macopin Middle School - Retro-Commissioning	$32,205	$3,354	9.60	Public Bidding	Yes
27	Macopin Middle School - Building Envelope Upgrades	$20,231	$2,365	8.55	Public Bidding	Yes
28	Macopin Middle School - Refrigeration Control Upgrades	$6,561	$1,695	3.87	Public Bidding	Yes
29	Macopin Middle School - PPA	$0	$0	N/A	Solar PPA	Yes
30	Macopin Middle School - Plug Load Controls	$9,446	$1,269	7.45	Public Bidding	Yes
31	Macopin Middle School - Destratification Fans	$16,112	$1,259	12.80	Public Bidding	Yes
32	Macopin Middle School - DHW Replacement	$22,150	$1,293	17.13	Public Bidding	Yes
33	Macopin Middle School - Unit Ventilator Refurbishment	$232,978	$531	438.85	Public Bidding	Yes

ECM ID	Energy Conservation Measure	ECM Hard Costs	Total Savings, $/yr	Simple Payback	Installation Plan	Recommend for Installation
34	Macopin Middle School - Pipe and Valve Insulation	$19,629	$2,085	9.41	Public Bidding	Yes
35	Macopin Middle School - Upgrade HVAC Controls to DDC-MER	$70,661	$1,482	47.68	Public Bidding	Yes
36	Macopin Middle School - Upgrade HVAC Controls to DDC-HVAC	$90,592	$1,947	46.54	Public Bidding	Yes
37	Macopin Middle School - Pay for Performance	$29,239	$0	N/A	P4P	Yes
Maple Road Elementary School						
38	Maple Road Elementary School - Kitchen Hood Control Upgrades	$12,309	$224	54.92	Public Bidding	Yes
39	Maple Road Elementary School - Fuel Economizer	$11,666	$990	11.79	Public Bidding	Yes
40	Maple Road Elementary School - Retro-Commissioning	$12,173	$901	13.51	Public Bidding	Yes
41	Maple Road Elementary School - Building Envelope Upgrades	$29,265	$2,638	11.10	Public Bidding	Yes
42	Maple Road Elementary School - Refrigeration Control Upgrades	$6,561	$834	7.87	Public Bidding	Yes
43	Maple Road Elementary School - PPA	$0	$0	N/A	Solar PPA	Yes
44	Maple Road Elementary School - Plug Load Controls	$4,838	$447	10.82	Public Bidding	Yes
45	Maple Road Elementary School - Destratification Fans	$8,081	$579	13.96	Public Bidding	Yes
46	Maple Road Elementary School - Unit Ventilator Refurbishment	$155,825	$170	918.75	Public Bidding	Yes
47	Maple Road Elementary School - Pipe and Valve Insulation	$6,371	$583	10.93	Public Bidding	Yes
48	Maple Road Elementary School - Upgrade HVAC Controls to DDC-MER	$32,918	$1,011	32.57	Public Bidding	Yes
49	Maple Road Elementary School - Upgrade HVAC Controls to DDC-HVAC	$8,674	$677	12.82	Public Bidding	Yes
50	Maple Road Elementary School - Direct Install	$36,383	$14,732	2.47	Direct Install	Yes
Marshall Hill Elementary School						
51	Marshall Hill Elementary School - Kitchen Hood Control Upgrades	$14,738	$735	20.05	Public Bidding	Yes
52	Marshall Hill Elementary School - Boiler Replacements	$116,639	$1,950	59.82	Public Bidding	Yes
53	Marshall Hill Elementary School - Retro-Commissioning	$11,198	$1,257	8.91	Public Bidding	Yes
54	Marshall Hill Elementary School - Building Envelope Upgrades	$9,331	$1,057	8.83	Public Bidding	Yes
55	Marshall Hill Elementary School - Refrigeration Control Upgrades	$4,986	$486	10.25	Public Bidding	Yes
56	Marshall Hill Elementary School - Plug Load Controls	$4,838	$885	5.47	Public Bidding	Yes
57	Marshall Hill Elementary School - Unit Ventilator Refurbishment	$122,842	$220	557.75	Public Bidding	Yes
58	Marshall Hill Elementary School - Pipe and Valve Insulation	$8,545	$813	10.51	Public Bidding	Yes
59	Marshall Hill Elementary School - Upgrade HVAC Controls to DDC-MER	$38,254	$1,628	23.50	Public Bidding	Yes
60	Marshall Hill Elementary School - Upgrade HVAC Controls to DDC-HVAC	$13,937	$733	19.02	Public Bidding	Yes
61	Marshall Hill Elementary School - Direct Install	$48,898	$9,906	4.94	Direct Install	Yes
Paradise Knoll Elementary School						
62	Paradise Knoll Elementary School - HVAC Armor-Refurbish Condensing Units	$2,334	$158	14.74	Public Bidding	Yes
63	Paradise Knoll Elementary School - Retro-Commissioning	$8,802	$1,054	8.35	Public Bidding	Yes
64	Paradise Knoll Elementary School - Building Envelope Upgrades	$20,343	$1,805	11.27	Public Bidding	Yes
65	Paradise Knoll Elementary School - Refrigeration Control Upgrades	$7,349	$905	8.12	Public Bidding	Yes
66	Paradise Knoll Elementary School - PPA	$0	$0	N/A	Solar PPA	Yes

ECM ID	Energy Conservation Measure	ECM Hard Costs	Total Savings, $/yr	Simple Payback	Installation Plan	Recommend for Installation
67	Paradise Knoll Elementary School - Plug Load Controls	**$3,456**	**$275**	**12.57**	Public Bidding	Yes
68	Paradise Knoll Elementary School - Unit Ventilator Refurbishment	**$39,485**	**$175**	**225.26**	Public Bidding	Yes
69	Paradise Knoll Elementary School - Pipe and Valve Insulation	**$10,549**	**$883**	**11.94**	Public Bidding	Yes
70	Paradise Knoll Elementary School - Upgrade HVAC Controls to DDC-MER	**$35,038**	**$1,495**	**23.44**	Public Bidding	Yes
71	Paradise Knoll Elementary School - Upgrade HVAC Controls to DDC-HVAC	**$46,344**	**$1,200**	**38.62**	Public Bidding	Yes
72	Paradise Knoll Elementary School - Direct Install	**$73,293**	**$7,682**	**9.54**	Direct Install	Yes
	Upper Greenwood Lake Elementary School					
73	Upper Greenwood Lake Elementary School - Lighting Upgrades - LED	**$99,130**	**$7,682**	**12.90**	Public Bidding	Yes
74	Upper Greenwood Lake Elementary School - Fuel Economizer	**$11,666**	**$1,527**	**7.64**	Public Bidding	Yes
75	Upper Greenwood Lake Elementary School - Retro-Commissioning	**$11,003**	**$1,058**	**10.40**	Public Bidding	Yes
76	Upper Greenwood Lake Elementary School - Building Envelope Upgrades	**$26,374**	**$2,752**	**9.58**	Public Bidding	Yes
77	Upper Greenwood Lake Elementary School - Refrigeration Control Upgrades	**$5,774**	**$764**	**7.56**	Public Bidding	Yes
78	Upper Greenwood Lake Elementary School - PPA	**$0**	**$0**	**N/A**	Solar PPA	Yes
79	Upper Greenwood Lake Elementary School - Plug Load Controls	**$4,608**	**$513**	**8.99**	Public Bidding	Yes
80	Upper Greenwood Lake Elementary School - Destratification Fans	**$10,465**	**$1,766**	**5.93**	Public Bidding	Yes
81	Upper Greenwood Lake Elementary School - Unit Ventilator Refurbishment	**$128,327**	**$225**	**569.74**	Public Bidding	Yes
82	Upper Greenwood Lake Elementary School - Pipe and Valve Insulation	**$3,643**	**$356**	**10.23**	Public Bidding	Yes
83	Upper Greenwood Lake Elementary School - Upgrade HVAC Controls to DDC-MER	**$38,254**	**$2,189**	**17.48**	Public Bidding	Yes
84	Upper Greenwood Lake Elementary School - Upgrade HVAC Controls to DDC-HVAC	**$6,969**	**$1,459**	**4.78**	Public Bidding	Yes
	West Milford High School					
85	West Milford High School - Lighting Upgrades - LED	**$341,360**	**$32,661**	**10.45**	Public Bidding	Yes
86	West Milford High School - Stage Lighting Upgrades - LED	**$145,495**	**$5,394**	**26.97**	Public Bidding	Yes
86	West Milford High School - Kitchen Hood Control Upgrades	**$19,467**	**$535**	**36.35**	Public Bidding	Yes
87	West Milford High School - Transformer Upgrades	**$159,836**	**$14,767**	**10.82**	Public Bidding	Yes
88	West Milford High School - Cooling Tower Fan - VFD	**$19,493**	**$333**	**58.56**		
89	West Milford High School - Refurbish Cooling Tower	**$56,468**	**$2,447**	**23.08**	Public Bidding	Yes
90	West Milford High School - HVAC Armor-Refurbish Condensing Units	**$4,116**	**$314**	**13.12**	Public Bidding	Yes
91	West Milford High School - Fuel Economizer	**$23,333**	**$3,610**	**6.46**	Public Bidding	Yes
92	West Milford High School - Retro-Commissioning	**$59,043**	**$7,460**	**7.91**	Public Bidding	Yes
93	West Milford High School - Building Envelope Upgrades	**$95,641**	**$8,801**	**10.87**	Public Bidding	Yes
94	West Milford High School - Refrigeration Control Upgrades	**$6,561**	**$1,695**	**3.87**	Solar PPA	Yes
95	West Milford High School - PPA	**$0**	**$0**	**N/A**	Public Bidding	Yes
96	West Milford High School - Plug Load Controls	**$9,446**	**$1,935**	**4.88**	Public Bidding	Yes
97	West Milford High School - Destratification Fans	**$31,973**	**$2,922**	**10.94**	Public Bidding	Yes
98	West Milford High School - Cogeneration (CHP)	**$121,298**	**$1,985**	**61.10**	Public Bidding	Yes
99	West Milford High School - Unit Ventilator Refurbishment	**$274,985**	**$516**	**532.46**	Public Bidding	Yes
100	West Milford High School - Pipe and Valve Insulation	**$17,268**	**$1,634**	**10.57**	Public Bidding	Yes

ECM ID	Energy Conservation Measure	ECM Hard Costs	Total Savings, $/yr	Simple Payback	Installation Plan	Recommend for Installation
101	West Milford High School - Upgrade HVAC Controls to DDC-MER	$69,978	$5,336	13.11	Public Bidding	Yes
102	West Milford High School - Upgrade HVAC Controls to DDC-Unitary	$179,454	$3,423	52.43	Public Bidding	Yes
103	West Milford High School - Upgrade HVAC Controls to DDC-HVAC	$90,592	$9,648	9.39	Public Bidding	Yes
Westbrook Elementary School						
105	Westbrook Elementary School - Lighting Upgrades - LED	$73,057	$5,644	12.94	Public Bidding	Yes
106	Westbrook Elementary School - Transformer Upgrades	$36,094	$2,745	13.15	Public Bidding	Yes
107	Westbrook Elementary School - HVAC Armor-Refurbish Condensing Units	$13,904	$1,365	10.19	Public Bidding	Yes
108	Westbrook Elementary School - Retro-Commissioning	$11,763	$1,050	11.20	Public Bidding	Yes
109	Westbrook Elementary School - Building Envelope Upgrades	$10,709	$1,356	7.90	Public Bidding	Yes
110	Westbrook Elementary School - Refrigeration Control Upgrades	$5,774	$1,487	3.88	Public Bidding	Yes
111	Westbrook Elementary School - Plug Load Controls	$2,189	$160	13.68	Public Bidding	Yes
112	Westbrook Elementary School - Unit Ventilator Refurbishment	$32,082	$114	280.49	Public Bidding	Yes
113	Westbrook Elementary School - Pipe and Valve Insulation	$10,162	$936	10.86	Public Bidding	Yes
114	Westbrook Elementary School - Upgrade HVAC Controls to DDC-MER	$24,658	$1,245	19.81	Public Bidding	Yes
115	Westbrook Elementary School - Upgrade HVAC Controls to DDC-HVAC	$27,485	$3,486	7.88	Public Bidding	Yes
		$5,373,079	$275,367	19.51		

Operational Savings for Financial Model	
ECM Description	**Annual Savings**
LED Lighting Upgrades – District Wide	$39,908
HVAC Upgrades / Equipment Replacement	$72,500
Totals	**$112,408**

NJ Clean Energy Rebates	
Energy Conservation Measure	**Energy Rebate/ Incentives**
West Milford High School - Lighting Upgrades - LED	$29,334
Upper Greenwood Lake Elementary School - Lighting Upgrades - LED	$7,744
Westbrook Elementary School - Lighting Upgrades - LED	$4,951
West Milford High School - Kitchen Hood Control Upgrades	$1,800
Maple Road Elementary School - Kitchen Hood Control Upgrades	$900
Marshall Hill Elementary School - Kitchen Hood Control Upgrades	$900
West Milford High School - Cooling Tower Fan - VFD	$1,300
West Milford High School - Refrigeration Control Upgrades	$200
Apshawa Elementary School - Refrigeration Control Upgrades	$200
Maple Road Elementary School - Refrigeration Control Upgrades	$200
Marshall Hill Elementary School - Refrigeration Control Upgrades	$100
Paradise Knoll Elementary School - Refrigeration Control Upgrades	$250
Upper Greenwood Lake Elementary School - Refrigeration Control Upgrades	$150
Westbrook Elementary School - Refrigeration Control Upgrades	$150
West Milford High School - Unit Ventilator Refurbishment	$954
Apshawa Elementary School - Unit Ventilator Refurbishment	$58
Maple Road Elementary School - Unit Ventilator Refurbishment	$299
Marshall Hill Elementary School - Unit Ventilator Refurbishment	$409
Paradise Knoll Elementary School - Unit Ventilator Refurbishment	$345
Upper Greenwood Lake Elementary School - Unit Ventilator Refurbishment	$58
Westbrook Elementary School - Unit Ventilator Refurbishment	$205
Totals	**$50,507**

Demand Response Energy – Emergency Capacity Credit		
PJM Payment Year	Approved Load (kW)	Annual Customer Capacity Benefit
2020/2021	127.5 kW	$5,234
2021/2022	127.5 kW	$4,618
2022/2023	127.5 kW	$3,848
2023/2024	127.5 kW	$3,848
Totals		**$17,548**

Incentive Breakout for Recommended Project

Year	DR EE Credit	NJ Clean Energy Rebates	Pay for Performance	CHP	Total
1	$5,234	$50,507	$12,000	$0	$67,741
2	$4,618	$0	$25,510	$0	$30,128
3	$3,848	$0	$25,510	$0	$29,358
4	$3,848	$0	$0	$0	$3,848
TOTAL	**$17,548**	**$50,507**	**$63,021**	**$0**	**$131,076**

Energy Conservation Measure	Electric Demand		Electrical Consumption		Natural Gas		Fuel Oil		Total's, $
	Monthly Demand Saved, kW	Demand, $	Annual Electric Saved, kWh	Annual Electric Saved, $	Annual Gas Saved, therms	Annual Gas Saved, $	Annual Fuel Oil Saved, Gal	Annual Fuel Oil Saved, $	
West Milford High School - Lighting Upgrades - LED	99.7	$5,374	225,846	$27,287	0	$0	0	$0	$32,661
Macopin Middle School - Lighting Upgrades - LED	77.9	$4,199	185,623	$22,427	0	$0	0	$0	$26,626
Upper Greenwood Lake Elementary School - Lighting Upgrades - LED	19.5	$1,050	54,891	$6,632	0	$0	0	$0	$7,682
Westbrook Elementary School - Lighting Upgrades - LED	15.2	$822	39,913	$4,822	0	$0	0	$0	$5,644
Westbrook Elementary School - Lighting Upgrades - LED	0.0	$0	44,642	$5,394	0	$0	0	$0	$5,394
West Milford High School - Kitchen Hood Control Upgrades	0.0	$0	4,432	$535	0	$0	0	$0	$535
Maple Road Elementary School - Kitchen Hood Control Upgrades	0.0	$0	1,855	$224	0	$0	0	$0	$224
Marshall Hill Elementary School - Kitchen Hood Control Upgrades	0.0	$0	6,085	$735	0	$0	0	$0	$735
West Milford High School - Transformer Upgrades	13.3	$716	116,297	$14,051	0	$0	0	$0	$14,767
Westbrook Elementary School - Transformer Upgrades	2.5	$133	21,619	$2,612	0	$0	0	$0	$2,745
Macopin Middle School - Addition of Cooling - RTU at Auditorium	0.0	$0	0	$0	0	$0	0	$0	$0
West Milford High School - Cooling Tower Fan - VFD	0.0	$0	2,755	$333	0	$0	0	$0	$333
West Milford High School – Refurbish Cooling Tower	0.0	$0	20,250	$2,447	0	$0	0	$0	$2,447
West Milford High School - HVAC Armor-Refurbish Condensing Units	0.0	$0	2,597	$314	0	$0	0	$0	$314
Paradise Knoll Elementary School - HVAC Armor-Refurbish Condensing Units	0.0	$0	1,710	$158	0	$0	0	$0	$158
Westbrook Elementary School - HVAC Armor-Refurbish Condensing Units	0.0	$0	11,298	$1,365	0	$0	0	$0	$1,365
West Milford High School - Fuel Economizer	0.0	$0	0	$0	4,281	$3,610	0	$0	$3,610
Macopin Middle School - Boiler Replacements	0.0	$0	0	$0	4,540	$3,877	0	$0	$3,877
Apshawa Elementary School - Fuel Economizer	0.0	$0	0	$0	0	$0	572	$1,430	$1,430
Maple Road Elementary School - Fuel Economizer	0.0	$0	0	$0	1,193	$990	0	$0	$990
Marshall Hill Elementary School - Boiler Replacements	0.0	$0	0	$0	2,347	$1,950	0	$0	$1,950

West Milford Township Public Schools
Energy Savings Plan

Energy Conservation Measure	Electric Demand		Electrical Consumption		Natural Gas		Fuel Oil		Total's, $
	Monthly Demand Saved, kW	Demand, $	Annual Electric Saved, kWh	Annual Electric Saved, $	Annual Gas Saved, therms	Annual Gas Saved, $	Annual Fuel Oil Saved, Gal	Annual Fuel Oil Saved, $	
Upper Greenwood Lake Elementary School - Fuel Economizer	0.0	$0	0	$0	0	$0	611	$1,527	$1,527
West Milford High School - Retro-Commissioning	0.0	$0	47,256	$5,710	2,076	$1,751	0	$0	$7,460
Macopin Middle School - Retro-Commissioning	0.0	$0	15,221	$1,839	1,774	$1,515	0	$0	$3,354
Apshawa Elementary School - Retro-Commissioning	0.0	$0	3,716	$449	0	$0	211	$528	$977
Maple Road Elementary School - Retro-Commissioning	0.0	$0	4,518	$546	429	$355	0	$0	$901
Marshall Hill Elementary School - Retro-Commissioning	0.0	$0	5,878	$710	658	$547	0	$0	$1,257
Paradise Knoll Elementary School - Retro-Commissioning	0.0	$0	5,840	$541	613	$513	0	$0	$1,054
Upper Greenwood Lake Elementary School - Retro-Commissioning	0.0	$0	4,101	$495	0	$0	225	$563	$1,058
Westbrook Elementary School - Retro-Commissioning	0.0	$0	6,469	$782	316	$268	0	$0	$1,050
Administration Building - Retro-Commissioning	0.0	$0	2,036	$246	45	$43	0	$0	$288
Bus Garage/Maintenance - Retro-Commissioning	0.0	$0	4,386	$530	163	$200	0	$0	$730
West Milford High School - Building Envelope Upgrades	0.0	$0	16,253	$1,964	8,107	$6,837	0	$0	$8,801
Macopin Middle School - Building Envelope Upgrades	0.0	$0	4,324	$522	2,157	$1,843	0	$0	$2,365
Apshawa Elementary School - Building Envelope Upgrades	0.0	$0	1,655	$200	0	$0	424	$1,060	$1,260
Maple Road Elementary School - Building Envelope Upgrades	0.0	$0	4,933	$596	2,461	$2,042	0	$0	$2,638
Marshall Hill Elementary School - Building Envelope Upgrades	0.0	$0	1,975	$239	985	$819	0	$0	$1,057
Paradise Knoll Elementary School - Building Envelope Upgrades	0.0	$0	3,536	$327	1,764	$1,478	0	$0	$1,805
Upper Greenwood Lake Elementary School - Building Envelope Upgrades	0.0	$0	3,613	$437	0	$0	926	$2,316	$2,752
Westbrook Elementary School - Building Envelope Upgrades	0.0	$0	2,491	$301	1,243	$1,055	0	$0	$1,356
Administration Building - Building Envelope Upgrades	0.0	$0	644	$78	321	$304	0	$0	$382
Bus Garage/Maintenance - Building Envelope Upgrades	0.0	$0	1,066	$129	532	$652	0	$0	$781
West Milford High School - Refrigeration Control Upgrades	0.0	$0	14,030	$1,695	0	$0	0	$0	$1,695

West Milford Township Public Schools
Energy Savings Plan

Energy Conservation Measure	Electric Demand		Electrical Consumption		Natural Gas		Fuel Oil		Total's, $
	Monthly Demand Saved, kW	Demand, $	Annual Electric Saved, kWh	Annual Electric Saved, $	Annual Gas Saved, therms	Annual Gas Saved, $	Annual Fuel Oil Saved, Gal	Annual Fuel Oil Saved, $	
Macopin Middle School - Refrigeration Control Upgrades	0.0	$0	14,030	$1,695	0	$0	0	$0	$1,695
Apshawa Elementary School - Refrigeration Control Upgrades	0.0	$0	6,900	$834	0	$0	0	$0	$834
Maple Road Elementary School - Refrigeration Control Upgrades	0.0	$0	6,900	$834	0	$0	0	$0	$834
Marshall Hill Elementary School - Refrigeration Control Upgrades	0.0	$0	4,025	$486	0	$0	0	$0	$486
Paradise Knoll Elementary School - Refrigeration Control Upgrades	0.0	$0	9,775	$905	0	$0	0	$0	$905
Upper Greenwood Lake Elementary School - Refrigeration Control Upgrades	0.0	$0	6,325	$764	0	$0	0	$0	$764
Westbrook Elementary School - Refrigeration Control Upgrades	0.0	$0	12,305	$1,487	0	$0	0	$0	$1,487
West Milford High School - Plug Load Controls	0.0	$0	16,015	$1,935	0	$0	0	$0	$1,935
Macopin Middle School - Plug Load Controls	0.0	$0	10,501	$1,269	0	$0	0	$0	$1,269
Apshawa Elementary School - Plug Load Controls	0.0	$0	3,516	$425	0	$0	0	$0	$425
Maple Road Elementary School - Plug Load Controls	0.0	$0	3,703	$447	0	$0	0	$0	$447
Marshall Hill Elementary School - Plug Load Controls	0.0	$0	7,321	$885	0	$0	0	$0	$885
Paradise Knoll Elementary School - Plug Load Controls	0.0	$0	2,970	$275	0	$0	0	$0	$275
Upper Greenwood Lake Elementary School - Plug Load Controls	0.0	$0	4,242	$513	0	$0	0	$0	$513
Westbrook Elementary School - Plug Load Controls	0.0	$0	1,324	$160	0	$0	0	$0	$160
Administration Building - Plug Load Controls	0.0	$0	2,693	$325	0	$0	0	$0	$325
West Milford High School - Destratification Fans	0.0	$0	-1,680	-$203	3,705	$3,125	0	$0	$2,922
Macopin Middle School - Destratification Fans	0.0	$0	-840	-$101	1,593	$1,360	0	$0	$1,259
Apshawa Elementary School - Destratification Fans	0.0	$0	-420	-$51	0	$0	579	$1,446	$1,396
Maple Road Elementary School - Destratification Fans	0.0	$0	-420	-$51	759	$630	0	$0	$579
Upper Greenwood Lake Elementary School - Destratification Fans	0.0	$0	-560	-$68	0	$0	734	$1,834	$1,766
West Milford High School - Cogeneration (CHP)	0.0	$0	22,393	$2,705	-854	-$720	0	$0	$1,985

West Milford Township Public Schools
Energy Savings Plan

Energy Conservation Measure	Electric Demand		Electrical Consumption		Natural Gas		Fuel Oil		Total's, $
	Monthly Demand Saved, kW	Demand, $	Annual Electric Saved, kWh	Annual Electric Saved, $	Annual Gas Saved, therms	Annual Gas Saved, $	Annual Fuel Oil Saved, Gal	Annual Fuel Oil Saved, $	
Macopin Middle School - DHW Replacement	0.0	$0	0	$0	1,514	$1,293	0	$0	$1,293
West Milford High School - Unit Ventilator Refurbishment	0.2	$12	736	$89	493	$416	0	$0	$516
Macopin Middle School - Unit Ventilator Refurbishment	0.4	$20	1,251	$151	421	$360	0	$0	$531
Apshawa Elementary School - Unit Ventilator Refurbishment	0.1	$5	343	$41	0	$0	67	$167	$214
Maple Road Elementary School - Unit Ventilator Refurbishment	0.1	$7	417	$50	136	$113	0	$0	$170
Marshall Hill Elementary School - Unit Ventilator Refurbishment	0.1	$5	343	$41	209	$173	0	$0	$220
Paradise Knoll Elementary School - Unit Ventilator Refurbishment	0.0	$3	110	$10	194	$163	0	$0	$175
Upper Greenwood Lake Elementary School - Unit Ventilator Refurbishment	0.1	$5	343	$41	0	$0	71	$178	$225
Westbrook Elementary School - Unit Ventilator Refurbishment	0.1	$3	215	$26	100	$85	0	$0	$114
West Milford High School - Pipe and Valve Insulation	0.0	$0	0	$0	1,938	$1,634	0	$0	$1,634
Macopin Middle School - Pipe and Valve Insulation	0.0	$0	0	$0	2,442	$2,085	0	$0	$2,085
Apshawa Elementary School - Pipe and Valve Insulation	0.0	$0	0	$0	0	$0	713	$1,781	$1,781
Maple Road Elementary School - Pipe and Valve Insulation	0.0	$0	0	$0	703	$583	0	$0	$583
Marshall Hill Elementary School - Pipe and Valve Insulation	0.0	$0	0	$0	979	$813	0	$0	$813
Paradise Knoll Elementary School - Pipe and Valve Insulation	0.0	$0	0	$0	1,055	$883	0	$0	$883
Upper Greenwood Lake Elementary School - Pipe and Valve Insulation	0.0	$0	0	$0	0	$0	143	$356	$356
Westbrook Elementary School - Pipe and Valve Insulation	0.0	$0	0	$0	1,102	$936	0	$0	$936
West Milford High School - Upgrade HVAC Controls to DDC-MER	0.0	$0	5,873	$710	5,486	$4,626	0	$0	$5,336
Macopin Middle School - Upgrade HVAC Controls to DDC-MER	0.0	$0	0	$0	1,735	$1,482	0	$0	$1,482
Apshawa Elementary School - Upgrade HVAC Controls to DDC-MER	0.0	$0	0	$0	0	$0	829	$2,072	$2,072
Maple Road Elementary School - Upgrade HVAC Controls to DDC-MER	0.0	$0	0	$0	1,218	$1,011	0	$0	$1,011
Marshall Hill Elementary School - Upgrade HVAC Controls to DDC-MER	0.0	$0	0	$0	1,959	$1,628	0	$0	$1,628

West Milford Township Public Schools

Energy Savings Plan

Energy Conservation Measure	Electric Demand		Electrical Consumption		Natural Gas		Fuel Oil		Total's, $
	Monthly Demand Saved, kW	Demand, $	Annual Electric Saved, kWh	Annual Electric Saved, $	Annual Gas Saved, therms	Annual Gas Saved, $	Annual Fuel Oil Saved, Gal	Annual Fuel Oil Saved, $	
Paradise Knoll Elementary School - Upgrade HVAC Controls to DDC-MER	0.0	$0	0	$0	1,785	$1,495	0	$0	$1,495
Upper Greenwood Lake Elementary School - Upgrade HVAC Controls to DDC-MER	0.0	$0	0	$0	0	$0	875	$2,189	$2,189
Westbrook Elementary School - Upgrade HVAC Controls to DDC-MER	0.0	$0	0	$0	1,466	$1,245	0	$0	$1,245
Administration Building - Upgrade HVAC Controls to DDC-MER	0.0	$0	320	$39	312	$295	0	$0	$334
Bus Garage/Maintenance - Upgrade HVAC Controls to DDC-MER	0.0	$0	0	$0	157	$193	0	$0	$193
West Milford High School - Upgrade HVAC Controls to DDC-Unitary	0.0	$0	2,460	$297	3,706	$3,125	0	$0	$3,423
West Milford High School - Upgrade HVAC Controls to DDC-HVAC	0.0	$0	33,356	$4,030	6,661	$5,618	0	$0	$9,648
Macopin Middle School - Upgrade HVAC Controls to DDC-HVAC	0.0	$0	1,802	$218	2,025	$1,729	0	$0	$1,947
Apshawa Elementary School - Upgrade HVAC Controls to DDC-HVAC	0.0	$0	115	$14	0	$0	622	$1,556	$1,570
Maple Road Elementary School - Upgrade HVAC Controls to DDC-HVAC	0.0	$0	57	$7	807	$670	0	$0	$677
Marshall Hill Elementary School - Upgrade HVAC Controls to DDC-HVAC	0.0	$0	115	$14	865	$719	0	$0	$733
Paradise Knoll Elementary School - Upgrade HVAC Controls to DDC-HVAC	0.0	$0	1,989	$184	1,213	$1,016	0	$0	$1,200
Upper Greenwood Lake Elementary School - Upgrade HVAC Controls to DDC-HVAC	0.0	$0	57	$7	581	$0	581	$1,452	$1,459
Westbrook Elementary School - Upgrade HVAC Controls to DDC-HVAC	0.0	$0	19,669	$2,376	1,307	$1,110	0	$0	$3,486
Apshawa Elementary School - Direct Install	2.4	$130	8,432	$1,019	1,164	$0	0	$0	$1,148
Maple Road Elementary School - Direct Install	21.6	$1,167	59,511	$7,190	7,686	$6,375	0	$0	$14,732
Marshall Hill Elementary School - Direct Install	25.0	$1,348	65,790	$7,949	734	$609	0	$0	$9,906
Paradise Knoll Elementary School - Direct Install	19.4	$1,499	54,502	$5,046	1,358	$1,137	0	$0	$7,682
Administration Building - Direct Install	7.1	$383	17,126	$2,069	564	$534	0	$0	$2,986
Bus Garage/Maintenance - Direct Install	7.5	$407	26,582	$3,212	371	$455	0	$0	$4,074

Business Case for Recommended Project

FORM VI - ENERGY SAVINGS PLAN

ESCO's PRELIMINARY ENERGY SAVINGS PLAN (ESP):
ESCO's PRELIMINARY ANNUAL CASH FLOW ANALYSIS FORM
West Milford Township School District
ENERGY SAVINGS IMPROVEMENT PROGRAM

ESCO Name: ENERGY SYSTEMS GROUP **Project Scenario 1** Solar PPA (Exludes roof restoration)

Note: Respondents must use the following assumptions in all financial calculations:

(a) The cost of all types of energy should be assumed to inflate at 2.4% gas, 2.2% electric per year; and

1. Term of Agreement: 19 years
2. Construction period² (months): 12
3. Cash Flow Analysis Format:

Total ESG Project Cost [(1)] $ 7,256,015
Capital Contribution $ 125,000
Total Financed Amount[(4)] $ 7,181,015

Interest Rate to be used for Proposal Purposes: 2.70%

	Annual Energy Savings	Annual Operational Savings	Energy Rebates/ Incentives	Solar PPA	Total Annual Savings	Annual Project Costs	Board Costs	Annual Service Costs	Net Cash-Flow to client	Cumulative Cash Flow
Installation[(3)]	$ 169,575	$ -	$ -	$ -	$ 169,575	$ -	$ -	$ -	$ 169,575	$ 169,575
1	$ 451,200	$ 112,408	$ 67,741	$ 121,191	$ 752,540	$ 724,365	$ 750,290	$ 25,925	$ 2,250	$ 171,825
2	$ 288,026	$ 112,408	$ 30,128	$ 123,857	$ 554,419	$ 552,169	$ 552,169	$ -	$ 2,250	$ 174,075
3	$ 294,573	$ 39,908	$ 29,358	$ 126,582	$ 490,421	$ 488,171	$ 488,171	$ -	$ 2,250	$ 176,325
4	$ 301,268	$ 39,908	$ 3,848	$ 129,366	$ 474,391	$ 472,141	$ 472,141	$ -	$ 2,250	$ 178,575
5	$ 308,116	$ 39,908	$ -	$ 132,212	$ 480,237	$ 477,987	$ 477,987	$ -	$ 2,250	$ 180,825
6	$ 315,120	$ -	$ -	$ 135,121	$ 450,241	$ 447,991	$ 447,991	$ -	$ 2,250	$ 183,075
7	$ 322,284	$ -	$ -	$ 138,094	$ 460,378	$ 458,128	$ 458,128	$ -	$ 2,250	$ 185,325
8	$ 329,610	$ -	$ -	$ 141,132	$ 470,742	$ 468,492	$ 468,492	$ -	$ 2,250	$ 187,575
9	$ 337,104	$ -	$ -	$ 144,237	$ 481,341	$ 479,091	$ 479,091	$ -	$ 2,250	$ 189,825
10	$ 344,768	$ -	$ -	$ 147,410	$ 492,178	$ 489,928	$ 489,928	$ -	$ 2,250	$ 192,075
11	$ 352,607	$ -	$ -	$ 150,653	$ 503,260	$ 501,010	$ 501,010	$ -	$ 2,250	$ 194,325
12	$ 360,624	$ -	$ -	$ 153,967	$ 514,591	$ 512,341	$ 512,341	$ -	$ 2,250	$ 196,575
13	$ 368,824	$ -	$ -	$ 157,355	$ 526,178	$ 523,928	$ 523,928	$ -	$ 2,250	$ 198,825
14	$ 377,210	$ -	$ -	$ 160,816	$ 538,027	$ 535,777	$ 535,777	$ -	$ 2,250	$ 201,075
15	$ 385,788	$ -	$ -	$ 164,354	$ 550,142	$ 547,892	$ 547,892	$ -	$ 2,250	$ 203,325
16	$ 394,561	$ -	$ -	$ -	$ 394,561	$ 392,311	$ 392,311	$ -	$ 2,250	$ 205,575
17	$ 403,534	$ -	$ -	$ -	$ 403,534	$ 401,284	$ 401,284	$ -	$ 2,250	$ 207,825
18	$ 412,712	$ -	$ -	$ -	$ 412,712	$ 410,462	$ 410,462	$ -	$ 2,250	$ 210,075
19	$ 422,098	$ -	$ -	$ -	$ 422,098	$ 414,689	$ 414,689	$ -	$ 7,409	$ 217,484
20	$ -	$ -	$ -	$ -		$ -	$ -	$ -	$ -	$ -
Totals	**$ 6,770,027**	**$ 344,540**	**$ 131,076**	**$ 2,126,347**	**$ 9,371,990**	**$ 9,298,156**	**$ 9,324,081**	**$ 25,925**	**$ 47,909**	**$ 217,484**

NOTES:

1 **Includes: Hard costs and project service fees defined in ESCO's PROPOSED 'FORM V"**
2 **No payments are made by the Board during the construction period.**
3 **Installation period savings for Energy Savings and Operational Savings are guaranteed. These savings will be used in addition to the first loan payment.**
4 **Total Financed Cost includes all Fees and project costs.**
5 **Interest rate is indicative rate only. Final rate will vary with market conditions at time of closing.**
6 **ESG is an energy services and engineering company, not a financial advisor.**
7 **ESG is not a financial advisor and the presented cash flow proforma is for information only**
8 **The cash flow shown is for illustration purposes, and is not intended as financial advice.**
9 **Loan repayment includes interest accumulation in the construction period**
10 **Loan repayment assumes that the 1st repayment starts immediately after construction**
11 **The annual energy 2.27% and labor .% escalation are in accordance with the RFP**
12 **The utility incentive amount shown is typical expected and is not indicative of the actual amount as project timing, changes to utility program and availability of funds affect the outcome**

APPENDIX 6. LIGHTING UPGRADES

Macopin Middle School

#	Ex Fixt Qty	Existing Fixture or Lamp Description	New Fixture or Lamp Qty	Replacement Fixture or Lamp Description
1	10	*2' FIXTURE, 2-F17/T8/STD LAMPS, (.88) ELECTRONIC BALLAST	10	INTERIOR LUMINAIRES, G2 THIN PANEL, 2X2, 20W, 4000K, 120-277VAC, DIMMABLE - DLC LISTED
2	24	*2' FIXTURE, 2-F17/T8/STD LAMPS, (.88) ELECTRONIC BALLAST	48	G4 SP 2 FOOT 8W 4000K 140LPW NANO LENS SEP LED TUBE - DLC LISTED
3	4	*2' FIXTURE, 2-F32/T8/U6 LAMPS, ELECTRONIC BALLAST	12	G4 SP 2 FOOT 8W 4000K 140LPW NANO LENS SEP LED TUBE - DLC LISTED
4	2	*2' FIXTURE, 2-F32/T8/U6 LAMPS, ELECTRONIC BALLAST	2	INTERIOR LUMINAIRES, G2 THIN PANEL, 2X2, 20W, 4000K, 120-277VAC, DIMMABLE - DLC LISTED
5	172	*4' FIXTURE, 1-F32/T8 LAMP, (.88) ELECTRONIC BALLAST	172	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED
6	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	1	FIXTURE REMOVAL
7	508	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	1040	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED
8	9	*4' FIXTURE, 4-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	9	INTERIOR LUMINAIRES, G2 THIN PANEL, 2X4, 36W, 4000K, 120-277VAC, DIMMABLE - DLC LISTED
9	19	*4' FIXTURE, 4-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	76	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED
10	7	*4' FIXTURE, 6-F32/T8 LAMPS, ELECTRONIC BALLAST	42	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED
11	10	1- 42 WATT CFL SCREW-IN	10	16.5 WATT, A21, 4000K, 277 V, A LAMP
12	2	1L - A LAMP 100 WATT INCANDESCENT	2	LED A21 14 WATT, FULLY OMNI E26 BASE, 120V, 4000K, DIMMABLE, ENCLOSED - ENERGY STAR
13	1	1L - A LAMP 200 WATT INCANDESCENT	1	HID LED E26 27W, 4000K, 120-277V NON-DIMMABLE
14	58	1L - A LAMP 60 WATT INCANDESCENT	58	LED A19 9 WATT, FULLY OMNI, E26 BASE, 120V, 4000K, DIM, ENCLOSED
15	116	1L - A LAMP 75 WATT INCANDESCENT	116	LED A19 10 WATT, FULLY OMNI E26 BASE, 120V, 4000K, DIMMABLE-ENCLOSED - ENERGYST
16	20	2 - 18 WATT QUAD-PIN	20	METALUX AP SERIES-ROUND FLUSH MOUNT-11" 13.5W 4000K 1100 LUMEN
17	21	2L - A LAMP 60 WATT INCANDESCENT	42	LED A19 9 WATT, FULLY OMNI, E26 BASE, 120V, 4000K, DIM, ENCLOSED
18	3	3' FIXTURE, 6-F25/T8/LAMPS, ELECTRONIC BALLAST	18	G4 SP 3 FOOT 12W 4000K 120LPW NANO LENS SEP LED TUBE
19	8	3L - A LAMP 60 WATT INCANDESCENT	27	LED A19 9 WATT, FULLY OMNI, E26 BASE, 120V, 4000K, DIM, ENCLOSED
20	28	4' FIXTURE, 4-F54/T5/HO/LAMPS, ELECTRONIC BALLAST	28	2 X 2, HIGH BAY, ECO LINEAR, 167W, 4000K, 120-277VAC, DIMMABLE, PRISMATIC OPTIC - DLC LISTED
21	4	4' FIXTURE, 4-F54/T5/HO/LAMPS, ELECTRONIC BALLAST	4	1 X 2, HIGH BAY, ECO LINEAR, 83W, 4000K, 120-277VAC, DIMMABLE, PRISMATIC OPTIC - DLC LISTED
22	3	4' FIXTURE, 4-F54/T5/HO/LAMPS, ELECTRONIC BALLAST	3	2 X 2, HIGH BAY, ECO LINEAR, 128W, 4000K, 120-277VAC, DIMMABLE, PRISMATIC OPTIC - DLC LISTED
23	10	4' FIXTURE, 8-F32/T8 LAMPS, ELECTRONIC BALLAST-TOTAL WATTS=256 WATTS	80	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED
24	4	8' FIXTURE, 2-F32/T8 LAMPS, ELECTRONIC BALLAST	8	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED
25	502	8' FIXTURE, 4-F32/T8 LAMPS, INSTANT START ELECT BALLAST BF: 95+	2008	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED
26	24	BR 40 90 WATT INCANDESCENT	24	PAR38, E26 BASE, 17 WATT, HIGH CRI, 120V 40°, 3000K, DIMMABLE - ENERGY STAR
27	6	METAL HALIDE, 1-100 WATT LAMP	6	LED PAR30, 13 WATT, 120V, DIMMABLE, 3000K, 40°, 1100 LUMEN, HIGH CRI
28	2	METAL HALIDE, 1-250 WATT LAMP	2	WALLPACK 55W NEUTRAL LED 120V PC W/ GLASS LENS BZ
29	0	0 - N/A	172	1 LAMP UNIVERSAL TOMBSTONE KIT WITH BALLAST DISCONNECT T8
30	0	0 - N/A	474	2 LAMP UNIVERSAL TOMBSTONE KIT WITH BALLAST DISCONNECT T8
31	0	0 - N/A	474	4 LAMP UNIVERSAL TOMBSTONE KIT WITH BALLAST DISCONNECT T8
32	0	0 - N/A	23	4FT 2 LAMP STRIP
33	0	0 - N/A	1046	4FT WRAP AROUND 2 LAMP
34	0	0 - N/A	10	6 LAMP UNIVERSAL TOMBSTONE KIT WITH BALLAST DISCONNECT T8
35	0	0 - N/A	10	8 LAMP UNIVERSAL TOMBSTONE KIT WITH BALLAST DISCONNECT T8
36	0	0 - N/A	2	ENERGI TRI-PACK WIRELESS CEILING/SWITCH PACKAGE
37	0	0 - N/A	35	IP65 RATED MICROWAVE MOTION/DAYLIGHT SENSOR
38	0	0 - N/A	2	LENS COVER -- PLACE HOLDER
39	0	0 - N/A	13	MAESTRO DUAL TECH OCCUPANCY SENSING SWITCH
40	0	0 - N/A	4	RETROFIT KIT FOR 2' U-TUBE (INCLUDES (3) SOCKETS)
41	0	0 - N/A	2546	T8 NON SHUNTED SOCKET - COMMON
42	0	0 - N/A	28	WIRE GUARD, 2 PIECES FOR 2'X 2' (DOUBLE SHORT)
TOTAL	**1578**		**8708**	

Upper Greenwood Lake Elementary School

#	Ex Fixt Qty	Existing Fixture or Lamp Description	New Fixture or Lamp Qty	Replacement Fixture or Lamp Description
1	38	*2' FIXTURE, 2-F17/T8/STD LAMPS, (.88) ELECTRONIC BALLAST	76	G4 SP 2 FOOT 8W 4000K 140LPW NANO LENS SEP LED TUBE - DLC LISTED
2	1	*3' FIXTURE, 2-F25/T8/LAMPS, ELECTRONIC BALLAST	2	G4 SP 2 FOOT 8W 4000K 140LPW NANO LENS SEP LED TUBE - DLC LISTED
3	422	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	844	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED
4	13	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	39	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED
5	3	*4' FIXTURE, 4-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	12	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED
6	7	1 - 15 WATT CFL	7	LED A19 9 WATT, FULLY OMNI, E26 BASE, 120V, 4000K, DIM, ENCLOSED
7	9	1 - 15 WATT CFL	9	METALUX AP SERIES-ROUND FLUSH MOUNT-9" 12W 950 LUMEN
8	2	1 - 23 WATT CFL	2	LED A19 8 WATT, FULLY OMNI E26 BASE, 120V, 4000K, DIMMABLE, NOT ENCLOSED - ESTAR
9	1	1L - A LAMP 100 WATT INCANDESCENT	1	LED A21 14 WATT, FULLY OMNI E26 BASE, 120V, 4000K, DIMMABLE, ENCLOSED - ENERGY STAR
10	1	1L - A LAMP 60 WATT INCANDESCENT	1	LED A19 8 WATT, FULLY OMNI E26 BASE, 120V, 4000K, DIMMABLE, NOT ENCLOSED - ESTAR
11	6	1L - A LAMP 60 WATT INCANDESCENT	6	LED A19 9 WATT, FULLY OMNI, E26 BASE, 120V, 4000K, DIM, ENCLOSED
12	2	1L - A LAMP 60 WATT INCANDESCENT	2	LED A21 14 WATT, FULLY OMNI E26 BASE, 120V, 4000K, DIMMABLE, ENCLOSED - ENERGY STAR
13	1	2 - 13 WATT CFL DUAL - PIN FIXTURE	2	"PLS GX23 6W SHORT VERSION PL EDGE SERIES HYBRID"
14	2	2 - 13 WATT CFL DUAL - PIN FIXTURE	4	LED A19 9 WATT, FULLY OMNI, E26 BASE, 120V, 4000K, DIM, ENCLOSED
15	28	2 - 13 WATT CFL DUAL - PIN FIXTURE	28	METALUX AP SERIES-ROUND FLUSH MOUNT-9" 12W 950 LUMEN
16	1	2 - 24 WATT CFL QUAD, TWIN BIAX - PIN FIXTURE	1	METALUX AP SERIES-ROUND FLUSH MOUNT-9" 12W 950 LUMEN
17	6	2L - A LAMP 60 WATT INCANDESCENT	12	LED A19 9 WATT, FULLY OMNI, E26 BASE, 120V, 4000K, DIM, ENCLOSED
18	3	2L - A LAMP 60 WATT INCANDESCENT	3	METALUX AP SERIES-ROUND FLUSH MOUNT-9" 12W 950 LUMEN
19	1	3' FIXTURE, 2-F30/T12/STD LAMPS, ENERGY SAVING MAGNETIC BALLAST	2	G4 SP 3 FOOT 12W 4000K 120LPW NANO LENS SEP LED TUBE
20	1	35 WATT MR 16 INCANDESCENT 12V - RECESSED FIXTURE	1	4" RETROFIT 6/9/14W INNOFIT SERIES 4000K 120-277V NON-DIMMABLE
21	16	4' FIXTURE, 4-F54/T5/HO/LAMPS, ELECTRONIC BALLAST	16	HIGH BAY, G2 ECO LINEAR, 2X2, 161W, 4000K, 120-277VAC, DIMMABLE, MEDIUM OPTIC
22	1	HIGH PRESSURE SODIUM, 1-70 WATT LAMP	1	WALLPACK 24W WARM LED BRONZE - DLC LISTED
23	1	METAL HALIDE, 1-150 WATT LAMP	1	WALLPACK 37W NUETRAL LED BRONZE - DLC LISTED
24	3	METAL HALIDE, 1-150 WATT LAMP	3	WALLPACK 37W NUETRAL LED BRONZE - DLC LISTED
25	2	METAL HALIDE, 1-250 WATT LAMP	2	WALLPACK 55W NUETRAL LED BRONZE - DLC LISTED
26	0	0 - N/A	16	ACCESSORY, HIGH BAY, G2 ECO LINEAR, WIRE GUARD KIT, COMPATIBLE WITH 128XX3-3XX (141W), 128X
27	0	0 - N/A	2	2X2 ECONOMY LAY IN ACRYLIC 4 LAMP
28	0	0 - N/A	1	4" RETROFIT 6/9/14W INNOFIT SERIES 4000K 120-277V NON-DIMMABLE
29	0	0 - N/A	30	MAESTRO DUAL TECH OCCUPANCY SENSING SWITCH
30	0	0 - N/A	24	ENERGI TRI-PACK WIRELESS CEILING/SWITCH PACKAGE
31	0	0 - N/A	980	NON-SHUNTED SOCKET, 600V, 660W
32	0	0 - N/A	460	2 LAMP UNIVERSAL TOMBSTONE KIT WITH BALLAST DISCONNECT T8
33	0	0 - N/A	13	3 LAMP UNIVERSAL TOMBSTONE KIT WITH BALLAST DISCONNECT T8
34	0	0 - N/A	3	4 LAMP UNIVERSAL TOMBSTONE KIT WITH BALLAST DISCONNECT T8
35	0	0 - N/A	20	LENS COVER -- PLACE HOLDER
TOTAL	**571**		**2626**	

Westbrook Elementary School

#	Ex Fixt Qty	Existing Fixture or Lamp Description	New Fixture or Lamp Qty	Replacement Fixture or Lamp Description
1	81	*2' FIXTURE, 2-F17/T8/STD LAMPS, (.88) ELECTRONIC BALLAST	162	G4 SP 2 FOOT 8W 4000K 140LPW NANO LENS SEP LED TUBE - DLC LISTED
2	2	*2' FIXTURE, 3-F17/T8/STD LAMPS, (.88) ELECTRONIC BALLAST	6	G4 SP 2 FOOT 8W 4000K 140LPW NANO LENS SEP LED TUBE - DLC LISTED
3	12	*4' FIXTURE, 1-F32/T8 LAMP, (.88) ELECTRONIC BALLAST	12	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED
4	312	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	624	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED
5	9	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	27	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED
6	21	*4' FIXTURE, 4-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	84	G4 SP 4 FOOT 15W 4000K 140LPW NANO LENS SEP LED TUBE - DLC LISTED
7	11	*4' FIXTURE, 4-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	44	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED
8	1	1 - 13W CFL	1	LED A19 8 WATT, FULLY OMNI E26 BASE, 120V, 4000K, DIMMABLE - ENERGY STAR
9	2	1- 40 WATT CFL SCREW-IN	2	LED A19 8 WATT, FULLY OMNI E26 BASE, 120V, 4000K, DIMMABLE - ENERGY STAR
10	2	1- 40 WATT CFL SCREW-IN	2	LED A21 14 WATT, FULLY OMNI E26 BASE, 120V, 4000K, DIMMABLE, ENCLOSED - ENERGY STAR
11	1	1L - A LAMP 25 WATT INCANDESCENT	1	LED A19 10 WATT, FULLY OMNI E26 BASE, 120V, 4000K, DIMMABLE-ENCLOSED - ENERGYST
12	1	1L - A LAMP 60 WATT INCANDESCENT	1	LED A19 8 WATT, FULLY OMNI E26 BASE, 120V, 4000K, DIMMABLE - ENERGY STAR
13	3	1L - A LAMP 60 WATT INCANDESCENT	3	LED A19 9 WATT, FULLY OMNI, E26 BASE, 120V, 4000K, DIM, ENCLOSED
14	7	2 - 13 WATT CFL DUAL - PIN FIXTURE	7	METALUX AP SERIES-ROUND FLUSH MOUNT-9" 12W 950 LUMEN
15	2	4' FIXTURE, 1-F34/T12 LAMP, ENERGY SAVING MAGNETIC BALLAST	2	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED
16	2	4' FIXTURE, 2-F34/T12 LAMPS, ENERGY SAVING MAGNETIC BALLAST	4	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED
17	3	8' FIXTURE, 4-F32/T8 LAMPS, INSTANT START ELECT BALLAST BF: .85-.95	12	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED
18	4	CIRCLE FIXTURE 32 WATT T8 FLUORESCENT	4	METALUX AP SERIES-ROUND FLUSH MOUNT-9" 12W 950 LUMEN
19	4	PAR 56 FLOOD 240 WATT	4	BR40, E26 BASE, 14 WATT, 120V, 3000K, DIMMABLE - ENERGY STAR
20	0	0 - N/A	10	4FT 2 LAMP STRIP
21	0	0 - N/A	5	MAESTRO DUAL TECH OCCUPANCY SENSING SWITCH
22	0	0 - N/A	50	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED
23	0	0 - N/A	1000	NON-SHUNTED SOCKET, 600V, 660W
24	0	0 - N/A	14	1 LAMP UNIVERSAL TOMBSTONE KIT WITH BALLAST DISCONNECT T8
25	0	0 - N/A	395	2 LAMP UNIVERSAL TOMBSTONE KIT WITH BALLAST DISCONNECT T8
26	0	0 - N/A	92	3 LAMP UNIVERSAL TOMBSTONE KIT WITH BALLAST DISCONNECT T8
27	0	0 - N/A	35	4 LAMP UNIVERSAL TOMBSTONE KIT WITH BALLAST DISCONNECT T8
28	0	0 - N/A	1	ENERGI TRI-PACK WIRELESS CEILING/SWITCH PACKAGE
29	0	0 - N/A	3	LENS COVER -- PLACE HOLDER
TOTAL	**480**		**2607**	

West Milford High School

#	Ex Fixt Qty	Existing Fixture or Lamp Description	New Fixture or Lamp Qty	Replacement Fixture or Lamp Description
1	52	*2' FIXTURE, 2-F17/T8/STD LAMPS, (.88) ELECTRONIC BALLAST	104	G4 SP 2 FOOT 8W 4000K 140LPW NANO LENS SEP LED TUBE - DLC LISTED
2	1	*2' FIXTURE, 2-F32/T8/U6 LAMPS, ELECTRONIC BALLAST	3	G4 SP 2 FOOT 8W 4000K 140LPW NANO LENS SEP LED TUBE - DLC LISTED
3	125	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	125	2' LED GENERAL LINEAR LIGHTING SERIES, 30W, 4000LM, 0-10V DIMMING, 120-277V, 40K
4	655	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	1310	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED
5	60	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	180	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED
6	12	*4' FIXTURE, 4-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	12	INTERIOR LUMINAIRES, G2 THIN PANEL, 2X4, 36W, 4000K, 120-277VAC, DIMMABLE - DLC LISTED
7	81	*4' FIXTURE, 4-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	324	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED
8	31	*4' FIXTURE, 6-F32/T8 LAMPS, ELECTRONIC BALLAST	186	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED
9	7	1 - 13W CFL	7	LED A19 10 WATT, FULLY OMNI E26 BASE, 120V, 4000K, DIMMABLE-ENCLOSED - ENERGYST
10	9	1 - 13W CFL	9	LED A19 9 WATT, FULLY OMNI, E26 BASE, 120V, 4000K, DIM, ENCLOSED
11	10	1 - 13W CFL	10	LED BR30 8 WATT CLOUD DESIGN, E26 BASE, 120V, 4000K, DIMMABLE (ENERGY STAR)
12	36	1 - 24 WATT CFL	36	LED A19 10 WATT, FULLY OMNI E26 BASE, 120V, 4000K, DIMMABLE-ENCLOSED - ENERGYST
13	2	12' FIXTURE, 3-F32/T8, ELECTRONIC BALLAST	6	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED
14	3	1-42 WATT CFL	3	LED A21 14 WATT, FULLY OMNI E26 BASE, 120V, 4000K, DIMMABLE, ENCLOSED - ENERGY STAR
15	15	1L - A LAMP 100 WATT INCANDESCENT	15	LED A21 14 WATT, FULLY OMNI E26 BASE, 120V, 4000K, DIMMABLE, ENCLOSED - ENERGY STAR
16	1	1L - A LAMP 200 WATT INCANDESCENT	1	LED A21 14 WATT, FULLY OMNI E26 BASE, 120V, 4000K, DIMMABLE, ENCLOSED - ENERGY STAR
17	6	1L - A LAMP 60 WATT INCANDESCENT	6	LED A19 10 WATT, FULLY OMNI E26 BASE, 120V, 4000K, DIMMABLE-ENCLOSED - ENERGYST
18	27	1L - A LAMP 60 WATT INCANDESCENT	27	LED A19 9 WATT, FULLY OMNI, E26 BASE, 120V, 4000K, DIM, ENCLOSED
19	2	1L - A LAMP 60 WATT INCANDESCENT	2	LED BR30 8 WATT CLOUD DESIGN, E26 BASE, 120V, 4000K, DIMMABLE (ENERGY STAR)
20	30	1L - A LAMP 75 WATT INCANDESCENT	30	LED A19 10 WATT, FULLY OMNI E26 BASE, 120V, 4000K, DIMMABLE-ENCLOSED - ENERGYST
21	1	4' FIXTURE, 2-F34/T12 LAMPS, ELECTRONIC BALLAST	2	4' FIXTURE, 2-F34/T12 LAMPS, ELECTRONIC BALLAST
22	25	4' FIXTURE, 6-F54/T5/HO/LAMPS, 2-ELECTRONIC BALLASTS	25	2 X 4, HIGH BAY, ECO LINEAR, 258W, 4000K, 120-277VAC, DIMMABLE, MEDIUM OPTIC - DLC LISTED
23	1	8' FIXTURE, 2-F34/T12 LAMPS, ENERGY SAVING MAGNETIC BALLAST	2	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED
24	51	8' FIXTURE, 4-F32/T8 LAMPS, INSTANT START ELECT BALLAST BF: 95+	204	G4 SP 4 FOOT 15W 4000K 140LPW NANO LENS SEP LED TUBE - DLC LISTED
25	537	8' FIXTURE, 4-F32/T8 LAMPS, INSTANT START ELECT BALLAST BF: 95+	2148	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED
26	24	8' FIXTURE, 6-F32/T8 LAMPS, INSTANT START ELECT BALLAST BF: .88	144	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED
27	3	8' FIXTURE, 8-32/T8, ELECTRONIC BALLAST	24	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED
28	1	HALOGEN LIGHT BULB T3 300W	1	FUTURE FLOOD 39W NEUTRAL LED + 277V PC BRONZE - DLC LISTED
29	3	METAL HALIDE, 1-150 WATT LAMP	3	WALLPACK 37W NEUTRAL LED 277V PC W/ GLASS LENS BZ - DLC LISTED
30	3	METAL HALIDE, 1-150 WATT LAMP	3	WALLPACK 55W NEUTRAL LED 120V PC W/ GLASS LENS BZ
31	50	METAL HALIDE, 1-175 WATT LAMP	50	LED BR30 8 WATT CLOUD DESIGN, E26 BASE, 120V, 4000K, DIMMABLE (ENERGY STAR)
32	4	METAL HALIDE, 1-250 WATT LAMP	4	FLEXFLOOD 78W NEUTRAL LED SLIPFITTER + SWIVEL PC BRONZE - DLC LISTED
33	0	0 - N/A	11	**** ALREADY LED ****
34	0	0 - N/A	21	16 INCH- 2 LAMP HARNESS
35	0	0 - N/A	735	2 LAMP UNIVERSAL TOMBSTONE KIT WITH BALLAST DISCONNECT T8
36	0	0 - N/A	11	2X4 PRISMATIC LENS
37	0	0 - N/A	122	3 LAMP UNIVERSAL TOMBSTONE KIT WITH BALLAST DISCONNECT T8
38	0	0 - N/A	699	4 LAMP UNIVERSAL TOMBSTONE KIT WITH BALLAST DISCONNECT T8
39	0	0 - N/A	18	4FT 2 LAMP STRIP
40	0	0 - N/A	4	ENERGI TRI-PACK WIRELESS CEILING/SWITCH PACKAGE
41	0	0 - N/A	23	LENS COVER -- PLACE HOLDER
42	0	0 - N/A	11	MAESTRO DUAL TECH OCCUPANCY SENSING SWITCH
43	0	0 - N/A	1	RETROFIT KIT FOR 2' U-TUBE (INCLUDES (3) SOCKETS)
44	0	0 - N/A	4634	T8 NON SHUNTED SOCKET - COMMON
45	0	0 - N/A	25	WIRE GUARD, 2 PIECES FOR 2'X4' (DOUBLE LONG)
TOTAL	**1868**		**11321**	

West Milford Township Public Schools
Energy Savings Program

APPENDIX 7. DIRECT INSTALL SCOPE OF WORK

Administration Building

Room Info		*Existing Fixture Info*		*Lighting Fixture Upgrades*	*Occupancy Sensor Upgrades*		
Floor	**Location**	**No. of Fix.**	**Fixture Type**	**Upgrade Description**	**Sens Qty**	**Sensor(s)**	**ECM Description**
Ground Floor	MAIN AREA	31	2x4-4FO32-L	New 35.6w 2x4 LED Flat Panel		No Sensor Control	Replace Existing Fixture with New 35.6 Watt 2x4 LED Flat Panel Fixture with 80,000 Hour L70 Rating.
Ground Floor	DR MCQUAID OFFICE	1	2x4-4FO32-L	New 35.6w 2x4 LED Flat Panel	1	MS-A-102-WH	Replace Existing Fixture with New 35.6 Watt 2x4 LED Flat Panel Fixture with 80,000 Hour L70 Rating.
Ground Floor	MR WINSTON OFFICE	1	2x4-4FO32-L	New 35.6w 2x4 LED Flat Panel	1	MS-A-102-WH	Replace Existing Fixture with New 35.6 Watt 2x4 LED Flat Panel Fixture with 80,000 Hour L70 Rating.
Ground Floor	MS WATSON OFFICE	1	2x4-4FO32-L	New 35.6w 2x4 LED Flat Panel		No Sensor Control	Replace Existing Fixture with New 35.6 Watt 2x4 LED Flat Panel Fixture with 80,000 Hour L70 Rating.
Ground Floor	CHRIS KELLY OFFICE	1	2x4-4FO32-L	New 35.6w 2x4 LED Flat Panel		No Sensor Control	Replace Existing Fixture with New 35.6 Watt 2x4 LED Flat Panel Fixture with 80,000 Hour L70 Rating.
Ground Floor	MS CONLON OFFICE	4	2x4-4FO32-L	New 35.6w 2x4 LED Flat Panel		No Sensor Control	Replace Existing Fixture with New 35.6 Watt 2x4 LED Flat Panel Fixture with 80,000 Hour L70 Rating.
Ground Floor	D. POPLASKI OFFICE	1	2x4-4FO32-L	New 35.6w 2x4 LED Flat Panel	1	MS-A-102-WH	Replace Existing Fixture with New 35.6 Watt 2x4 LED Flat Panel Fixture with 80,000 Hour L70 Rating.
Ground Floor	Conf Rm	1	2x4-4FO32-L	New 35.6w 2x4 LED Flat Panel	1	MS-A-102-WH	Replace Existing Fixture with New 35.6 Watt 2x4 LED Flat Panel Fixture with 80,000 Hour L70 Rating.
Ground Floor	D. NOVAK OFFICE	2	2x4-4FO32-L	New 35.6w 2x4 LED Flat Panel	1	MS-A-102-WH	Replace Existing Fixture with New 35.6 Watt 2x4 LED Flat Panel Fixture with 80,000 Hour L70 Rating.
Ground Floor	B. SCHOLTS OFFICE	1	2x4-4FO32-L	New 35.6w 2x4 LED Flat Panel	1	MS-A-102-WH	Replace Existing Fixture with New 35.6 Watt 2x4 LED Flat Panel Fixture with 80,000 Hour L70 Rating.
Ground Floor	D. COSTELLO OFFICE	2	2x4-4FO32-L	New 35.6w 2x4 LED Flat Panel	1	MS-A-102-WH	Replace Existing Fixture with New 35.6 Watt 2x4 LED Flat Panel Fixture with 80,000 Hour L70 Rating.
Ground Floor	D. COSTELLO OFFICE	1	2x2-2FO32U-L	New 20w 2x2 LED Flat Panel	1	MS-A-102-WH	Replace Existing Fixture with New 20 Watt 2x2 LED Flat Panel Fixture with 80,000 Hour L70 Rating.
Ground Floor	A. ANEMONE OFFICE	3	2x4-4FO32-L	New 35.6w 2x4 LED Flat Panel	1	MRF2-1S8A-10C	Replace Existing Fixture with New 35.6 Watt 2x4 LED Flat Panel Fixture with 80,000 Hour L70 Rating.
Ground Floor	MENS BR	2	2x2-2FO32U-L	New 20w 2x2 LED Flat Panel		No Sensor Control	Replace Existing Fixture with New 20 Watt 2x2 LED Flat Panel Fixture with 80,000 Hour L70 Rating.
Ground Floor	WOMENS BR	2	2x4-4FO32-L	New 35.6w 2x4 LED Flat Panel		No Sensor Control	Replace Existing Fixture with New 35.6 Watt 2x4 LED Flat Panel Fixture with 80,000 Hour L70 Rating.
Ground Floor	WOMENS BR WALL	1	1x4-2FO32-S	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Basement	LOWER STAIR	1	Bare-CF13	(1) 10w Dimmable LED A		No Sensor Control	Re-Lamp 1-Lamp Incandescent or Compact Fluorescent Fixture with (1) 10 Watt Dimmable LED A Lamp.
Basement	LOWER AREA AT COKE MACHINE	1	Bare-CF28	(1) 10w Dimmable LED A		No Sensor Control	Re-Lamp 1-Lamp Incandescent or Compact Fluorescent Fixture with (1) 10 Watt Dimmable LED A Lamp.
Basement	B. FRANSISCO OFFICE	2	2x4-4FO32-L	New 35.6w 2x4 LED Flat Panel	1	MS-A-102-WH	Replace Existing Fixture with New 35.6 Watt 2x4 LED Flat Panel Fixture with 80,000 Hour L70 Rating.
Basement	LOWER HALL	4	2x4-4FO32-L	New 35.6w 2x4 LED Flat Panel		No Sensor Control	Replace Existing Fixture with New 35.6 Watt 2x4 LED Flat Panel Fixture with 80,000 Hour L70 Rating.
Basement	BACK STORAGE HALL	2	1x4-2FO32-S	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Basement	BACK STORAGE HALL	1	1x8-4FO32-S	(4) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 4-Lamp 4' Fixtures with (4) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Basement	LOWER BACK STORAGE	1	1x4-2FO32-S	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Basement	LOWER PLAN RM	1	2x4-4FO32-L	New 35.6w 2x4 LED Flat Panel		No Sensor Control	Replace Existing Fixture with New 35.6 Watt 2x4 LED Flat Panel Fixture with 80,000 Hour L70 Rating.
Basement	GARAGE STORAGE	2	1x4-2FO32-S	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Basement	BOILER ROOM	2	1x4-2F40-S	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Basement	BOILER ROOM	2	1x4-2FO32-S	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Basement	LOWER COPY RM	1	2x4-4FO32-L	New 35.6w 2x4 LED Flat Panel		No Sensor Control	Replace Existing Fixture with New 35.6 Watt 2x4 LED Flat Panel Fixture with 80,000 Hour L70 Rating.
Basement	LOWER PAPER STORAGE	2	1x4-2FO32-S	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Basement	LOWER CONFERENCE ROOM	3	2x4-4FO32-L	New 35.6w 2x4 LED Flat Panel	1	MS-A-102-WH	Replace Existing Fixture with New 35.6 Watt 2x4 LED Flat Panel Fixture with 80,000 Hour L70 Rating.
Basement	LOWER XMAS STORAGE	1	2x4-2FO32-L	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Basement	LOWER KITCHEN	2	2x4-4FO32-L	New 35.6w 2x4 LED Flat Panel	1	MRF2-1S8A-10C	Replace Existing Fixture with New 35.6 Watt 2x4 LED Flat Panel Fixture with 80,000 Hour L70 Rating.
Basement	LOWER KITCHEN BACK DOOR	3	2x4-4FO32-L	New 35.6w 2x4 LED Flat Panel		No Sensor Control	Replace Existing Fixture with New 35.6 Watt 2x4 LED Flat Panel Fixture with 80,000 Hour L70 Rating.
Basement	LOWER DATA ROOM	1	2x4-4FO32-L	New 35.6w 2x4 LED Flat Panel		No Sensor Control	Replace Existing Fixture with New 35.6 Watt 2x4 LED Flat Panel Fixture with 80,000 Hour L70 Rating.
Basement	LOWER OFFICE NO ACCESS	6	2x4-4FO32-L	New 35.6w 2x4 LED Flat Panel		No Sensor Control	Replace Existing Fixture with New 35.6 Watt 2x4 LED Flat Panel Fixture with 80,000 Hour L70 Rating.

Room Info		*Existing Fixture Info*		*Lighting Fixture Upgrades*	*Occupancy Sensor Upgrades*		
Floor	**Location**	**No. of Fix.**	**Fixture Type**	**Upgrade Description**	**Sens Qty**	**Sensor(s)**	**ECM Description**
Exterior	EXTERIOR-ENTRY MAIN	3	HH-65R30	(1) 9w Dimmable LED R30		No Sensor Control	Re-Lamp 1-Lamp Incandescent or Compact Fluorescent Fixture with (1) 9 Watt Dimmable LED R30 Lamp.
Exterior	EXTEIOR-@GREEN DOOR LEFT SIDE	1	Wallpack-MH70	New 24.5w LED Wallpack		No Sensor Control	Replace Existing Fixture with New 24.5 Watt LED Wallpack Fixture with 100,000 Hour L70 Rating. Includes Photocell.
Exterior	EXTERIOR @ GREEN GARAGE DOOR	1	Jelly-CF28	New 13.7w LED Security Wallpack		No Sensor Control	Replace Existing Fixture with New 13.7 Watt LED Security Wallpack Fixture with 60,000 Hour L70 Rating. Includes Photocell.
Exterior	EXTERIOR CAGE DOOR	1	Wallpack-MH100	New 24.5w LED Wallpack		No Sensor Control	Replace Existing Fixture with New 24.5 Watt LED Wallpack Fixture with 100,000 Hour L70 Rating. Includes Photocell.
Exterior	EXTERIOR @ GREEN DOOR RIGHT SIDE	1	Wallpack-MH70	New 24.5w LED Wallpack		No Sensor Control	Replace Existing Fixture with New 24.5 Watt LED Wallpack Fixture with 100,000 Hour L70 Rating. Includes Photocell.
Exterior	EXTERIOR LOWER RIGHT SIDE	1	Wallpack-MH100	New 24.5w LED Wallpack		No Sensor Control	Replace Existing Fixture with New 24.5 Watt LED Wallpack Fixture with 100,000 Hour L70 Rating. Includes Photocell.
Exterior	EXTERIOR FRONT FLOODS	2	Flood-MH400	New 168w LED Flood		No Sensor Control	Replace Existing Fixture with New 168 Watt LED Flood Fixture with 100,000 Hour L70 Rating. Includes Photocell.
	Total	**103**			**12**		

West Milford Township Public Schools
Energy Savings Program

Apshawa Elementary School

Room Info		Existing Fixture Info		Lighting Fixture Upgrades		Occupancy Sensor Upgrades		
Floor	Location	No. of Fix.	Fixture Type	ECM No.	Upgrade Description	Sens Qty	Sensor(s)	ECM Description
Ground Floor	GYM	16	High Bay-4FP54HO	9NE10	lew 130.2w Linear LED High Ba	16	12800P-302	Install New 130.2 Watt Linear LED High Bay Fixture with 50,000 Hour L70 Rating.
Ground Floor		16		\L923	Lens Kit for 1'x2' High Bay			Install Lens Kit for 1'x2' High Bay Fixture.
Ground Floor	GYM	2	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	HALL DISPLAY	1	1x4-1FO32-S	T4L11	(1) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 1-Lamp 4' Fixtures with (1) 10.5 Watt Line Voltage Type B LED T8 Tube.
Ground Floor	GYM STORAGE BEHIND KITCHEN	2	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	STAGE STORAGE	1	Bare-75A	ID09	(1) 14w Dimmable LED A		No Sensor Control	Re-Lamp 1-Lamp Incandescent or Compact Fluorescent Fixture with (1) 14 Watt Dimmable LED A Lamp.
Ground Floor	STAGE STORAGE	2	Drum-(2)PL13	IN15	New 13.5w LED Flush Mount		No Sensor Control	Replace Existing Fixture with New 13.5 Watt LED Flush Mount Fixture with 50,000 Hour L70 Rating.
Ground Floor	STAGE	1	2x2-2FO17-L	T222	(2) 8w 2' T8 LED B		No Sensor Control	Retrofit 2-Lamp 2' Fixtures with (2) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	STAGE STORAGE	1	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CUSTODIAN STORAGE @ C1	1	Bare-150A	ID09	(1) 14w Dimmable LED A		No Sensor Control	Re-Lamp 1-Lamp Incandescent or Compact Fluorescent Fixture with (1) 14 Watt Dimmable LED A Lamp.
Ground Floor	FIXTURE ADD: CUSTODIAN STORAGE @	1	(None Existing)	IN15	New 13.5w LED Flush Mount		No Sensor Control	Replace Existing Fixture with New 13.5 Watt LED Flush Mount Fixture with 50,000 Hour L70 Rating.
Ground Floor	EXIT STAIR @C1	2	Bare-60A	ID08	(1) 10w Dimmable LED A		No Sensor Control	Re-Lamp 1-Lamp Incandescent or Compact Fluorescent Fixture with (1) 10 Watt Dimmable LED A Lamp.
Exterior	EXTERIOR DOOR D2	1	Wallpack-Cut-MH70	HN197	New 24.5w LED Wallpack		No Sensor Control	Replace Existing Fixture with New 24.5 Watt LED Wallpack Fixture with 100,000 Hour L70 Rating. Includes Photocell
Exterior	CANOPY EXTERIOR FLOOD	1	Flood-300Q	HN95	New 42w LED Flood		No Sensor Control	Replace Existing Fixture with New 42 Watt LED Flood Fixture with 100,000 Hour L70 Rating. Includes Photocell.
	Total	32				16		

West Milford Township Public Schools

Energy Savings Program

Maple Road Elementary School

Room Info		Existing Fixture Info		Lighting Fixture Upgrades		Occupancy Sensor Upgrades		
Floor	Location	No. of Fix.	Fixture Type	ECM No.	Upgrade Description	Sens Qty	Sensor(s)	ECM Description
Ground Floor	MAIN OFFICE	3	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B	1	MRF2-1S8A-10C	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	MAIN OFFICE	1	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	MAIN OFFICE PRINCIPAL OFFI	2	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B	1	MRF2-1S8A-10C	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	MAIN OFFICE SAFE	1	Drum-(2)PL13	IN15	New 13.5w LED Flush Mount		No Sensor Control	Replace Existing Fixture with New 13.5 Watt LED Flush Mount Fixture with 50,000 Hour L70 Rating.
Ground Floor	NURSE	13	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	NURSE BR	1	2x2-2FO17-L	T222	(2) 8w 2' T8 LED B		No Sensor Control	Retrofit 2-Lamp 2' Fixtures with (2) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	HALL B1 TO LOBBY	9	2x2-2FO17-L	T222	(2) 8w 2' T8 LED B		No Sensor Control	Retrofit 2-Lamp 2' Fixtures with (2) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	HALL B1 TO LOBBY	2	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	MAIN LOBBY A3 ENTRY	4	2x2-2FO17-L	T222	(2) 8w 2' T8 LED B		No Sensor Control	Retrofit 2-Lamp 2' Fixtures with (2) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	MAIN LOBBY A3 ENTRY	2	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	MAIN LOBBY A3 ENTRY	4	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	MAIN LOBBY A3 ENTRY	4	HH-65R30	IRD25	(1) 9w Dimmable LED R30		No Sensor Control	Re-Lamp 1-Lamp Incandescent or Compact Fluorescent Fixture with (1) 9 Watt Dimmable LED R30 Lamp.
Ground Floor	HALL MAIN OFFICE TO D3	7	2x2-2FO17-L	T222	(2) 8w 2' T8 LED B		No Sensor Control	Retrofit 2-Lamp 2' Fixtures with (2) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	HALL MAIN OFFICE TO D3	2	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	NEW WING	8	2x4-3FO32-L	T4L33	(3) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 3-Lamp 4' Fixtures with (3) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	NEW WING	4	2x2-3FO17-L	T233	(3) 8w 2' T8 LED B		No Sensor Control	Retrofit 3-Lamp 2' Fixtures with (3) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	NEW WING A1 DOOR	2	2x2-2FO32U-L	T2UR3	(3) 8w 2' T8 LED B-Ref		No Sensor Control	Retrofit U-Lamp 2' Fixtures with (3) 8 Watt Line Voltage Type B LED T8 Tubes, New Socket Bar Kit and White Reflector.
Ground Floor	NEW WING D3 DOOR	1	2x2-3F31U-L	T2UR3	(3) 8w 2' T8 LED B-Ref		No Sensor Control	Retrofit U-Lamp 2' Fixtures with (3) 8 Watt Line Voltage Type B LED T8 Tubes, New Socket Bar Kit and White Reflector.
Ground Floor	HALL MAIN OFFICE	20	2x2-2FO17-L	T222	(2) 8w 2' T8 LED B		No Sensor Control	Retrofit 2-Lamp 2' Fixtures with (2) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	HALL RAINBOW WALL	5	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	D1 ENTRY	1	2x2-2FO17-L	T222	(2) 8w 2' T8 LED B		No Sensor Control	Retrofit 2-Lamp 2' Fixtures with (2) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	C1	1	2x2-2FO17-L	T222	(2) 8w 2' T8 LED B		No Sensor Control	Retrofit 2-Lamp 2' Fixtures with (2) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	C1 STORAGE	2	Bare-CF23	ID09	(1) 14w Dimmable LED A		No Sensor Control	Re-Lamp 1-Lamp Incandescent or Compact Fluorescent Fixture with (1) 14 Watt Dimmable LED A Lamp.
Ground Floor	STAGE CLOSET	1	Bare-CF13	ID08	(1) 10w Dimmable LED A		No Sensor Control	Re-Lamp 1-Lamp Incandescent or Compact Fluorescent Fixture with (1) 10 Watt Dimmable LED A Lamp.
Ground Floor	STAGE	3	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	STAGE TRACKS	4	Track-75PAR38	IRD08	(1) 17w Dimmable LED PAR38		No Sensor Control	Re-Lamp 1-Lamp Incandescent or Compact Fluorescent Fixture with (1) 17 Watt Dimmable LED PAR38 Lamp.
Ground Floor	GYM	16	High Bay-4FP54HO	9NE11	New 165.1w Linear LED High Bay	16	12800P-302	Install New 165.1 Watt Linear LED High Bay Fixture with 50,000 Hour L70 Rating.
Ground Floor		16		\L923	Lens Kit for 1'x2' High Bay			Install Lens Kit for 1'x2' High Bay Fixture.
Ground Floor	GYM JELLY JARS	4	Bare-60A	ID08	(1) 10w Dimmable LED A		No Sensor Control	Re-Lamp 1-Lamp Incandescent or Compact Fluorescent Fixture with (1) 10 Watt Dimmable LED A Lamp.
Ground Floor	GYM STORAGE	1	Drum-(2)PL13	IN15	New 13.5w LED Flush Mount		No Sensor Control	Replace Existing Fixture with New 13.5 Watt LED Flush Mount Fixture with 50,000 Hour L70 Rating.
Ground Floor	GYM STORAGE	2	Bare-CF18	IN15	New 13.5w LED Flush Mount		No Sensor Control	Replace Existing Fixture with New 13.5 Watt LED Flush Mount Fixture with 50,000 Hour L70 Rating.
Ground Floor	KITCHEN	8	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	KITCHEN HOODS	5	Bare-75A	ID08	(1) 10w Dimmable LED A		No Sensor Control	Re-Lamp 1-Lamp Incandescent or Compact Fluorescent Fixture with (1) 10 Watt Dimmable LED A Lamp.
Ground Floor	CR 1	14	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 1 BR	1	2x2-2FO17-L	T222	(2) 8w 2' T8 LED B		No Sensor Control	Retrofit 2-Lamp 2' Fixtures with (2) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR1A SPEECH	8	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 2	14	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 2 BR	1	2x2-2FO17-L	T222	(2) 8w 2' T8 LED B		No Sensor Control	Retrofit 2-Lamp 2' Fixtures with (2) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR2A	8	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 3	19	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 3 BR	1	2x2-2FO17-L	T222	(2) 8w 2' T8 LED B		No Sensor Control	Retrofit 2-Lamp 2' Fixtures with (2) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR3 CLOSET	1	2x2-2FO17-L	T222	(2) 8w 2' T8 LED B		No Sensor Control	Retrofit 2-Lamp 2' Fixtures with (2) 8 Watt Line Voltage Type B LED T8 Tubes.

West Milford Township Public Schools

Energy Savings Program

Room Info		Existing Fixture Info		Lighting Fixture Upgrades		Occupancy Sensor Upgrades		
Floor	Location	No. of Fix.	Fixture Type	ECM No.	Upgrade Description	Sens Qty	Sensor(s)	ECM Description
Ground Floor	CR 4	19	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 4 BR	1	2x2-2FO17-L	T222	(2) 8w 2' T8 LED B		No Sensor Control	Retrofit 2-Lamp 2' Fixtures with (2) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 4 CLOSET	1	2x2-2FO17-L	T222	(2) 8w 2' T8 LED B		No Sensor Control	Retrofit 2-Lamp 2' Fixtures with (2) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 5	14	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 5 BR	1	2x2-2FO17-L	T222	(2) 8w 2' T8 LED B		No Sensor Control	Retrofit 2-Lamp 2' Fixtures with (2) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 6	10	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 6	4	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 6 BR	1	2x2-2FO17-L	T222	(2) 8w 2' T8 LED B		No Sensor Control	Retrofit 2-Lamp 2' Fixtures with (2) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 6A	8	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B	1	MRF2-1S8A-10C	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 7	14	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 7 BR	1	2x2-2FO17-L	T222	(2) 8w 2' T8 LED B		No Sensor Control	Retrofit 2-Lamp 2' Fixtures with (2) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 7 CLOSET	1	2x2-2FO17-L	T222	(2) 8w 2' T8 LED B		No Sensor Control	Retrofit 2-Lamp 2' Fixtures with (2) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 8	14	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 8 BR	1	2x2-2FO17-L	T222	(2) 8w 2' T8 LED B		No Sensor Control	Retrofit 2-Lamp 2' Fixtures with (2) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	BOILER RM	5	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	BOILER RM	1	1x4-1FO32-S	T4L11	(1) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 1-Lamp 4' Fixtures with (1) 10.5 Watt Line Voltage Type B LED T8 Tube.
Ground Floor	BOILER RM	2	Bare-75A	ID09	(1) 14w Dimmable LED A		No Sensor Control	Re-Lamp 1-Lamp Incandescent or Compact Fluorescent Fixture with (1) 14 Watt Dimmable LED A Lamp.
Ground Floor	CUSTODIAL CLOSET	1	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	MENS BR	1	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	MENS BR WALL	1	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	FACULTY LOUNGE	7	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	WOMENS BR	1	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	WOMENS BR WALL	1	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	STORAGE AT A3	3	1x4-1FO32-S	T4L11	(1) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 1-Lamp 4' Fixtures with (1) 10.5 Watt Line Voltage Type B LED T8 Tube.
Ground Floor	MEDIA CENTER	31	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 9	14	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 9 CLOSET	1	Drum-(2)PL13	IN15	New 13.5w LED Flush Mount		No Sensor Control	Replace Existing Fixture with New 13.5 Watt LED Flush Mount Fixture with 50,000 Hour L70 Rating.
Ground Floor	CR 9 BR	1	2x2-2FO17-L	T222	(2) 8w 2' T8 LED B		No Sensor Control	Retrofit 2-Lamp 2' Fixtures with (2) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 10	14	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 10 BR	1	2x2-2FO17-L	T222	(2) 8w 2' T8 LED B		No Sensor Control	Retrofit 2-Lamp 2' Fixtures with (2) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 11	12	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 11 BR	1	2x2-2FO17-L	T222	(2) 8w 2' T8 LED B		No Sensor Control	Retrofit 2-Lamp 2' Fixtures with (2) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 11 CLOSET	1	2x2-2FO17-L	T222	(2) 8w 2' T8 LED B		No Sensor Control	Retrofit 2-Lamp 2' Fixtures with (2) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 12	12	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 12 BR	1	2x2-2FO17-L	T222	(2) 8w 2' T8 LED B		No Sensor Control	Retrofit 2-Lamp 2' Fixtures with (2) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 13	14	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 13 BR	1	2x2-2FO17-L	T222	(2) 8w 2' T8 LED B		No Sensor Control	Retrofit 2-Lamp 2' Fixtures with (2) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 14	14	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 14 BR	1	2x2-2FO17-L	T222	(2) 8w 2' T8 LED B		No Sensor Control	Retrofit 2-Lamp 2' Fixtures with (2) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	ELECTRIC RM	3	2x4-4FO32-L	T4L44	(4) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 4-Lamp 4' Fixtures with (4) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 15	12	2x4-3FO32-L	T4L33	(3) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 3-Lamp 4' Fixtures with (3) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 15 BR	1	2x2-3FO17-L	T232	(2) 8w 2' T8 LED B		No Sensor Control	Retrofit 3-Lamp 2' Fixtures with (2) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 15 CLOSET	2	2x4-3FO32-L	T4L33	(3) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 3-Lamp 4' Fixtures with (3) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 16	12	2x4-3FO32-L	T4L33	(3) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 3-Lamp 4' Fixtures with (3) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 16 BR	1	2x2-3FO17-L	T232	(2) 8w 2' T8 LED B		No Sensor Control	Retrofit 3-Lamp 2' Fixtures with (2) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	OPEN OFFICE RM 17	14	2x4-3FO32-L	T4L33	(3) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 3-Lamp 4' Fixtures with (3) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	OPEN OFFICE RM 17 BR	1	2x2-3FO17-L	T232	(2) 8w 2' T8 LED B		No Sensor Control	Retrofit 3-Lamp 2' Fixtures with (2) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CLOSET WORK RM	2	2x4-3FO32-L	T4L33	(3) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 3-Lamp 4' Fixtures with (3) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	FILE RM	1	2x4-3FO32-L	T4L33	(3) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 3-Lamp 4' Fixtures with (3) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CONFERENCE RM	3	2x4-3FO32-L	T4L33	(3) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 3-Lamp 4' Fixtures with (3) 10.5 Watt Line Voltage Type B LED T8 Tubes.

West Milford Township Public Schools

Energy Savings Program

Room Info		Existing Fixture Info		Lighting Fixture Upgrades		Occupancy Sensor Upgrades		
Floor	**Location**	**No. of Fix.**	**Fixture Type**	**ECM No.**	**Upgrade Description**	**Sens Qty**	**Sensor(s)**	**ECM Description**
Ground Floor	SPEECH RM	4	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B	1	MS-A-102-WH	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	WORK RM 1B	4	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B	1	MS-A-102-WH	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 19 MUSIC	15	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B	1	MRF2-1S8A-10C	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 19 CLOSET	1	Drum-(2)PL13	IN15	New 13.5w LED Flush Mount		No Sensor Control	Replace Existing Fixture with New 13.5 Watt LED Flush Mount Fixture with 50,000 Hour L70 Rating.
Ground Floor	BOYS BR	2	2x2-2FO17-L	T222	(2) 8w 2' T8 LED B		No Sensor Control	Retrofit 2-Lamp 2' Fixtures with (2) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	JANITOR CLOSET	1	Drum-(2)PL13	IN15	New 13.5w LED Flush Mount		No Sensor Control	Replace Existing Fixture with New 13.5 Watt LED Flush Mount Fixture with 50,000 Hour L70 Rating.
Ground Floor	GIRLS BR	2	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 20	12	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B	1	MRF2-1S8A-10C	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 20 CLOSET	1	2x2-2FO17-L	T222	(2) 8w 2' T8 LED B		No Sensor Control	Retrofit 2-Lamp 2' Fixtures with (2) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 21	12	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 21 CLOSET	1	2x2-2FO17-L	T222	(2) 8w 2' T8 LED B		No Sensor Control	Retrofit 2-Lamp 2' Fixtures with (2) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 22	12	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 22 CLOSET	1	2x2-2FO17-L	T222	(2) 8w 2' T8 LED B		No Sensor Control	Retrofit 2-Lamp 2' Fixtures with (2) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 23	12	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 23 CLOSET	1	2x2-2FO17-L	T222	(2) 8w 2' T8 LED B		No Sensor Control	Retrofit 2-Lamp 2' Fixtures with (2) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 24	12	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 24 CLOSET	1	2x2-2FO17-L	T222	(2) 8w 2' T8 LED B		No Sensor Control	Retrofit 2-Lamp 2' Fixtures with (2) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 25	12	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 25 CLOSET	1	2x2-2FO17-L	T222	(2) 8w 2' T8 LED B		No Sensor Control	Retrofit 2-Lamp 2' Fixtures with (2) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 26	12	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 26 CLOSET	1	2x2-2FO17-L	T222	(2) 8w 2' T8 LED B		No Sensor Control	Retrofit 2-Lamp 2' Fixtures with (2) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 27	12	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 27 CLOSET	1	2x2-2FO17-L	T222	(2) 8w 2' T8 LED B		No Sensor Control	Retrofit 2-Lamp 2' Fixtures with (2) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 28	12	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 28 CLOSET	1	2x2-2FO17-L	T222	(2) 8w 2' T8 LED B		No Sensor Control	Retrofit 2-Lamp 2' Fixtures with (2) 8 Watt Line Voltage Type B LED T8 Tubes.
Exterior	EXTERIOR A3 MAIN ENTRY	2	Jelly-PL32	I42	(1) 10.5w Horizontal LED 4-Pin PL B		No Sensor Control	Retrofit 1-Lamp Plug-In Compact Fluorescent Fixture with (1) 10.5 Watt Line Voltage Horizontal LED 4-Pin PL B Lamp.
Exterior	EXTERIOR D2	1	Wallpack-PL32	HN71	New 13.7w LED Security Wallpack		No Sensor Control	Replace Existing Fixture with New 13.7 Watt LED Security Wallpack Fixture with 60,000 Hour L70 Rating. Includes Photocell.
	Total	**643**				**23**		

West Milford Township Public Schools

Energy Savings Program

Marshall Hill Elementary School

Room Info		*Existing Fixture Info*		*Lighting Fixture Upgrades*		*Occupancy Sensor Upgrades*		
Floor	**Location**	**No. of Fix.**	**Fixture Type**	**ECM No.**	**Upgrade Description**	**Sens Qty**	**Sensor(s)**	**ECM Description**
Ground Floor	STAIR TO D6	1	1x4-1FO32-S	T4L11	(1) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 1-Lamp 4' Fixtures with (1) 10.5 Watt Line Voltage Type B LED T8 Tube.
Ground Floor	STAIR TO D6	2	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	BASEMENT HALL	6	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 1-K	17	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 1K GIRLS BR	1	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 1-K CUBBY	1	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR1-K BOYS BR	1	Bare-CF13	ID08	(1) 10w Dimmable LED A		No Sensor Control	Re-Lamp 1-Lamp Incandescent or Compact Fluorescent Fixture with (1) 10 Watt Dimmable LED A Lamp.
Ground Floor	CR 1-K CUBBY	2	Bare-CF13	ID08	(1) 10w Dimmable LED A		No Sensor Control	Re-Lamp 1-Lamp Incandescent or Compact Fluorescent Fixture with (1) 10 Watt Dimmable LED A Lamp.
Ground Floor	CR 1-K CLOSET	1	2x2-2FO17-L	T222	(2) 8w 2' T8 LED B		No Sensor Control	Retrofit 2-Lamp 2' Fixtures with (2) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 2-K	17	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B	1	MS-A-102-WH	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 2-K CLOSET	1	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 2-K CUBBY	1	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 2-K BR'S	4	Sconce-CF23	ID08	(1) 10w Dimmable LED A		No Sensor Control	Re-Lamp 1-Lamp Incandescent or Compact Fluorescent Fixture with (1) 10 Watt Dimmable LED A Lamp.
Ground Floor	CR 2-K CUBBY	2	Bare-CF13	ID08	(1) 10w Dimmable LED A		No Sensor Control	Re-Lamp 1-Lamp Incandescent or Compact Fluorescent Fixture with (1) 10 Watt Dimmable LED A Lamp.
Ground Floor	CR 2-K CUBBY	1	Bare-60A	ID08	(1) 10w Dimmable LED A		No Sensor Control	Re-Lamp 1-Lamp Incandescent or Compact Fluorescent Fixture with (1) 10 Watt Dimmable LED A Lamp.
Ground Floor	GIRLS BR	1	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	GIRLS BR	1	1x4-1FO32-S	T4L11	(1) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 1-Lamp 4' Fixtures with (1) 10.5 Watt Line Voltage Type B LED T8 Tube.
Ground Floor	GIRLS BR	1	Bare-60A	ID08	(1) 10w Dimmable LED A		No Sensor Control	Re-Lamp 1-Lamp Incandescent or Compact Fluorescent Fixture with (1) 10 Watt Dimmable LED A Lamp.
Ground Floor	CUSTODIAN CLOSET	1	2x2-2FO17-L	T222	(2) 8w 2' T8 LED B		No Sensor Control	Retrofit 2-Lamp 2' Fixtures with (2) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	BOYS BR	1	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	BOYS BR	1	1x4-1FO32-S	T4L11	(1) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 1-Lamp 4' Fixtures with (1) 10.5 Watt Line Voltage Type B LED T8 Tube.
Ground Floor	BOYS BR	1	Bare-60A	ID08	(1) 10w Dimmable LED A		No Sensor Control	Re-Lamp 1-Lamp Incandescent or Compact Fluorescent Fixture with (1) 10 Watt Dimmable LED A Lamp.
Ground Floor	BASEMENT HALL	6	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	BASEMENT KITCHEN	8	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	KITCHEN HOOD	1	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	STORAGE 1	1	1x8-4FO32-S	T4L44	(4) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 4-Lamp 4' Fixtures with (4) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	STORAGE 1	1	2x2-2FO17-L	T222	(2) 8w 2' T8 LED B		No Sensor Control	Retrofit 2-Lamp 2' Fixtures with (2) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	STORAGE 2	1	2x2-2FO17-L	T222	(2) 8w 2' T8 LED B		No Sensor Control	Retrofit 2-Lamp 2' Fixtures with (2) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	BR	1	2x2-2FO17-L	T222	(2) 8w 2' T8 LED B		No Sensor Control	Retrofit 2-Lamp 2' Fixtures with (2) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	BASEMENT CAFETERIA HALL	5	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	PE STORAGE	2	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	HEAD CUSTODIAN OFFICE	4	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	GYM	12	High Bay-3FP54HO	9NE10	lew 130.2w Linear LED High Ba	12	12800P-302	Install New 130.2 Watt Linear LED High Bay Fixture with 50,000 Hour L70 Rating.
Ground Floor		12		\L923	Lens Kit for 1'x2' High Bay			Install Lens Kit for 1'x2' High Bay Fixture.
Ground Floor	GYM STAGE	2	HH-65R30	IRD25	(1) 9w Dimmable LED R30		No Sensor Control	Re-Lamp 1-Lamp Incandescent or Compact Fluorescent Fixture with (1) 9 Watt Dimmable LED R30 Lamp.
Ground Floor	GYM	6	HH-65R30	IRD08	(1) 17w Dimmable LED PAR38		No Sensor Control	Re-Lamp 1-Lamp Incandescent or Compact Fluorescent Fixture with (1) 17 Watt Dimmable LED PAR38 Lamp.
Ground Floor	CR B3	15	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR B3	2	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR B3	1	2x4-3FO32-L	T4L33	(3) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 3-Lamp 4' Fixtures with (3) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR B3 OFFICE	2	1x4-2FO32-W	3NEL12	New 1x4-2LED10.5-W	1	MS-A-102-WH	Replace Existing Fixture with New 1'x4' Fixture containing (2) 10.5 Watt Line Voltage Type B LED T8 Tubes and Wrap Lens.
Ground Floor	COPIER ROOM	2	1x4-2FO32-W	3NEL12	New 1x4-2LED10.5-W	1	MS-A-102-WH	Replace Existing Fixture with New 1'x4' Fixture containing (2) 10.5 Watt Line Voltage Type B LED T8 Tubes and Wrap Lens.
Ground Floor	FACULTY ENTRY	1	Bare-60A	ID08	(1) 10w Dimmable LED A		No Sensor Control	Re-Lamp 1-Lamp Incandescent or Compact Fluorescent Fixture with (1) 10 Watt Dimmable LED A Lamp.

West Milford Township Public Schools
Energy Savings Program

Room Info		Existing Fixture Info		Lighting Fixture Upgrades		Occupancy Sensor Upgrades		
Floor	Location	No. of Fix.	Fixture Type	ECM No.	Upgrade Description	Sens Qty	Sensor(s)	ECM Description
Ground Floor	FACULTY BR	1	Bare-60A	ID08	(1) 10w Dimmable LED A		No Sensor Control	Re-Lamp 1-Lamp Incandescent or Compact Fluorescent Fixture with (1) 10 Watt Dimmable LED A Lamp.
Ground Floor	SPEECH	2	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	SPEECH	2	Bare-CF13	ID08	(1) 10w Dimmable LED A		No Sensor Control	Re-Lamp 1-Lamp Incandescent or Compact Fluorescent Fixture with (1) 10 Watt Dimmable LED A Lamp.
Ground Floor	MAIN OFFICE	3	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	PRINCIPAL OFFICE	2	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	PRINCIPAL BR	1	Bare-60A	ID08	(1) 10w Dimmable LED A		No Sensor Control	Re-Lamp 1-Lamp Incandescent or Compact Fluorescent Fixture with (1) 10 Watt Dimmable LED A Lamp.
Ground Floor	NURSE	2	2x4-4FO32-L	7NE02	New 35.6w 2x4 LED Flat Panel		No Sensor Control	Replace Existing Fixture with New 35.6 Watt 2x4 LED Flat Panel Fixture with 80,000 Hour L70 Rating.
Ground Floor	NURSE BR	1	Bare-60A	ID08	(1) 10w Dimmable LED A		No Sensor Control	Re-Lamp 1-Lamp Incandescent or Compact Fluorescent Fixture with (1) 10 Watt Dimmable LED A Lamp.
Ground Floor	MAIN ENTRY HALL	8	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	TR. CARE	3	HH-65R30	IRD25	(1) 9w Dimmable LED R30		No Sensor Control	Re-Lamp 1-Lamp Incandescent or Compact Fluorescent Fixture with (1) 9 Watt Dimmable LED R30 Lamp.
Ground Floor	STORAGE	9	2x2-2FO17-L	T222	(2) 8w 2' T8 LED B		No Sensor Control	Retrofit 2-Lamp 2' Fixtures with (2) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	HALL TO MEDIA	17	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 4	21	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 5	21	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 6	21	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 7	21	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	GIRLS BR	1	Bare-60A	ID08	(1) 10w Dimmable LED A		No Sensor Control	Re-Lamp 1-Lamp Incandescent or Compact Fluorescent Fixture with (1) 10 Watt Dimmable LED A Lamp.
Ground Floor	GIRLS BR	2	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	GIRLS BR	1	1x4-1FO32-S	T4L11	(1) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 1-Lamp 4' Fixtures with (1) 10.5 Watt Line Voltage Type B LED T8 Tube.
Ground Floor	FACULTY 8	21	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CUSTODIAN	1	1x4-1FO32-S	T4L11	(1) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 1-Lamp 4' Fixtures with (1) 10.5 Watt Line Voltage Type B LED T8 Tube.
Ground Floor	BOYS BR	2	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	BOYS BR	1	1x4-1FO32-S	T4L11	(1) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 1-Lamp 4' Fixtures with (1) 10.5 Watt Line Voltage Type B LED T8 Tube.
Ground Floor	BOYS BR	1	Bare-60A	ID08	(1) 10w Dimmable LED A		No Sensor Control	Re-Lamp 1-Lamp Incandescent or Compact Fluorescent Fixture with (1) 10 Watt Dimmable LED A Lamp.
Ground Floor	CR 9	21	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 10 ART	21	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 11	21	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 13	21	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	MEDIA CTR 12/14	42	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	MEDIA CTR BOOKCASES	6	1x4-1FO32-S	T4L11	(1) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 1-Lamp 4' Fixtures with (1) 10.5 Watt Line Voltage Type B LED T8 Tube.
Ground Floor	UPPER HALL	18	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 15	1	2x2-2FO17-L	T222	(2) 8w 2' T8 LED B		No Sensor Control	Retrofit 2-Lamp 2' Fixtures with (2) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 15	24	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 15 CUBBY	2	Bare-60A	ID08	(1) 10w Dimmable LED A		No Sensor Control	Re-Lamp 1-Lamp Incandescent or Compact Fluorescent Fixture with (1) 10 Watt Dimmable LED A Lamp.
Ground Floor	CR 15 CLOSET	1	1x4-1FO32-S	T4L11	(1) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 1-Lamp 4' Fixtures with (1) 10.5 Watt Line Voltage Type B LED T8 Tube.
Ground Floor	CR 15 BR'S	4	Sconce-CF23	ID08	(1) 10w Dimmable LED A		No Sensor Control	Re-Lamp 1-Lamp Incandescent or Compact Fluorescent Fixture with (1) 10 Watt Dimmable LED A Lamp.
Ground Floor	CR 16 MUSIC	1	2x2-2FO17-L	T222	(2) 8w 2' T8 LED B		No Sensor Control	Retrofit 2-Lamp 2' Fixtures with (2) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 16 MUSIC	24	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 16 MUSIC BR'S	2	Bare-CF13	ID08	(1) 10w Dimmable LED A		No Sensor Control	Re-Lamp 1-Lamp Incandescent or Compact Fluorescent Fixture with (1) 10 Watt Dimmable LED A Lamp.
Ground Floor	CR 16 MUSIC CUBBY	2	Bare-60A	ID08	(1) 10w Dimmable LED A		No Sensor Control	Re-Lamp 1-Lamp Incandescent or Compact Fluorescent Fixture with (1) 10 Watt Dimmable LED A Lamp.
Ground Floor	CR 16 MUSIC STORAGE	1	1x4-1FO32-S	T4L11	(1) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 1-Lamp 4' Fixtures with (1) 10.5 Watt Line Voltage Type B LED T8 Tube.
Ground Floor	MEN BR	1	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 17	18	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 18	18	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	GIRLS BR	2	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.

West Milford Township Public Schools

Energy Savings Program

Room Info		Existing Fixture Info		Lighting Fixture Upgrades		Occupancy Sensor Upgrades		
Floor	Location	No. of Fix.	Fixture Type	ECM No.	Upgrade Description	Sens Qty	Sensor(s)	ECM Description
Ground Floor	FACULTY BR	1	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	BOYS BR	1	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 19	18	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 20	18	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 21	18	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 22	18	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 23	18	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 24	18	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 25	18	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 26	18	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 27	18	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 28	18	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Exterior	EXTERIOR: B4 STORAGE	1	HH-65R30	IRD25	(1) 9w Dimmable LED R30		No Sensor Control	Re-Lamp 1-Lamp Incandescent or Compact Fluorescent Fixture with (1) 9 Watt Dimmable LED R30 Lamp.
Exterior	EXTERIOR B1 DOOR CANOPY	4	Canopy-60A	ID08	(1) 10w Dimmable LED A		No Sensor Control	Re-Lamp 1-Lamp Incandescent or Compact Fluorescent Fixture with (1) 10 Watt Dimmable LED A Lamp.
Exterior	B5 DOOR RECESED CAN	1	HH6-MH100	HE02	(1) 25w LED HID		No Sensor Control	Retrofit 1-Lamp HID Fixture with (1) 25 Watt LED HID Lamp. Existing ballast will be disconnected.
Exterior	EXTERIOR D1	1	Jelly-CF32	ID08	(1) 10w Dimmable LED A		No Sensor Control	Re-Lamp 1-Lamp Incandescent or Compact Fluorescent Fixture with (1) 10 Watt Dimmable LED A Lamp.
Exterior	EXTERIOR D4 CANOPY	1	Canopy-MH100	HE02	(1) 25w LED HID		No Sensor Control	Retrofit 1-Lamp HID Fixture with (1) 25 Watt LED HID Lamp. Existing ballast will be disconnected.
Exterior	EXTERIOR D6	1	Jelly-CF32	ID08	(1) 10w Dimmable LED A		No Sensor Control	Re-Lamp 1-Lamp Incandescent or Compact Fluorescent Fixture with (1) 10 Watt Dimmable LED A Lamp.
Exterior	D5 GARAGE DOOR LOCKED NO ACCE	4	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Exterior	EXTERIOR DOOR D8	3	Sconce-MH70	HE02	(1) 25w LED HID		No Sensor Control	Retrofit 1-Lamp HID Fixture with (1) 25 Watt LED HID Lamp. Existing ballast will be disconnected.
Exterior	EXTERIOR A3	2	Sconce-MH70	HE02	(1) 25w LED HID		No Sensor Control	Retrofit 1-Lamp HID Fixture with (1) 25 Watt LED HID Lamp. Existing ballast will be disconnected.
	Total	754				15		

West Milford Township Public Schools

Energy Savings Program

Paradise Knoll Elementary School

Room Info		*Existing Fixture Info*		*Lighting Fixture Upgrades*		*Occupancy Sensor Upgrades*		
Floor	**Location**	**No. of Fix.**	**Fixture Type**	**ECM No.**	**Upgrade Description**	**Sens Qty**	**Sensor(s)**	**ECM Description**
Ground Floor	MAIN HALL TO DOOR A1	18	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	DOOR B1 ENTRY	1	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 9-K	17	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B	3	MRF2-1S8A-10C	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 9-K BR'S	2	2x2-2FO17-L	T222	(2) 8w 2' T8 LED B		No Sensor Control	Retrofit 2-Lamp 2' Fixtures with (2) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 8 ART	8	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 7-K	12	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B	2	MRF2-1S8A-10C	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 6	8	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 5	12	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B	2	MRF2-1S8A-10C	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 4	12	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B	2	MRF2-1S8A-10C	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	BOYS BR	2	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	JANITOR CLOSET	1	2x2-2FO17-L	T222	(2) 8w 2' T8 LED B		No Sensor Control	Retrofit 2-Lamp 2' Fixtures with (2) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	JANITOR CLOSET	1	Drum-PL26	IN15	New 13.5w LED Flush Mount		No Sensor Control	Replace Existing Fixture with New 13.5 Watt LED Flush Mount Fixture with 50,000 Hour L70 Rating.
Ground Floor	GIRLS BR	2	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	PAPPES	2	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	BOILER RM	7	1x4-2FO32-S	3NEL09	New 1x4-2LED10.5-S		No Sensor Control	Replace Existing Fixture with New 1'x4' Strip Fixture containing (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	A2 ENTRY	1	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	MAIN OFFICE	6	2x4-3FO32-L	T4BL33	(3) 10.5w 4' T8 LED B-Bi		No Sensor Control	Retrofit 3-Lamp 4' Bi-Level Switched Fixtures with (3) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	PRINCIPAL OFFICE	3	2x4-3FO32-L	T4BL33	(3) 10.5w 4' T8 LED B-Bi		No Sensor Control	Retrofit 3-Lamp 4' Bi-Level Switched Fixtures with (3) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	PRINCIPAL BR	1	2x2-3FO17-L	6NE01	New 20w 2x2 LED Flat Panel		No Sensor Control	Replace Existing Fixture with New 20 Watt 2x2 LED Flat Panel Fixture with 80,000 Hour L70 Rating.
Ground Floor	CR 3	8	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		Under Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 2	8	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B	2	MRF2-1S8A-10C	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	NURSE	5	2x4-3FO32-L	T4BL33	(3) 10.5w 4' T8 LED B-Bi		No Sensor Control	Retrofit 3-Lamp 4' Bi-Level Switched Fixtures with (3) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	NURSE BR	1	2x2-3FO17-L	6NE01	New 20w 2x2 LED Flat Panel		No Sensor Control	Replace Existing Fixture with New 20 Watt 2x2 LED Flat Panel Fixture with 80,000 Hour L70 Rating.
Ground Floor	CR 1	8	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B	2	MRF2-1S8A-10C	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	SMGG 24	3	2x4-3FO32-L	T4BL33	(3) 10.5w 4' T8 LED B-Bi	2	MRF2-1S8A-10C	Retrofit 3-Lamp 4' Bi-Level Switched Fixtures with (3) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	STORAGE	1	2x2-2FO17-L	T222	(2) 8w 2' T8 LED B		No Sensor Control	Retrofit 2-Lamp 2' Fixtures with (2) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	STORAGE	1	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	GYM ENTRY	2	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	COPY RM	2	2x2-2FO17-L	T222	(2) 8w 2' T8 LED B		No Sensor Control	Retrofit 2-Lamp 2' Fixtures with (2) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	OLD SHOWER	2	Bare-CF13	ID08	(1) 10w Dimmable LED A		No Sensor Control	Re-Lamp 1-Lamp Incandescent or Compact Fluorescent Fixture with (1) 10 Watt Dimmable LED A Lamp.
Ground Floor	GIRL BR	1	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	STORAGE	1	2x2-2FO17-L	T222	(2) 8w 2' T8 LED B		No Sensor Control	Retrofit 2-Lamp 2' Fixtures with (2) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	BOYS BR	1	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	BOYS BR	1	Bare-CF13	ID08	(1) 10w Dimmable LED A		No Sensor Control	Re-Lamp 1-Lamp Incandescent or Compact Fluorescent Fixture with (1) 10 Watt Dimmable LED A Lamp.
Ground Floor	BOYS BR ENTRY	1	Bare-CF13	ID08	(1) 10w Dimmable LED A		No Sensor Control	Re-Lamp 1-Lamp Incandescent or Compact Fluorescent Fixture with (1) 10 Watt Dimmable LED A Lamp.
Ground Floor	CULLEN OFFICE	2	2x2-2FO17-L	T222	(2) 8w 2' T8 LED B		No Sensor Control	Retrofit 2-Lamp 2' Fixtures with (2) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CULLEN OFFICE	2	Bare-60A	ID08	(1) 10w Dimmable LED A		No Sensor Control	Re-Lamp 1-Lamp Incandescent or Compact Fluorescent Fixture with (1) 10 Watt Dimmable LED A Lamp.
Ground Floor	OFFICE	2	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	GYM	18	High Bay-3FP54HO	9NE09	New 83.2w Linear LED High Bay	18	12800P-302	Install New 83.2 Watt Linear LED High Bay Fixture with 50,000 Hour L70 Rating.
Ground Floor		18		\L923	Lens Kit for 1'x2' High Bay			Install Lens Kit for 1'x2' High Bay Fixture.
Ground Floor	GYM FIXTURES	2	High Bay-3FP54HO	9NE09	New 83.2w Linear LED High Bay	2	12800P-302	Install New 83.2 Watt Linear LED High Bay Fixture with 50,000 Hour L70 Rating.
Ground Floor		2		\L923	Lens Kit for 1'x2' High Bay			Install Lens Kit for 1'x2' High Bay Fixture.

West Milford Township Public Schools

Energy Savings Program

Room Info		Existing Fixture Info		Lighting Fixture Upgrades		Occupancy Sensor Upgrades		
Floor	Location	No. of Fix.	Fixture Type	ECM No.	Upgrade Description	Sens Qty	Sensor(s)	ECM Description
Ground Floor	STAGE	1	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	STAGE ENTRY	2	2x2-2FO17-L	T222	(2) 8w 2' T8 LED B		No Sensor Control	Retrofit 2-Lamp 2' Fixtures with (2) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	STAGE 2 ENTRY	4	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	STAGE WALLPACK	2	Wallpack-MH70	HN197	New 24.5w LED Wallpack		No Sensor Control	Replace Existing Fixture with New 24.5 Watt LED Wallpack Fixture with 100,000 Hour L70 Rating. Includes Photocell.
Ground Floor	ROOMS ABOVE STAGE	4	Bare-60A	ID08	(1) 10w Dimmable LED A		No Sensor Control	Re-Lamp 1-Lamp Incandescent or Compact Fluorescent Fixture with (1) 10 Watt Dimmable LED A Lamp.
Ground Floor	KITCHEN	4	1x8-4FO32-S	5NEL08	New 1x8-4LED10.5-W		No Sensor Control	Replace Existing Fixture with New 1'x8' Fixture containing (4) 10.5 Watt Line Voltage Type B LED T8 Tubes and Wrap Lens.
Ground Floor	KITCHEN	1	2x2-2FO17-L	T222	(2) 8w 2' T8 LED B		No Sensor Control	Retrofit 2-Lamp 2' Fixtures with (2) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	KITCHEN BR	1	2x2-2FO17-L	T222	(2) 8w 2' T8 LED B		No Sensor Control	Retrofit 2-Lamp 2' Fixtures with (2) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	KITCHEN OFFICE LOCKE	2	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	HALL TO LIBRARY	5	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	STORAGE	1	2x2-2FO17-L	T222	(2) 8w 2' T8 LED B		No Sensor Control	Retrofit 2-Lamp 2' Fixtures with (2) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 23	3	2x4-3FO32-L	T4BL33	(3) 10.5w 4' T8 LED B-Bi	2	MRF2-1S8A-10C	Retrofit 3-Lamp 4' Bi-Level Switched Fixtures with (3) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	STORAGE	1	2x2-2FO17-L	T222	(2) 8w 2' T8 LED B		No Sensor Control	Retrofit 2-Lamp 2' Fixtures with (2) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	FACULTY 22	4	2x4-3FO32-L	T4BL33	(3) 10.5w 4' T8 LED B-Bi	2	MRF2-1S8A-10C	Retrofit 3-Lamp 4' Bi-Level Switched Fixtures with (3) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	FACULTY 22	1	2x2-3FO17-L	T233	(3) 8w 2' T8 LED B		No Sensor Control	Retrofit 3-Lamp 2' Fixtures with (3) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	FACULTY 22 BR	1	2x2-3FO17-L	T233	(3) 8w 2' T8 LED B		No Sensor Control	Retrofit 3-Lamp 2' Fixtures with (3) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 21 SGI	2	2x4-3FO32-L	T4BL33	(3) 10.5w 4' T8 LED B-Bi	3	MRF2-1S8A-10C	Retrofit 3-Lamp 4' Bi-Level Switched Fixtures with (3) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	LIBRARY ENTRY	2	2x2-3FO17-L	T233	(3) 8w 2' T8 LED B		No Sensor Control	Retrofit 3-Lamp 2' Fixtures with (3) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	LIBRARY	17	2x4-3FO32-L	T4BL33	(3) 10.5w 4' T8 LED B-Bi		No Sensor Control	Retrofit 3-Lamp 4' Bi-Level Switched Fixtures with (3) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	ROOM 10	2	2x2-3FO17-L	T233	(3) 8w 2' T8 LED B		No Sensor Control	Retrofit 3-Lamp 2' Fixtures with (3) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	HALL TO D2	7	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	SG 10	3	2x4-3FO32-L	T4BL33	(3) 10.5w 4' T8 LED B-Bi	3	MRF2-1S8A-10C	Retrofit 3-Lamp 4' Bi-Level Switched Fixtures with (3) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	JANITOR CLOSET	1	2x2-2FO17-L	T222	(2) 8w 2' T8 LED B		No Sensor Control	Retrofit 2-Lamp 2' Fixtures with (2) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 11	9	2x4-3FO32-L	T4BL33	(3) 10.5w 4' T8 LED B-Bi		No Sensor Control	Retrofit 3-Lamp 4' Bi-Level Switched Fixtures with (3) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 11 BR'S	2	2x2-2FO17-L	T222	(2) 8w 2' T8 LED B		No Sensor Control	Retrofit 2-Lamp 2' Fixtures with (2) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 11 STORAGE	1	2x2-2FO17-L	T222	(2) 8w 2' T8 LED B		No Sensor Control	Retrofit 2-Lamp 2' Fixtures with (2) 8 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	STORAGE	1	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	GIRLS BR	2	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	FACULTY BR	1	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	JANITOR CLOSET	1	Drum-Circ22	IN15	New 13.5w LED Flush Mount		No Sensor Control	Replace Existing Fixture with New 13.5 Watt LED Flush Mount Fixture with 50,000 Hour L70 Rating.
Ground Floor	BOYS BR	2	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 1 MUSIC	21	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR C1 ENTRY	1	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	HALL TO D1	11	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	ENTRY D1	1	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 13	21	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B	3	MRF2-1S8A-10C	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 14	21	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B	3	MRF2-1S8A-10C	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 15	21	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B	3	MRF2-1S8A-10C	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 16	21	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B	3	MRF2-1S8A-10C	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 17	21	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B	3	MRF2-1S8A-10C	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 18	21	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B	3	MRF2-1S8A-10C	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 19	21	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B	3	MRF2-1S8A-10C	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	CR 20	21	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B	3	MRF2-1S8A-10C	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor	GARAGE LOCKED	6	1x8-4FO32-S	T8L44	(4) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 4-Lamp 8' Fixtures with (4) 10.5 Watt Line Voltage Type B LED T8 Tubes.

West Milford Township Public Schools

Energy Savings Program

Room Info		*Existing Fixture Info*		*Lighting Fixture Upgrades*		*Occupancy Sensor Upgrades*		
Floor	**Location**	**No. of Fix.**	**Fixture Type**	**ECM No.**	**Upgrade Description**	**Sens Qty**	**Sensor(s)**	**ECM Description**
Exterior	B2 WALLPACK	1	Flood-MH70	HN95	New 42w LED Flood		No Sensor Control	Replace Existing Fixture with New 42 Watt LED Flood Fixture with 100,000 Hour L70 Rating. Includes Photocell.
Exterior	B3	1	HH8-2PL26	IN12	New 18w 8-Inch LED Downlight		No Sensor Control	Replace Existing Fixture with New 18 Watt 8-Inch LED Downlight Fixture with 50,000 Hour L70 Rating.
Exterior	B4	1	HH8-2PL26	IN12	New 18w 8-Inch LED Downlight		No Sensor Control	Replace Existing Fixture with New 18 Watt 8-Inch LED Downlight Fixture with 50,000 Hour L70 Rating.
Exterior	D5 & D6	2	Wallpack-MH100	HN197	New 24.5w LED Wallpack		No Sensor Control	Replace Existing Fixture with New 24.5 Watt LED Wallpack Fixture with 100,000 Hour L70 Rating. Includes Photocell.
Exterior	D1	1	Wallpack-MH100	HN197	New 24.5w LED Wallpack		No Sensor Control	Replace Existing Fixture with New 24.5 Watt LED Wallpack Fixture with 100,000 Hour L70 Rating. Includes Photocell.
	Total	**492**				**69**		

West Milford Township Public Schools

Energy Savings Program

Bus Garage/Maintenance

Room Info		*Existing Fixture Info*		*Lighting Fixture Upgrades*		*Occupancy Sensor Upgrades*		
Floor	**Location**	**No. of Fix.**	**Fixture Type**	**ECM No.**	**Upgrade Description**	**Sens Qty**	**Sensor(s)**	**ECM Description**
Ground Floor - Bus Garage	MAIN AREA	6	High Bay-MH250	9NE10	New 130.2w Linear LED High Bay		No Sensor Control	Install New 130.2 Watt Linear LED High Bay Fixture with 50,000 Hour L70 Rating.
Ground Floor - Bus Garage	MAIN AREA	10	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor - Bus Garage	MAIN AREA	1	High Bay-MH400	9NE10	New 130.2w Linear LED High Bay		No Sensor Control	Install New 130.2 Watt Linear LED High Bay Fixture with 50,000 Hour L70 Rating.
Ground Floor - Bus Garage	TECH RM	3	2x4-4FO32-L	T4L44	(4) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 4-Lamp 4' Fixtures with (4) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor - Bus Garage	BOILER RM	2	2x4-4FO32-L	T4L44	(4) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 4-Lamp 4' Fixtures with (4) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor - Bus Garage	BR	2	2x4-4FO32-L	T4L44	(4) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 4-Lamp 4' Fixtures with (4) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor - Bus Garage	UPPER MEZZ OFFICE	2	2x4-4FO32-L	T4L44	(4) 10.5w 4' T8 LED B	1	MS-A-102-WH	Retrofit 4-Lamp 4' Fixtures with (4) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor - Bus Garage	UPPER MEZZ KITCHEN	4	2x4-4FO32-L	T4L44	(4) 10.5w 4' T8 LED B	1	MRF2-1S8A-10C	Retrofit 4-Lamp 4' Fixtures with (4) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor - Bus Garage	UPPER MEZZ ENTRY	1	2x4-4FO32-L	T4L44	(4) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 4-Lamp 4' Fixtures with (4) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Exterior - Bus Garage	EXTERIOR WALL PACK	1	Wallpack-Cut-MH70	HN71	New 13.7w LED Security Wallpack		No Sensor Control	Replace Existing Fixture with New 13.7 Watt LED Security Wallpack Fixture with 60,000 Hour L70 Rating. Includes Photocell.
Exterior - Bus Garage	EXTERIOR READ WALLPACK	2	Wallpack-MH250	HN199	New 55w LED Wallpack		No Sensor Control	Replace Existing Fixture with New 55 Watt LED Wallpack Fixture with 100,000 Hour L70 Rating. Includes Photocell.
Exterior - Bus Garage	EXTERIOR REAR ENTRY	1	Wallpack-MH150	HN200	New 38.2w LED Wallpack		No Sensor Control	Replace Existing Fixture with New 38.2 Watt LED Wallpack Fixture with 100,000 Hour L70 Rating. Includes Photocell.
Exterior - Bus Garage	EXTERIOR LEFT SIDE FLOOD	2	Flood-MH250	HN102	New 76.8w LED Flood		No Sensor Control	Replace Existing Fixture with New 76.8 Watt LED Flood Fixture with 100,000 Hour L70 Rating. Includes Photocell.
Exterior - Bus Garage	EXTERIOR LEFT SIDE DOOR WP	1	Wallpack-MH150	HN200	New 38.2w LED Wallpack		No Sensor Control	Replace Existing Fixture with New 38.2 Watt LED Wallpack Fixture with 100,000 Hour L70 Rating. Includes Photocell.
Exterior - Bus Garage	GAS CANOPY	4	Canopy-MH150	HE29	(1) 54w LED HID		No Sensor Control	Retrofit 1-Lamp HID Fixture with (1) 54 Watt LED HID Lamp. Existing ballast will be disconnected.
Ground Floor - Transportation	MAIN ROOM	2	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor - Transportation	MAIN AREA	6	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor - Transportation	BR	2	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor - Transportation	OFFICE-WILM	1	2x4-2FO32-L	T4H22	(2) 15w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 15 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor - Transportation	BACK AREA	4	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor - Transportation	KITCHEN	2	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor - Transportation	MAIN ROOM	2	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor - Transportation	TRAILER EMPLOYEE LOUNGE	7	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor - Transportation	TRAILER BR	1	2x4-2FO32-L	T4L22	(2) 10.5w 4' T8 LED B		No Sensor Control	Retrofit 2-Lamp 4' Fixtures with (2) 10.5 Watt Line Voltage Type B LED T8 Tubes.
Ground Floor - Transportation	BLUE GROUNDS MAINTENANCE BLDG MAIN A	18	2x4-4FO32-L	7NE02	New 35.6w 2x4 LED Flat Panel		No Sensor Control	Replace Existing Fixture with New 35.6 Watt 2x4 LED Flat Panel Fixture with 80,000 Hour L70 Rating.
Exterior - Transportation	EXTERIOR ENTRY	2	Bare-75A	ID08	(1) 10w Dimmable LED A		No Sensor Control	Re-Lamp 1-Lamp Incandescent or Compact Fluorescent Fixture with (1) 10 Watt Dimmable LED A Lamp.
Exterior - Transportation	TRAILER EXTERIOR DOOR SCONCE	2	Bare-CF18	ID08	(1) 10w Dimmable LED A		No Sensor Control	Re-Lamp 1-Lamp Incandescent or Compact Fluorescent Fixture with (1) 10 Watt Dimmable LED A Lamp.
Exterior - Transportation	HIGHLANDER DRIVE BLDG A EXTERIOR FLOOD	2	Flood-500Q	HN95	New 42w LED Flood		No Sensor Control	Replace Existing Fixture with New 42 Watt LED Flood Fixture with 100,000 Hour L70 Rating. Includes Photocell.
	Total	**93**				**2**		

APPENDIX 8. 3RD PARTY REVIEW COMMENTS (DLB ASSOCIATES)

WEST MILFORD BOARD OF EDUCATION - THIRD PARTY ENERGY SAVINGS PLAN REVIEW

July 24, 2019

Final Revised August 1, 2019

Prepared by: DLB Associates
(dlb # 15046)

WEST MILFORD BOARD OF EDUCATION - THIRD PARTY ENERGY SAVINGS PLAN REVIEW

Table of Contents

SECTION 1: EXECUTIVE SUMMARY

WEST MILFORD BOARD OF EDUCATION - THIRD PARTY ENERGY SAVINGS PLAN REVIEW

1.1 Executive Summary

1.1.1 Overview

DLB Associates has been commissioned by the West Milford Board of Education to provide a Third-Party Review of an Energy Savings Plan (ESP) for conformance with State requirements for ten (10) of the Board's facilities. State requirements are set forth in P.L. 2009, Chapter 4, "Energy Savings Improvement Program" and Local Finance Notices 2009-11 and 2011-17. Amendments to P.L. 2009, Chapter 4, are included in P.L. 2012, Chapter 55.

DLB's review includes an analysis of the Energy Savings Plan for conformance with the New Jersey Board of Public Utilities (BPU) Standards and for verification that all required sections were submitted in the ESP Report. A review of the calculations methodology and plan savings as specified by the BPU protocol also was performed.

This report includes the summary and conclusions of DLB's Third-Party Review of the submitted Energy Savings Plan prepared by Energy Systems Group and dated July 2019.

1.1.2 Energy Savings Plan Review

The ESP appears to be complete and contains the required components. DLB has indicated items for further review and expect that the comments can be incorporated without affecting the ESP results significantly.

1.1.3 Energy Savings Calculations Review

The review of the energy savings calculations included within the ESP concluded that the calculations were performed in accordance with industry standard practice and utilizing the intent of the BPU protocol. Spreadsheet analyses were used to calculate Energy Conservation Measure (ECM) savings. The equations used to determine savings follow the protocol's calculation methods for energy efficient construction, but DLB recommends a few areas be clarified as identified in this report.

1.1.4 Conclusion

Both the ESP and the associated calculations appear to be completed with satisfactory effort and in accordance with P.L. 2012, Chapter 55, Amendments to "Energy Savings Improvement Program" and Local Finance Notices 2009-11 and 2011-17. A few calculations and concepts should be verified as indicated within the body of this report and revisions should be reviewed and addressed prior to adoption by the West Mlford Board of Education. Overall, DLB comments should have a low impact on the predicted savings.

DLB comments have been addressed in the attached Appendix by ESG, sent to DLB July 30, 2019, and have been incorporated into the revised ESP. The Energy Savings Plan is ready for review and adoption by West Milford Board of Education.

We have reviewed the revised West Milford Board of Education Energy Savings Plan dated July 29, 2019, as submitted by ESG in accordance with P.L. 2012, c. 55 (2009 c.4.).

WEST MILFORD BOARD OF EDUCATION - THIRD PARTY ENERGY SAVINGS PLAN REVIEW

According to this legislation, an independent third party must review the plan and certify that the plan savings were properly calculated pursuant to the Board of Public Utilities protocols and / or the International Performance Measurement and Verification Protocol.

As a qualified New Jersey licensed engineer and in accordance with good engineering principles, we have reviewed each calculation outlined in the plan along with the associated energy conservation measure described. Our review indicates that the plan was established and compiled with sound measurement and verification protocols and in compliance with established standards set by the NJBPU.

SECTION 2: ENERGY SAVINGS PLAN REVIEW

2.1 Executive Summary

2.1.1 Energy Savings Plan Overview

The ESP reviewed by DLB Associates was prepared by Energy Systems Group and dated July 2019. The ESP Report includes an analysis for the following ten (10) facilities:

FACILITY INFORMATION	
Building Name	**Street Address**
West Milford High School	67 Highlander Dr, West Milford, NJ 07480
Macopin Middle School	70 Highlander Dr, West Milford, NJ 07480
Apshawa Elementary School	140 High Crest Dr., West Milford, NJ 07480
Maple Road Elementary School	36 Maple Rd, West Milford, NJ 07480
Marshall Hill Elementary School	210 Marshall Hill Rd, West Milford, NJ 07480
Paradise Knoll Elementary School	103 Paradise Rd, Oak Ridge, NJ 07438
Upper Greenwood Lake Elementary School	41 Henry Rd, Hewitt, NJ 07421
Westbrook Elementary School	46 Nosenzo Pond Rd, West Milford, NJ 07480
Administration Building	46 Highlander Rd, West Milford, NJ 07480
Bus Garage	51 Highlander Drive, West Milford, NJ 07480

SECTION 3: ENERGY SAVINGS PLAN REVIEW

3.1 Energy Savings Plan Review

3.1.1 Plan Components – Required By P.L. 2012, C.55

The Energy Savings Plan is the core of the Energy Savings Implementation Program (ESIP) process. Planned ECMs are described and the cost calculations supporting how the plan will pay for itself in reduced energy costs are provided. Under the law, the ESP must address the following elements:

- Energy audit results
- Energy conservation measure descriptions
- Greenhouse gas reduction calculations based on energy savings
- Design and compliance issue identification and identification of who will provide these services
- Risk assessment for the successful implementation of the plan
- Identification of eligibility, costs and revenues for demand response and curtailable service activities
- Schedules showing calculations of all costs of implementing the proposed energy conservation measures and the projected energy savings
- Maintenance requirements necessary to ensure continued energy savings
- Description and cost estimates for energy services company (ESCO) savings guarantee

3.1.2 Plan Components – Submitted Plan Review

The submitted ESP, dated July, 2019, is the basis for the Third-Party Review. The table below lists the required elements of the ESP as required by the law, whether the items were addressed satisfactorily in the ESP, and any associated comments.

ENERGY SAVINGS PLAN COMPONENT REVIEW			
Plan Component	**Included In Plan**	**Location In Plan**	**Comments**
Energy Audit Results	No	Not found	LGEA reports were not mentioned
ECM Descriptions	Yes	Section 4, Pages 64 – 128	See Section 4 of this Report
Greenhouse Gas Calculations	Yes	Section 3, Page 63	See Section 4.1.6 of this Report
Design and Compliance Issues	Yes	Section 6, Pages 139	None
Implementation Risk Assessment	Yes	Section 6, Page 141	None

ENERGY SAVINGS PLAN COMPONENT REVIEW			
Plan Component	**Included In Plan**	**Location In Plan**	**Comments**
Demand Response Program / Curtailable Energy Services	Yes	Section 3, Page 61 & Appendix 1, Page 146	Section 3 states district eligible for incentives, Appendix 1 states currently under contract. Confirm which section is accurate.
Implementation Costs	Yes	Section 3, Page 54-57	See Section 4.1.5 of this Report
Projected Energy Savings	Yes	Section 3, Page 62	See Section 4 of this Report
Maintenance Requirements	Yes	Section 6, Page 138	None
Savings Guarantee Information	Yes	Section 5, Page 136	$24,788 for the 1st year
Measurement and Verification Plan	Yes	Section 5, Pages 129-137	None

SECTION 4: ENERGY SAVINGS CALCULATIONS REVIEW

4.1 Energy Savings Calculations Review

4.1.1 Methodology of Submitted Calculations

The Energy Savings Improvement Plan included calculations that utilized BPU-acceptable equations and spreadsheet analyses.

The twenty-one (21) ECMs analyzed and accepted in the base project include:

1. Comprehensive LED Lighting Upgrades
2. Install Kitchen Hood Controls
3. Transformer Upgrades
4. Addition of Cooling – RTU for Middle School Auditorium
5. Install Variable Frequency Drive (VDF) on Cooling Tower Fan Motor
6. Refurbish Condensing Units and Install HVAC Armor
7. Replace Boilers with High Efficiency Boilers
8. Fuel-Use Economizers (Boilers)
9. Retro-commissioning Study & HVAC Improvements
10. Building Envelope Upgrades
11. Refrigeration Control Upgrades
12. Plug Load Controls
13. Destratification Fans
14. Cogeneration (CHP)
15. DHW Replacement
16. Unit Ventilator Refurbishment
17. Valve and Pipe Insulation
18. Upgrade HVAC Controls to DDC
19. Direct Install Program (Lighting, Controls, HVAC)
20. Pay for Performance
21. Solar Power Purchase Agreement (PPA)

4.1.2 General Calculation Quality

The quality of the energy savings calculations is satisfactory and representative sample sets were checked for accuracy. Spreadsheet analyses were provided by Energy Systems Group as separate appendix files and have been spot-checked by DLB.

The approach and equations used were summarized broadly in the body of the report with no results given in the ECM description sections. References for equations were listed for some ECMs in the report body. The report body could be expanded to include more details on methodology and results for clarity, but they are included in the Appendix sections.

DLB notes the following comments for the overall report:

1. Any ECMs which propose to modify temperature setpoints or operation schedules of any equipment, including, but not limited to, HVAC equipment, equipment connected to plug load control devices, walk-in freezers or coolers or computing equipment, should be confirmed with the District to ensure there will be no detrimental operations impacts.
2. The total kWh and therm savings for the project should be verified and updated for consistency throughout the report. For example, in the Greenhouse Gas Reductions section on page 63, the total electric savings is listed as 1,331,822 kWh, whereas the sum of the savings shown in the table starting on page 168 yields a total savings of 1,078,182 kWh.

4.1.3 Mechanical and Electrical Energy Conservation Measures

ECMs were evaluated using spreadsheet analyses. The ECMs submitted agree with Standard Industry Practice and BPU protocol requirements.

Some ECMs presented in the Energy Systems Group Report are not included in the recommended baseline financial analysis. These ECMs only were spot-checked with the protocol for consistency.

DLB notes the following possible issues with the ECM analysis:

ECM 2 – Install Kitchen Hood Controls (7 Facilities)

a) In the Savings Calculations appendix, each measure is identified by letters only without indication of the facility which it is applied to. Please provide facility names for each measure.

b) The Savings Calculations appendix lists only 6 measures while on page 57 of ESP, 7 facilities are mentioned for this ECM. Please add a missing facility to savings calculations.

c) For Measure D, in the Savings Calculations, please indicate how the make-up air is provided into the space?

d) No actual dollar amount savings are provided in the Savings Calculation appendix. Please add.

e) Please provide a brief explanation of the utility rates source.

ECM 3 – High Efficiency Transformer Upgrade (2 Facilities)

a) Electrical escalation rates in savings calculation spreadsheets do not match the rate listed on page 62 of ESP. Please revise or provide explanation.

ECM 4 – Addition Of Cooling – RTU For Middle School Auditorium (Macopin Middle School)

a) Cut sheets are provided for the proposed units, but a capacity is not indicated. Additionally, the unit cuts show heat pump operation or a gas-fired / electric heating coil for heating. The ECM description states that the unit will have a hot water coil, similar to the current H & V unit. DLB suggests calling out the proposed unit capacity and matching proposed unit cuts to the ECM description.

ECM 5 – Install Variable Frequency Drive (VFD) On Cooling Tower Fan Motor (West Milford High School)

a) The ABB VFD cut provided does not indicate that a NEMA 3R rated enclosure is provided. DLB recommends ESG confirm that the appropriate NEMA rating will be provided based on the mounting location.

b) The 2019 BPU Protocols indicate a revised approach for VFD savings calculations on page 101. This approach indicates an Energy Savings Factor (ESF) of 290 kWh / year-HP and a Demand Savings Factor (DSF) of -0.025 kW / HP. DLB recommends reviewing the savings calculations to ensure compliance with the protocols.

ECM 6 – Refurbish Condensing Units And Install HVAC Armor (3 Facilities)

a) The age of the existing units to be refurbished does not appear to be indicated in the report. DLB recommends including the age of the equipment to ensure that the scope of the ECM is appropriate for the units.

b) The Energy Savings and Cost Summary in Section 3 shows that this ECM has a simple payback between 10 to 15 years, depending on the facility. ESG should confirm whether the refurbishment will extend the life of the units long enough to realize the simple payback. DLB gathers from the report that the units in the scope of work are aging and in need of repair or replacement already, and requiring the units to run an additional 10 to 15 years to realize the simple payback when they already are at the end of their lifespan may not be realistic.

c) The ECM contractor's calculations show savings percentages used to calculate electric consumption reduction, but do not explain how those percentages were obtained and how the baseline kWh were obtained for the units. More information on how the factors used were obtained should be provided.

ECM 7 – Replace Boilers With High Efficiency Boilers (Macopin Middle School)

a) Boiler replacements are indicated at the Macopin Middle School and Marshall Hill Elementary School in the Executive Summary and in the backup calculations, but only the Macopin Middle School is shown in the Financial Impact table in Section 3 and in the ECM description on page 77. The scope of work should be confirmed.

b) The existing Macopin Middle School boilers are stated to have conflicting capacities and efficiencies in different sections of the report. For example, the facility description shows five (5) 1,615 MBH boilers at 83% efficiency, whereas the ECM description shows five (5) at 2,000 MBh and 82% efficiency, and the calculations show a total boiler output of 6,460 MBH. The boiler data should be reviewed and revised for consistency.

c) The replacement boilers will yield a total of 1,840 MBH heating capacity, whereas the existing boilers can provide 6,460 MBH output, according to the calculations section. ESG should confirm that the proposed boiler design can meet the heat load. The bin analysis presented in the calculations show heat loads greater than the proposed boiler output.

d) The ECM description states that 2 new hot water distribution pumps and motors will be replaced, however, no savings are presented in the report. It would be beneficial to address whether these motors will be more efficient and provide energy savings.

e) A Boiler Loading Calculation Parameter is presented in the calculations. An explanation of how this factor was derived would be beneficial.

ECM 8 – Fuel Use Economizers (Boilers) (4 Facilities)

a) The calculations show an 19 BTU/h / SF Heat Load Engineering Check factor. This rate seems low for the application and should be verified.

b) The calculations utilize a 4% combustion efficiency to calculation savings. This rate is below the maximum % reduction, but the rationale behind the percentage used should be explained.

c) The Heating Profile shown in the calculations includes a 10% load when the temperature is greater than 60F, however, the high school does not seem to utilize the heating hot water boilers for domestic water. It would be beneficial to explain how this value was determined.

ECM 9 – Retro-Commissioning Study & HVAC Improvements (All Facilities)

a) DLB recommends including a note for Apshawa and Upper Greenwood Lake Elementary to indicate these facilities utilize fuel oil.

b) The stipulated savings are shown as percentage reductions of utilities used. DLB recommends explaining the factors contributing to how the percentages were chosen for each facility. For example, if the sizes of the buildings, types of equipment, and existing control system types are considered in the value, these should be highlighted.

ECM 10 – Building Envelope Upgrades (All Facilities)

a) Cooling savings are calculated for all facilities in the ESP, however, many facilities are described only to have a few areas cooled with window air conditioning units. The calculations should be reviewed to confirm that the cooling savings are derated or have a safety factor applied to consider that in many cases, 100% of the building is not cooled.

b) The ECM calculations utilize 5,901 heating degree days (HDD), associated with the Wanaque Raymond Dam weather data station. The boiler replacement and controller calculations, however, utilize the Newark weather data with 5,057 HDD. DLB recommends standardizing the weather data used for all ECM calculations.

c) The hard costs differ between the ECM calculations from BER and the summary table in Section 3. DLB recommends explaining the factors used to reduce the projected cost.

d) The BER supporting calculations include equations to demonstrate how savings were derived, however, some constants and factors used are not specified. DLB recommends including the flow factor, wind pressure, heating efficiency, and enthalpy conditions used to calculate savings.

e) The calculations show a 1.2 kW / ton cooling efficiency to calculate savings, but the cooling equipment ages and types vary throughout the facilities. DLB recommends reviewing this value to confirm that it is accurate for all applications.

ECM 11 – Refrigeration Control Upgrades (8 Facilities)

a) Baseline electric consumption values are provided for each type of unit, but no explanation of how these were determined is provided. DLB suggests providing a calculation or description stating how these values were obtained.

b) A list of the type and quantity of equipment included is provided in the ECM description and calculation, but the list is not broken down by facility. The type and number of units associated with each school should be shown so that savings can be validated.

c) The calculations show maintenance savings, however, DLB recommends including this savings in the operational savings, shown on page 152 of the report, instead.

d) The calculations seem to calculate savings by applying a 23% savings factor to the baseline consumption. The 23% savings value seems high and should be clearly defined.

ECM 12 – Plug Load Controls (9 Facilities)

e) DLB recommends considering the reduced plug load impact on HVAC loads as part of the savings calculations.

f) Confirm that the installation of Bert controls will not negatively affect the performance of the charging cart at night.

g) The calculations consider a baseline of 8,760 hours at a single wattage. ESG should confirm that the baseline hours and power are correct. For example, the printers or projectors may have a standby mode that consumes less power for many of the hours.

ECM 13 – Destratification Fans (5 Facilities)

h) The supporting files for this ECM include a vendor sheet with project pricing and a product cut sheet. There are no other calculations given showing how the savings were determined. DLB recommends providing calculations and including assumptions for temperatures, space heat load, equipment thermal efficiencies, and runtime hours.

ECM 14 – Cogeneration (CHP), (1 facility)

i) Calculation spreadsheet (monthly table) is missing the savings data. Please complete the table to show the savings for each month and total.

j) Payback period for this ECM on page 57 is indicated as 44 years. This looks high. Please revise or explain.

k) Please confirm that maintenance costs / contract is included in Cost Estimate.

l) Page 97 states that this ECM will benefit from NJ Clean Energy incentives, but it is not listed on page 59 in the NJ Clean Energy Rebates table. Please revise one or the other.

m) Please provide a brief outline about the strategy to generate demand response revenue as mentioned on page 97, Benefits section.

ECM 15 – DHW Heaters Replacement (1 Facility):

n) The manufacturer and model of the water heater in the cut sheet don't match the one proposed in the ESP. Please review for consistency.

o) The payback period as listed on page 55 (17.13 years) seems high and exceeds the useful life of the water heater.

ECM 16 – Unit Ventilator Refurbishment (8 Facilities)

a) The ECM calculations should include the load factor and coincidence factors shown on page 81 of the BPU protocols.

ECM 17 – Valve & Pipe Insulation (8 Facilities)

a) The ECM includes insulation thicknesses for each pipe to be repaired. The piping systems are indicated; however, system operating temperatures are not shown. The temperatures should be included to confirm insulation thicknesses.

b) Additional supporting data should be provided for this ECM, including information on the heat loss coefficients, the fluid and ambient temperature assumptions, and heating equipment efficiencies assumed.

ECM 18 – Upgrade HVAC Controls to DDC (All Facilities)

a) ECM description includes central plant and H&V units for most of the schools, may want to clarify if any Exhaust Fans or Classroom Unit Ventilators are included in the DDC control scope (if applicable)

b) May be beneficial to confirm he temperature settings on the Calculation Table for Occupied / Unoccupied with current operations – table notes 72/78 cooling and 72/64 heating and not sure how these compare to current system temperature settings.

c) Confirm if there is cooling in unit ventilators and update if needed. Looks as though there is a reference in the Appendix Calculation to Cooling UVs but did not see them noted in the ECM Description.

d) OA Damper Control appendix sheet notes proposed operating schedule reduction per day retrofitting Outdoor Damper Control on Unit Ventilators. Is this being proposed at all the schools as part of the HVAC Controls work?

ECM 19 – Direct Install Program (Lighting, Controls, HVAC) (6 Facilities)

a) Would be beneficial to include the Direct Install information in the appendix that details the project scope for each of the 6 facilities for the school to review. Appendix seems to only contain lighting info.

b) Please list peak electric demand and other required data confirming the eligibility of these 6 facilities for the Direct Install Program.

c) Confirm that the scope for this ECM falls under the current Direct Install Program, this program has been significantly changing each year.

d) Double check the savings for direct install, some of the school savings seems high if we are comparing the right numbers (Paradise Knoll lists $ 7,600 savings out of total electric bill of $ 25,000)

ECM 20 – Pay for Performance (Macopin Middle School)

a) Has initial eligibility (Incentive 0 applications) been submitted for P4P to confirm base eligibility?

b) ES and CS table show $29K for each school under this ECM as a Hard Cost, what does this cost represent?

c) Table on page 28 lists dollar amounts anticipated for all 3 incentives. Please provide written explanation or example calculations to support those and verify that that ECMs being applied to these do not overlap.

d) Are there calculations / measurements indicating buildings' eligibility (200kW peak demand, 15% source energy savings) for this incentive available? May be worthwhile to illustrate how close the proposed ECMS are to the 15% threshold.

ECM 21 – Solar Power Purchase Agreement (7 Facilities)

a) DLB recommends noting some of the PPA agreement requirements for reference such as; panel warranty, panel removal terms, any specific insurance provisions or site licensure or access requirements.

b) Looks like some of the new solar panels are proposed to be installed on sections of the roof of various buildings of various ages and roof materials. Suggest clarification be added to on who would be sponsible for any structural modifications required to support the weight of the new solar panels, and if applicable, include the associated costs in the financial analysis.

c) It is unclear if maintenance access was taken into account in the general panel layout which should be considered for any roof top equipment.

d) Also, it may be worthwhile to highlight any system down time incorporated in the estimated production values. From what we have seen some PPA vendors note this in their contracts and we have seen down times that stretch for months which would affect savings.

e) Are any of the proposed solar array sizes close to or higher than 80% of building usage / service sizes?

f) Appendix includes excel sheet with Solar Production Data but it does not contain information of where this data was obtained, BPU protocols recombed PV Watts.

4.1.4 Lighting Energy Conservation Measures

Lighting improvement savings calculations were performed in a satisfactory manner using a spreadsheet analysis and reviewed in a spot-check fashion.

DLB notes the following potential issues with the lighting ECM analysis:

ECM 1 – Comprehensive LED Lighting Upgrades (All Facilities)

a) The energy savings calculations do not appear to utilize the iterative factor (IF) used in the BPU Protocols.

b) The quantity of fixtures being replaced should be identical and should be checked. In the Appendix there appear to be a few locations where the quantity numbers differ, such as in Main Office (7 vs. 14), but these may relate to lamps not fixtures.

c) Please, identify reduction in hours for some areas, such as "75 VP Suite office 115" (2000 vs 1600) that appear on the Appendix table.

d) Please, identify source of "Current Hours." It appears that the classrooms use 2,500 operational hours, which differs from the suggested hours of operation in the BPU protocol.

4.1.5 Financial Calculations

The financial calculations included within the ESP incorporate a 2.7% interest rate for the loan and the BPU-required 2.2% electric and 2.4% natural gas and fuel oil utility escalation.

The baseline option includes twenty-one (21) ECMs and is analyzed over a 19-year financing term.

DLB notes the following potential issues with the financial calculations:

1. Form VI, shown on page 62 of the report, shows a 1st year annual savings of $286,845, whereas the total savings shown in the cost summary on page 57 is $280,466. The annual savings should be reviewed and coordinated throughout the report.

2. Form VI shows a total of $131,816 Energy Rebates / Incentives to be received over the course of 4 years, but page 61 indicates a total of $180,044. The projected incentives should match throughout the report.
3. Macopin Middle School is shown as being eligible for Pay for Performance incentives, however, the billed peak demand shown on page 50 is 184.8 kW. The program typically requires buildings to have a minimum 200 kW peak demand. Eligibility of the facility should be confirmed to ensure incentives can be obtained.
4. LFN 2009-11 requires that any capital improvements be paid through other appropriations (i.e., bonds or capital improvement funds), not energy savings obligations. DLB recommends to confirm that any capital improvements are planned to be funded appropriately.

4.1.6 Greenhouse Gas Calculations

Greenhouse gas calculations are provided, and the factors used to calculate savings are clearly called out in the report. The factors should be revised to meet the current BPU guidelines, shon on page 13 of the protocol:

- 1,374 lbs. CO_2 per MWh saved
- 1.11 lbs. NO_x per MWh saved
- 0.98 lbs. SO_2 per MWh saved
- 11.7 lbs. CO_2 per therm saved
- 0.0092 lbs. NO_x per therm saved

SECTION 5: REVIEW DISCLAIMER

5.1 Review Disclaimer

DLB Associates, as part of the Third-Party Review services, is providing our professional opinion in the evaluation of the energy savings calculations, ESP and any other supporting documentation provided.

This evaluation is not a guarantee that the savings and assumptions stated are valid. DLB Associates will not be responsible for any failure in achieving the predicted energy and cost savings detailed. Our intention is to complete our due diligence in verifying the energy savings calculations in accordance with the BPU protocols; however, it is impractical to review all inputs in detail. As a result, bottom line numbers and a limited number of parameters have been verified to conclude validity of savings.

SECTION 6: ATTACHMENT

SECTION 4: ENERGY SAVINGS CALCULATIONS REVIEW

4.1 Energy Savings Calculations Review

4.1.1 Methodology of Submitted Calculations

The Energy Savings Improvement Plan included calculations that utilized BPU-acceptable equations and spreadsheet analyses.

The twenty-one (21) ECMs analyzed and accepted in the base project include:

1. Comprehensive LED Lighting Upgrades
2. Install Kitchen Hood Controls
3. Transformer Upgrades
4. Addition of Cooling – RTU for Middle School Auditorium
5. Install Variable Frequency Drive (VDF) on Cooling Tower Fan Motor
6. Refurbish Condensing Units and Install HVAC Armor
7. Replace Boilers with High Efficiency Boilers
8. Fuel-Use Economizers (Boilers)
9. Retro-commissioning Study & HVAC Improvements
10. Building Envelope Upgrades
11. Refrigeration Control Upgrades
12. Plug Load Controls
13. Destratification Fans
14. Cogeneration (CHP)
15. DHW Replacement
16. Unit Ventilator Refurbishment
17. Valve and Pipe Insulation
18. Upgrade HVAC Controls to DDC
19. Direct Install Program (Lighting, Controls, HVAC)
20. Pay for Performance
21. Solar Power Purchase Agreement (PPA)

4.1.2 General Calculation Quality

The quality of the energy savings calculations is satisfactory and representative sample sets were checked for accuracy. Spreadsheet analyses were provided by Energy Systems Group as separate appendix files and have been spot-checked by DLB.

The approach and equations used were summarized broadly in the body of the report with no results given in the ECM description sections. References for equations were listed for some ECMs in the report body. The report body could be expanded to include more details on methodology and results for clarity, but they are included in the Appendix sections.

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DLB notes the following comments for the overall report:

1. Any ECMs which propose to modify temperature setpoints or operation schedules of any equipment, including, but not limited to, HVAC equipment, equipment connected to plug load control devices, walk-in freezers or coolers or computing equipment, should be confirmed with the District to ensure there will be no detrimental operations impacts.

   ESG has confirmed that the proposed schedules and temperature setpoints are acceptable to the client.

2. The total kWh and therm savings for the project should be verified and updated for consistency throughout the report. For example, in the Greenhouse Gas Reductions section on page 63, the total electric savings is listed as 1,331,822 kWh, whereas the sum of the savings shown in the table starting on page 168 yields a total savings of 1,078,182 kWh.

   ESG has verified and updated the kWh and therm savings and other utility savings in the applicable sections and tables based on revisions incorporated from this Review. The guaranteed savings are as follows:

   - ***1,311,854 kWh***
   - ***95,652 therms***
   - ***8182 gallons (fuel oil)***

4.1.3 Mechanical and Electrical Energy Conservation Measures

ECMs were evaluated using spreadsheet analyses. The ECMs submitted agree with Standard Industry Practice and BPU protocol requirements.

Some ECMs presented in the Energy Systems Group Report are not included in the recommended baseline financial analysis. These ECMs only were spot-checked with the protocol for consistency.

DLB notes the following possible issues with the ECM analysis:

ECM 2 – Install Kitchen Hood Controls (7 Facilities)

a) In the Savings Calculations appendix, each measure is identified by letters only without indication of the facility which it is applied to. Please provide facility names for each measure.

   ESG has updated the calculations to included facility names. A = Westbrook; B=High School; C=Upper Greenwood Lake; D=Marshall Hill; E=Middle; F=Maple Road; G=Apshawa

b) The Savings Calculations appendix lists only 6 measures while on page 57 of ESP, 7 facilities are mentioned for this ECM. Please add a missing facility to savings calculations.

   ESG has updated the calculations to include all 7 facilities.

c) For Measure D, in the Savings Calculations, please indicate how the make-up air is provided into the space?

ESG has updated the calculations to include a source of make-up air for Marshall Hill (comes from adjacent spaces).

d) No actual dollar amount savings are provided in the Savings Calculation appendix. Please add.

The calculations are intended for quantifying the energy unit savings only so the cost data has been removed.

e) Please provide a brief explanation of the utility rates source.

The calculations are intended for quantifying the energy unit savings only; the rates in these calculations were an initial assumption and not revised since only the energy unit savings are used in the financial analysis.

ECM 3 – High Efficiency Transformer Upgrade (2 Facilities)

a) Electrical escalation rates in savings calculation spreadsheets do not match the rate listed on page 62 of ESP. Please revise or provide explanation.

The calculations are intended for quantifying the energy unit savings only; the rates in these calculations were an initial assumption and not revised since only the energy unit savings are used in the financial analysis.

ECM 4 – Addition Of Cooling – RTU For Middle School Auditorium (Macopin Middle School)

a) Cut sheets are provided for the proposed units, but a capacity is not indicated. Additionally, the unit cuts show heat pump operation or a gas-fired / electric heating coil for heating. The ECM description states that the unit will have a hot water coil, similar to the current H & V unit. DLB suggests calling out the proposed unit capacity and matching proposed unit cuts to the ECM description.

ESG's final recommendation is to reuse the existing heating and ventilating (H&V) unit currently serving the Auditorium. ESG proposes to retrofit the existing H&V unit with a DX cooling coil and adding a 25-ton DX condensing unit on the roof and replacing the supply fan and motor. An updated ECM description and cutsheet for the proposed condensing unit is included in the revised ESP.

ECM 5 – Install Variable Frequency Drive (VFD) On Cooling Tower Fan Motor (West Milford High School)

a) The ABB VFD cut provided does not indicate that a NEMA 3R rated enclosure is provided. DLB recommends ESG confirm that the appropriate NEMA rating will be provided based on the mounting location.

ESG will provide the appropriate NEMA rating based on final location selected for the enclosure.

b) The 2019 BPU Protocols indicate a revised approach for VFD savings calculations on page 101. This approach indicates an Energy Savings Factor (ESF) of 290 kWh / year-HP and a Demand Savings Factor (DSF) of -0.025 kW / HP. DLB recommends reviewing the savings calculations to ensure compliance with the protocols.

ESG has updated the savings calculations in compliance with the 2019 BPU protocols.

ECM 6 – Refurbish Condensing Units And Install HVAC Armor (3 Facilities)

a) The age of the existing units to be refurbished does not appear to be indicated in the report. DLB recommends including the age of the equipment to ensure that the scope of the ECM is appropriate for the units.

   ESG has included the age of the equipment.

b) The Energy Savings and Cost Summary in Section 3 shows that this ECM has a simple payback between 10 to 15 years, depending on the facility. ESG should confirm whether the refurbishment will extend the life of the units long enough to realize the simple payback. DLB gathers from the report that the units in the scope of work are aging and in need of repair or replacement already, and requiring the units to run an additional 10 to 15 years to realize the simple payback when they already are at the end of their lifespan may not be realistic.

   Based on similar installations, ESG expects the life of the refurbished equipment to be extended beyond the simple payback period.

c) The ECM contractor's calculations show savings percentages used to calculate electric consumption reduction, but do not explain how those percentages were obtained and how the baseline kWh were obtained for the units. More information on how the factors used were obtained should be provided.

   Savings are based on the measurement and verification results of similar installations and the operating hours provided by the District.

ECM 7 – Replace Boilers With High Efficiency Boilers (Macopin Middle School)

a) Boiler replacements are indicated at the Macopin Middle School and Marshall Hill Elementary School in the Executive Summary and in the backup calculations, but only the Macopin Middle School is shown in the Financial Impact table in Section 3 and in the ECM description on page 77. The scope of work should be confirmed.

   Scope of works and Financial Impact table have been updated to include Marshall Hill Elementary School.

b) The existing Macopin Middle School boilers are stated to have conflicting capacities and efficiencies in different sections of the report. For example, the facility description shows five (5) 1,615 MBH boilers at 83% efficiency, whereas the ECM description shows five (5) at 2,000 MBh and 82% efficiency, and the calculations show a total boiler output of 6,460 MBH. The boiler data should be reviewed and revised for consistency.

   Boiler data revised for consistency in write-ups and calculations.

c) The replacement boilers will yield a total of 1,840 MBH heating capacity, whereas the existing boilers can provide 6,460 MBH output, according to the calculations section. ESG should confirm that the proposed boiler design can meet the heat load. The bin analysis presented in the calculations show heat loads greater than the proposed boiler output.

Original proposed boiler data was an error; updated to (5) 2000 MBH boilers at the Middle School.

d) The ECM description states that 2 new hot water distribution pumps and motors will be replaced, however, no savings are presented in the report. It would be beneficial to address whether these motors will be more efficient and provide energy savings.

No energy savings expected from the motor upgrades.

e) A Boiler Loading Calculation Parameter is presented in the calculations. An explanation of how this factor was derived would be beneficial.

Boiler loading = Heat Load (BTU/SF) x Building Area / Total Boiler Output

Heat Load = 29 BTU/SF (assumption); Building Area = 120,000 sq ft; Total Boiler Output = 5 x 1615 MBH

ECM 8 – Fuel Use Economizers (Boilers) (4 Facilities)

a) The calculations show an 19 BTU/h / SF Heat Load Engineering Check factor. This rate seems low for the application and should be verified.

The Heat Load factor was assumed and utilized to insure the existing fuel usage was within an acceptable range of the utility baseline.

b) The calculations utilize a 4% combustion efficiency to calculation savings. This rate is below the maximum % reduction, but the rationale behind the percentage used should be explained.

The %reduction was based on assuming an average of 4% over the operating range of the boilers and existing efficiencies and was also used to take into account interactive effects to insure the total utility baseline reduction was within expected ranges.

c) The Heating Profile shown in the calculations includes a 10% load when the temperature is greater than 60F, however, the high school does not seem to utilize the heating hot water boilers for domestic water. It would be beneficial to explain how this value was determined.

Input error; however, the "Outside Air Boiler Cutoff Temp." input overrides the profile setting so there is no heating when temperatures are above 60F

ECM 9 – Retro-Commissioning Study & HVAC Improvements (All Facilities)

a) DLB recommends including a note for Apshawa and Upper Greenwood Lake Elementary to indicate these facilities utilize fuel oil.

Note added to calculations.

b) The stipulated savings are shown as percentage reductions of utilities used. DLB recommends explaining the factors contributing to how the percentages were chosen for each facility. For example, if the sizes of the buildings, types of equipment, and existing control system types are considered in the value, these should be highlighted.

The savings calculation for this measure was estimated as a percentage of the total utility consumption based on the total annual electricity and natural gas usage of the sites. The percent stipulated savings for electric and natural gas is based on the assumption that following a proper calibration / retro-commissioning effort that the existing to remain (and upgraded systems) will perform more efficiently. This value and been reviewed and approved by the Client to be appropriate based on the current operation of the building.

ECM 10 – Building Envelope Upgrades (All Facilities)

a) Cooling savings are calculated for all facilities in the ESP, however, many facilities are described only to have a few areas cooled with window air conditioning units. The calculations should be reviewed to confirm that the cooling savings are derated or have a safety factor applied to consider that in many cases, 100% of the building is not cooled.

The savings calculation for this measure were reviewed and a safety factor was used to derate the savings.

b) The ECM calculations utilize 5,901 heating degree days (HDD), associated with the Wanaque Raymond Dam weather data station. The boiler replacement and controller calculations, however, utilize the Newark weather data with 5,057 HDD. DLB recommends standardizing the weather data used for all ECM calculations.

The heating savings were derated to account for the difference in the selected weather stations HDDs.

c) The hard costs differ between the ECM calculations from BER and the summary table in Section 3. DLB recommends explaining the factors used to reduce the projected cost.

There was a 3% contingency factor used to reduce the project cost.

d) The BER supporting calculations include equations to demonstrate how savings were derived, however, some constants and factors used are not specified. DLB recommends including the flow factor, wind pressure, heating efficiency, and enthalpy conditions used to calculate savings.

Flow factor = 20; wind pressure = 6.1; heating efficiency = 85%; enthalpy based on Wanaque Raymond Dam weather station

e) The calculations show a 1.2 kW / ton cooling efficiency to calculate savings, but the cooling equipment ages and types vary throughout the facilities. DLB recommends reviewing this value to confirm that it is accurate for all applications.

ESG reviewed the calculations and applied safety factors and is satisfied with the accuracy of

the calculated savings.

ECM 11 – Refrigeration Control Upgrades (8 Facilities)

a) Baseline electric consumption values are provided for each type of unit, but no explanation of how these were determined is provided. DLB suggests providing a calculation or description stating how these values were obtained.

Baseline electric consumption values based on results documented in over 500 independent customer studies.

b) A list of the type and quantity of equipment included is provided in the ECM description and calculation, but the list is not broken down by facility. The type and number of units associated with each school should be shown so that savings can be validated.

The ECM description has been updated to show type and quantity at each school.

c) The calculations show maintenance savings, however, DLB recommends including this savings in the operational savings, shown on page 152 of the report, instead.

ESG did not include maintenance savings for this ECM.

d) The calculations seem to calculate savings by applying a 23% savings factor to the baseline consumption. The 23% savings value seems high and should be clearly defined.

The brochure provides a generalized energy savings for the equipment. The calculations are based on the specific equipment and operation of the equipment for this site.

ECM 12 – Plug Load Controls (9 Facilities)

a) DLB recommends considering the reduced plug load impact on HVAC loads as part of the savings calculations.

The proposed plug load controls will have a minimal impact to the HVAC consumption in the space. The measure is cost justified without the potential benefit of reduced HVAC consumption / cost.

b) Confirm that the installation of Bert controls will not negatively affect the performance of the charging cart at night.

The proposed plug load controls are programable to allow the client to modify the schedule to ensure that the equipment is available when needed (i.e. to allow sufficient charging time).

c) The calculations consider a baseline of 8,760 hours at a single wattage. ESG should confirm that the baseline hours and power are correct. For example, the printers or projectors may have a standby mode that consumes less power for many of the hours.

Power consumption is an average of full power and standby mode power consumption. Hours were assumed based on interviews with staff.

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ECM 13 – Destratification Fans (5 Facilities)

a) The supporting files for this ECM include a vendor sheet with project pricing and a product cut sheet. There are no other calculations given showing how the savings were determined. DLB recommends providing calculations and including assumptions for temperatures, space heat load, equipment thermal efficiencies, and runtime hours.

   Refer to updated calculations, developed in coordination with District.

ECM 14 – Cogeneration (CHP), (1 facility)

a) Calculation spreadsheet (monthly table) is missing the savings data. Please complete the table to show the savings for each month and total.

   Refer to updated calculations,

b) Payback period for this ECM on page 57 is indicated as 44 years. This looks high. Please revise or explain.

   Refer to updated calculations; payback is higher; Payback based on estimated costs and updated savings calculations.

c) Please confirm that maintenance costs / contract is included in Cost Estimate.

   Confirmed. Maintenance costs for the CHP are included in the project as per BPU requirements.

d) Page 97 states that this ECM will benefit from NJ Clean Energy incentives, but it is not listed on page 59 in the NJ Clean Energy Rebates table. Please revise one or the other.

   Revised page 97.

e) Please provide a brief outline about the strategy to generate demand response revenue as mentioned on page 97, Benefits section.

   Revised page 97 to removed demand response revenue reference.

ECM 15 – DHW Heaters Replacement (1 Facility):

a) The manufacturer and model of the water heater in the cut sheet don't match the one proposed in the ESP. Please review for consistency.

   Updated ESP; providing 120 MBH water heater, AO Smith BTH-120.

b) The payback period as listed on page 55 (17.13 years) seems high and exceeds the useful life of the water heater.

   District requested this ECM as their existing system is beyond useful life.

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ECM 16 – Unit Ventilator Refurbishment (8 Facilities)

a) The ECM calculations should include the load factor and coincidence factors shown on page 81 of the BPU protocols.

   Refer to updated calculations.

ECM 17 – Valve & Pipe Insulation (8 Facilities)

a) The ECM includes insulation thicknesses for each pipe to be repaired. The piping systems are indicated; however, system operating temperatures are not shown. The temperatures should be included to confirm insulation thicknesses.

   Heating hot water systems were assumed to be at 185F (average) and domestic hot water systems were assumed to be at 125F (average).

b) Additional supporting data should be provided for this ECM, including information on the heat loss coefficients, the fluid and ambient temperature assumptions, and heating equipment efficiencies assumed.

   Attached supplemental data to calculatins.

ECM 18 – Upgrade HVAC Controls to DDC (All Facilities)

a) ECM description includes central plant and H&V units for most of the schools, may want to clarify if any Exhaust Fans or Classroom Unit Ventilators are included in the DDC control scope (if applicable)

   The High School includes Exhaust Fans and Unit Ventilators in the DDC controls scope; other schools include central plant and primary AHUs/H&V units; this specific scope was developed in coordination with District.

b) May be beneficial to confirm he temperature settings on the Calculation Table for Occupied / Unoccupied with current operations – table notes 72/78 cooling and 72/64 heating and not sure how these compare to current system temperature settings.

   The temperature setting were developed in coordination with the District.

c) Confirm if there is cooling in unit ventilators and update if needed. Looks as though there is a reference in the Appendix Calculation to Cooling UVs but did not see them noted in the ECM Description.

   Existing UVs do not have cooling; some in the High School did at one point but the cooling is no longer operable. No cooling savings have been included.

d) OA Damper Control appendix sheet notes proposed operating schedule reduction per day retrofitting Outdoor Damper Control on Unit Ventilators. Is this being proposed at all the schools as part of the HVAC Controls work?

   Yes, in coordination with the UV refurbishment scope.

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ECM 19 – Direct Install Program (Lighting, Controls, HVAC) (6 Facilities)

a) Would be beneficial to include the Direct Install information in the appendix that details the project scope for each of the 6 facilities for the school to review. Appendix seems to only contain lighting info.

Updated information included in revised Appendix.

b) Please list peak electric demand and other required data confirming the eligibility of these 6 facilities for the Direct Install Program.

Existing small to mid-sized commercial and industrial facilities with an average peak electric demand that did not exceed 200 kW in any of the preceding 12 months are eligible to participate in Direct Install. Applicants will submit the last 12 months of electric utility bills indicating that they are below the demand threshold and have occupied the building during that time. Buildings must be located in New Jersey and served by one of the state's public, regulated electric or natural gas utility companies.

c) Confirm that the scope for this ECM falls under the current Direct Install Program, this program has been significantly changing each year.

Effective July 1, 2019, entitles owned or operated by municipalities, K-12 public schools, and customers located in Urban Enterprise Zones or Opportunity Zones may be eligible for up to 80% of the cost of the installed measures. Measures eligible for Direct Install are limited to specific equipment categories, types and capacities. Boilers may not exceed 1,500,000 Btuh and furnaces may not exceed 140,000 Btuh. Limitations on packaged HVAC, motors and other equipment also apply. Larger capacity equipment may be eligible for financial incentives through NJ SmartStart Buildings.

d) Double check the savings for direct install, some of the school savings seems high if we are comparing the right numbers (Paradise Knoll lists $ 7,600 savings out of total electric bill of $ 25,000)

Savings were confirmed.

ECM 20 – Pay for Performance (Macopin Middle School)

a) Has initial eligibility (Incentive 0 applications) been submitted for P4P to confirm base eligibility?

No applications have been submitted.

b) ES and CS table show $29K for each school under this ECM as a Hard Cost, what does this cost represent?

This cost is the P4P Partner's administrative costs for implementing the rebate (preparing the applications, energy modeling, etc.).

c) Table on page 28 lists dollar amounts anticipated for all 3 incentives. Please provide written explanation or example calculations to support those and verify that that ECMs being applied to these do not overlap.

The incentives are calculated utilizing the NJCEP's standard criteria for P4P projects and do not overlap with any of the other ECM's / Incentives. The utility historical utility bill information is included as an appendix to the Energy Savings Plan. Refer to Form IV for utility reduction quantities. ESG has reviewed the proposed project and is confident that the project will meet the requirements of P4P and taken a 75% safety factor on

the incentive to ensure the project is able to achieve the stated incentive amount.

d) Are there calculations / measurements indicating buildings' eligibility (200kW peak demand, 15% source energy savings) for this incentive available? May be worthwhile to illustrate how close the proposed ECMS are to the 15% threshold.

The utility historical utility bill information is included as an appendix to the Energy Savings Plan. Refer to Form IV for utility reduction quantities. ESG has reviewed the proposed project and is confident that the project will meet the requirements of P4P and taken a 75% safety factor on the incentive to ensure the project is able to achieve the stated incentive amount.

ECM 21 – Solar Power Purchase Agreement (7 Facilities)

a) DLB recommends noting some of the PPA agreement requirements for reference such as; panel warranty, panel removal terms, any specific insurance provisions or site licensure or access requirements.

This information has been provided to the District which is contracting directly for the PPA.

b) Looks like some of the new solar panels are proposed to be installed on sections of the roof of various buildings of various ages and roof materials. Suggest clarification be added to on who would be responsible for any structural modifications required to support the weight of the new solar panels, and if applicable, include the associated costs in the financial analysis.

PPA provider is responsible for items noted.

c) It is unclear if maintenance access was taken into account in the general panel layout which should be considered for any roof top equipment.

PPA provider did take maintenance access into account and is responsible for items noted.

d) Also, it may be worthwhile to highlight any system down time incorporated in the estimated production values. From what we have seen some PPA vendors note this in their contracts and we have seen down times that stretch for months which would affect savings.

PPA provider has denoted these items in their proposal.

e) Are any of the proposed solar array sizes close to or higher than 80% of building usage / service sizes?

PPA provider sized systems to insure that there is minimal excess generation.

f) Appendix includes excel sheet with Solar Production Data but it does not contain information of where this data was obtained, BPU protocols recommend PV Watts.

PPA provider utilized PV Watts.

Lighting Energy Conservation Measures

Lighting improvement savings calculations were performed in a satisfactory manner using a spreadsheet analysis and reviewed in a spot-check fashion.

DLB notes the following potential issues with the lighting ECM analysis:

ECM 1 – Comprehensive LED Lighting Upgrades (All Facilities)

f) The energy savings calculations do not appear to utilize the iterative factor (IF) used in the BPU Protocols.

The Iterative Factor increases the calculated savings associated with the lighting retrofit. ESG has elected not to account for this savings out an abundance of prudence.

g) The quantity of fixtures being replaced should be identical and should be checked. In the Appendix there appear to be a few locations where the quantity numbers differ, such as in Main Office (7 vs. 14), but these may relate to lamps not fixtures.

The proposed lighting retrofit will not be adding any additional fixtures. As noted, the quantity in question refers to 7 fixtures, 14 lamps.

h) Please, identify reduction in hours for some areas, such as "75 VP Suite office 115" (2000 vs 1600) that appear on the Appendix table.

All areas that indicate reduce run hours in the post-retrofit calculations are being retrofitted with occupancy controls.

i) Please, identify source of "Current Hours." It appears that the classrooms use 2,500 operational hours, which differs from the suggested hours of operation in the BPU protocol.

The total run hours for all areas was coordinated with and approved by the Client.

4.1.4 Financial Calculations

The financial calculations included within the ESP incorporate a 2.7% interest rate for the loan and the BPU-required 2.2% electric and 2.4% natural gas and fuel oil utility escalation.

The baseline option includes twenty-one (21) ECMs and is analyzed over a 19-year financing term.

DLB notes the following potential issues with the financial calculations:

1. Form VI, shown on page 62 of the report, shows a 1st year annual savings of $286,845, whereas the total savings shown in the cost summary on page 57 is $280,466. The annual savings should be reviewed and coordinated throughout the report.

   Annual savings updated and coordinated throughout the report; see revised ESP. Initial guaranteed savings= $273,624; Year 1 Guaranteed savings = $279,844 (based on one year of escalation at the BPU approved escalation rates for electric and natural gas)

2. Form VI shows a total of $131,816 Energy Rebates / Incentives to be received over the course of 4 years, but

page 61 indicates a total of $180,044. The projected incentives should match throughout the report.

Energy Rebates/Incentives updated and coordinated throughout the report; see revised ESP.

3. Macopin Middle School is shown as being eligible for Pay for Performance incentives, however, the billed peak demand shown on page 50 is 184.8 kW. The program typically requires buildings to have a minimum 200 kW peak demand. Eligibility of the facility should be confirmed to ensure incentives can be obtained.

   ESG elected to used Middle School as a conservative estimate of the Pay for Performance incentives; during design it is likely that the High School will be eligible utilized for the Pay for Performance incentives.

4. LFN 2009-11 requires that any capital improvements be paid through other appropriations (i.e., bonds or capital improvement funds), not energy savings obligations. DLB recommends to confirm that any capital improvements are planned to be funded appropriately.

   The District to insure capital improvements are funded appropriately.

4.1.5 Greenhouse Gas Calculations

Greenhouse gas calculations are provided, and the factors used to calculate savings are clearly called out in the report. The factors should be revised to meet the current BPU guidelines, shon on page 13 of the protocol:

- 1,374 lbs. CO_2 per MWh saved
- 1.11 lbs. NO_x per MWh saved
- 0.98 lbs. SO_2 per MWh saved
- 11.7 lbs. CO_2 per therm saved
- 0.0092 lbs. NO_x per therm saved

Factors revised, see attached revised ESP.