TOWNSHIP OF NORTH BRUNSWICK
DEPARTMENT OF PUBLIC WORKS BUILDING
ENERGY ASSESSMENT

for

NEW JERSEY
BUREAU OF PUBLIC UTILITIES

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1.0 INTRODUCTION & BACKGROUND

This report summarizes the energy audit for the North Brunswick Township Department of Public Works (DPW) building. The one story, approximately 18,400 square foot building houses the office space for the DPW employees; and the garage, maintenance and storage bays for the DPW vehicles.

New Jersey's Clean Energy Program, funded by the New Jersey Board of Public Utilities, supports energy efficiency and sustainability for Municipal and Local Government Energy Audits. Through the support of a utility trust fund, New Jersey is able to assist state and local authorities in reducing energy consumption while increasing comfort.

This report shall cover the energy audit for the North Brunswick DPW Building.

2.0 EXECUTIVE SUMMARY

This report summarizes the energy audit for the North Brunswick Township Department of Public Works (DPW) building. The 18,400 SF, single story structure consists of office space; and garage, maintenance, and storage bays for the DPW vehicles. The following areas were evaluated for energy conservation measures:

- Lighting replacement
- Occupancy sensors
- Lighting replacements with occupancy sensors
- Photocells for exterior lighting
- Night setback
- Packaged rooftop unit replacement
- Unit heater replacement
- Window air conditioner replacement
- Insulation upgrade
- Domestic hot water storage tank removal

Various potential Energy Conservation Measures (ECMs) were identified for the above categories. Measures which are recommended for implementation have a payback of 10 years or less. This threshold is considered a viable return on investment. Potential annual savings of $15,200 for the recommended ECMs may be realized with a payback of 4.0 years.

The ECMs identified in this report will allow for the building to reduce its energy usage and if pursued has the opportunity to qualify for the New Jersey SmartStart Buildings Program. A summary of the costs, savings, and paybacks for the recommended ECMs follows:

ECM-3 T-12 Lighting Retrofit with Occupancy Sensors

Budgetary Cost	Annual Utility Savings				ROI	Potential Incentive*	Payback (without incentive)	Payback (with incentive)
	Electricity		Natural Gas	Total				
$	kW	kWh	Therms	$		$	Years	Years
14,200	4.9	15,600	0	2,600	1.8	1,700	5.6	4.9

* Incentive shown is per the New Jersey Smart Start Program, 2009 Lighting Controls Application. Incentive is based on the use of 11 wall-mounted, occupancy sensors. Incentive is based on the following: retrofitting 60, two-lamp T-12 fixtures < 250 watt with T-8 lamps; and retrofitting 48, three-lamp T-12 fixtures < 250 watt with T-8 lamps.

ECM-4 Use of Photocells for Pump Station Lighting

Budgetary Cost	Annual Utility Savings				ROI	Potential Incentive*	Payback (without incentive)	Payback (with incentive)
	Electricity		Natural Gas	Total				
$	kW	kWh	Therms	$		$	Years	Years
200	-	3,300	0	500	36.50	N/A	0.4	N/A

* There is no incentive available through the New Jersey Smart Start Program for this ECM.

ECM-5 Apply Night Setback to Mechanical Systems

Budgetary Cost	Annual Utility Savings				ROI	Potential Incentive*	Payback (without incentive)	Payback (with incentive)
	Electricity		Natural Gas	Total				
$	kW	kWh	Therms	$		$	Years	Years
7,400	-	1,100	1,700	2,600	4.3	N/A	2.8	N/A

* There is no incentive available through the New Jersey Smart Start Program for this ECM.

ECM-6 Replace Unit Heaters with Infrared Heaters

Budgetary Cost	Annual Utility Savings				ROI	Potential Incentive*	Payback (without incentive)	Payback (with incentive)
	Electricity		Natural Gas	Total				
$	kW	kWh	Therms	$		$	Years	Years
40,000	10.1	21,900	3,900	9,200	3.6	N/A	4.3	N/A

* There is no incentive available through the New Jersey Smart Start Program for this ECM.

ECM-10 Eliminate DHW Storage Tanks and Circulating Pump

Budgetary Cost	Annual Utility Savings				ROI	Potential Incentive*	Payback (without incentive)	Payback (with incentive)
	Electricity		Natural Gas	Total				
$	kW	kWh	Therms	$		$	Years	Years
900	0.1	600	200	300	9.00	N/A	3.0	N/A

* There is no incentive available through the New Jersey Smart Start Program for this ECM

3.0 EXISTING CONDITIONS

3.1 Building General

3.1.1 Structure

The North Brunswick DPW building consists of a 4,000 square foot office building section and a 14,400 high bay garage section. The high bay garage is used for equipment storage, maintenance/repair of DPW vehicles, and vehicle parts storage. The facility also contains a separate unheated road salt storage building and vehicle fueling station, which are not included in the square footage noted above.

The building is steel column and beam construction and the exterior is composed of sheet metal siding with metal fascia. The office area walls are constructed with 4" metal studs, ½" gypsum board and include 4 inches of fiberglass R-11 batt insulation. The garage wall sections consist of 4 inches of fiberglass vinyl faced R-11 batt insulation and has 8 foot high metal siding around the perimeter of the interior.

The office windows and exterior doors are double pane glass with metal frames. The garage section has five 12' wide x 14' high overhead doors, and two 3' x 7' exterior metal personnel doors.

The roof consists of sheet metal roofing panels and is original to the building construction. The roof has 6 inches of vinyl faced fiberglass R-19 batt insulation.

3.1.2 Operating Hours

The building is operational from 6:00 AM – 4:30 PM weekdays and approximately one Saturday per month from 6:30 AM to 12:00 noon.

3.2 Utility Usage

The building uses electricity, natural gas, municipal water, and is connected into the municipal sewage system.

Electricity and natural gas are purchased from and delivered by the Public Service Electric and Gas Company (PSE&G). From January 2008 through December 2008, the DPW facility had an annual electrical consumption of 122,400, kWh and natural gas usage of 21,100 therms. DPW's annual electric and natural gas bill is $49,500.

Sixty percent of the energy bill is for natural gas; the average blended rate is $1.41 per therm. Approximately 95% of the natural gas usage is for building heating, the remaining is for domestic hot water production.

The average blended electricity rate is $0.163 per kWh. Electricity is used for garage and office lighting, office air conditioning and equipment, garage shop tools, compressed air, garage ventilation fans, and vehicle fueling station. The salt storage building has a separate metered electrical service with minimal usage for building lighting.

Utility data is provided in Appendix A

3.3 HVAC Systems

3.3.1 Office System

The HVAC system for the office consists of a packaged rooftop heating/cooling unit with a single thermostat control. Conditioned supply air is delivered from the unit to the office spaces by ductwork located in the suspended ceiling area. The unit was installed in 2006, has a cooling capacity a 12.5 tons and an output heating capacity of 128,000 Btuh. The office area also includes three wall mounted electric heaters which provide supplemental heat to individual offices. Each electric heater has a single thermostat.

3.3.2 Garage Heating System

Heat is provided to the garage area by 10 roof suspended natural gas fired unit heaters. Each heater has an output capacity of 231,000 Btuh and is controlled by an individual thermostat.

3.3.3 Ventilation Fans

The garage has five wall mounted exhaust fans and two wall mounted air make up fans used to clear the occasional exhaust fumes created when vehicle engines are operating within the garage. The fans are manually switched on and off and are operated on an as-needed basis by garage employees.

3.4 Lighting/Electrical Systems

The lighting in the garage and office area is fluorescent T12 lamps controlled manually by switches in the spaces. The lighting is turned on and off by employees and is on when the building is occupied.

The building has one Caterpillar/Olympian 75 kW diesel fuel powered generator located in a fenced area outside of the facility and provides backup power during electrical power outages.

3.5 Plumbing Systems

The plumbing system for the facility consists of domestic water piping, sanitary piping, and vent piping. Domestic hot water is generated by one natural gas 65 gallon tank water heater connected to two 75 gallon tanks (storage only) for a combined storage capacity of 215 gallons. Hot water is circulated to the storage tanks by a 1/25 HP circulating pump. Plumbing fixtures include urinals, water closets, lavatories, sinks, showers, hose bibbs, and floor drains.

4.0 ENERGY CONSERVATION MEASURES

4.1 ECM-1 Retrofit T-12 Lighting Fixtures

Over 100 interior lighting fixtures utilize inefficient T-12 fluorescent lamps equipped with either two or three 4' bulbs. Overall energy consumption can be reduced by retrofitting the fixtures to operate with more efficient T-8 fluorescent lamps.

To compute the annual savings for this ECM, the existing energy consumption of the lighting fixtures was determined. The total hours of fixture operation was projected using 10.5 hours per day at 5 days per week, and 52 weeks per year. The same calculations were then performed using the reduced energy requirements of the proposed T-8 fixtures at the same projected hours of operation. The difference between the existing and proposed annual energy expenditures was taken as the overall energy savings. See Appendix B for calculations.

Implementation of this ECM would require that the existing lamps and ballasts of each fixture be removed. Electronic ballasts and 4', T-8 fluorescent lamps must then be installed in all fixtures.

Light fixtures have an expected life of 15 years, according to the manufacturer, and total energy savings over the life of the project are estimated at 183,900 kWh and $31,500.

The implementation cost and savings related to this ECM are presented in Appendix B and summarized below:

ECM-1 Retrofit T-12 Lighting Fixtures

Budgetary Cost	Annual Utility Savings				ROI	Potential Incentive*	Payback (without incentive)	Payback (with incentive)
	Electricity		Natural Gas	Total				
$	kW	kWh	Therms	$		$	Years	Years
12,000	4.9	12,260	0	2,200	1.6	1,500	5.6	4.9

* Incentive shown is per the New Jersey Smart Start Program, 2009 Prescriptive Lighting Application. Incentive is based on the following: retrofitting 60, two-lamp T-12 fixtures < 250 watt with T-8 lamps; and retrofitting 48, three-lamp T-12 fixtures < 250 watt with T-8 lamps.

This measure is not recommended in lieu of ECM-3.

4.2 ECM-2 Install Occupancy Sensors for Interior Lighting

Lighting fixtures throughout the building are all manually switched on and off. Therefore, they are turned on at about 6:00 AM and operated until about 4:30 in the afternoon. In total, the interior building lights are operated approximately 10.5 hours per day or 52.5 hours per week. The operating time of many of the building's interior lighting fixtures can be reduced by installing occupancy sensors in the following areas: garage storage area, men's locker room and restroom, women's restroom, lunch room, conference room, supervisor's office, and the three small offices along the building's south wall. Occupancy sensors were not considered for the garage vehicle repair section due to safety concerns. If a sensor does not have a clear view of the occupant's room or is obstructed by large vehicles being serviced, it may darken even with people in the space, creating an unsafe condition.

Applying the same process used in the calculation of ECM-1, the existing baseline energy consumption for each fixture was determined, and typical traffic patterns for each space were taken into account to

approximate the actual occupancy hours per day. It was established that the annual energy consumption of the lighting fixtures can be reduced by 5,740 kWh.

This measure will require the purchase and installation of occupancy sensors for each area. Approximately 11 occupancy sensors, and some standard electrical work is required for this measure.

Occupancy sensors have an expected life of 15 years, according to the manufacturer, and total energy savings over the life of the project are estimated at 86,100 kWh, and $10,500.

The implementation cost and savings related to this ECM are presented in Appendix C and summarized below:

ECM-2 Install Occupancy Sensors for Interior Lighting

Budgetary Cost	Annual Utility Savings				ROI	Potential Incentive*	Payback (without incentive)	Payback (with incentive)
	Electricity		Natural Gas	Total				
$	kW	kWh	Therms	$		$	Years	Years
2,200	-	5,740	0	700	3.8	200	3.2	2.9

* Incentive shown is per the New Jersey Smart Start Program, 2009 Lighting Controls Application. Incentive is based on the use of 11 wall-mounted, occupancy sensors.

This measure is not recommended in lieu of ECM-3.

4.3 ECM-3 T-12Lighting Retrofit with Occupancy Sensors

Due to interactive effects, the energy and cost savings for occupancy sensors and lighting upgrades are not cumulative. This measure is a combination of ECMs 1 and 2 to allow for maximum energy and demand reduction.

Occupancy sensors have an expected lifetime of 15 years, according to the manufacturer, and total energy savings over the life of the project are estimated at 234,000 kWh, and $39,000.

The implementation cost and savings related to this ECM are presented in Appendix D and summarized below:

ECM-3 T-12 Lighting Retrofit with Occupancy Sensors

Budgetary Cost	Annual Utility Savings				ROI	Potential Incentive*	Payback (without incentive)	Payback (with incentive)
	Electricity		Natural Gas	Total				
$	kW	kWh	Therms	$		$	Years	Years
14,200	4.9	15,600	0	2,600	1.8	1,700	5.6	4.9

* Incentive shown is per the New Jersey Smart Start Program, 2009 Lighting Controls Application. Incentive is based on the use of 11 wall-mounted, occupancy sensors. Incentive is based on the following: retrofitting 60, two-lamp T-12 fixtures < 250 watt with T-8 lamps; and retrofitting 48, three-lamp T-12 fixtures < 250 watt with T-8 lamps.

This measure is recommended.

4.4 ECM-4 Use of Photocells for Vehicle Fueling Station Lighting

During the site visit it was noted that lighting for the fuel pumping station was on during daytime hours. As it is unnecessary for these four light fixtures to be activated during the daytime, installing a photocell controller to energize the lights only when it is dark outside will provide energy savings.

The calculation for this ECM follows the same methodology as ECM-2. However, since the lights are on continually, the baseline annual hours of operation are the total hours in a year, or 8,760 hours. The proposed hours of operation are nighttime, which on average are 12 hours per day and 4,380 hours per year. Multiplying the combined fixture wattage of the fuel station lights by the baseline and proposed hours of operation yields an annual energy consumption of about 6,600 kWh and 3,300 kWh, respectively. The annual energy savings is taken as the difference between the two values.

Applying this energy conservation measure will require installation of one photocell sensor on the roof of the fuel pump station shelter. The photocell must be hard wired into the power supply line for the lights.

Photocells have an expected life of 15 years, according to the manufacturer, and total energy savings over the life of the project are estimated at 49,500 kWh, and $7,500.

The implementation cost and savings related to this ECM are presented in Appendix E and summarized below:

ECM-4 Use of Photocells for Pump Station Lighting

Budgetary Cost	Annual Utility Savings				ROI	Potential Incentive*	Payback (without incentive)	Payback (with incentive)
	Electricity		Natural Gas	Total				
$	kW	kWh	Therms	$		$	Years	Years
150	-	3,300	0	400	36.50	N/A	0.4	N/A

* There is no incentive available through the New Jersey Smart Start Program for this ECM.

This measure is recommended.

4.5 ECM-5 Apply Night Setback to Mechanical Systems

Existing unit heaters in the garage area at the Department of Public Works building are being individually controlled by wall-mounted thermostats with a setpoint of 65°F. The packaged rooftop unit providing HVAC to the office area is equipped with a programmable thermostat, which is not utilized. Therefore, the office space is held constant at the 70°F heating and 73°F cooling setpoints 24 hours per day. This ECM evaluates the energy associated with applying night and weekend temperature setback to the entire building to eliminate the unnecessary consumption of electrical and natural gas utilities during unoccupied periods. By reducing the unoccupied heating setpoint temperatures in the garage and office areas to 60°F and raising the unoccupied cooling setpoint temperature in the office area to 80°, the building will achieve an immediate reduction in energy use.

To calculate the benefits of night setback, a block load building model was created to approximate the existing energy load for the building. Since the office and garage areas have differing building shells and mechanical equipment, separate block loads were created for each area. The block loads, provided in Appendix E, model the maximum overall cooling and/or heating load for the spaces, taking into account various parameters such as roof, wall, and window construction, total envelope surface area, ventilation and infiltration loads, building occupancy, internal heat generation, and other sources of heat gain and

loss. By entering this calculated maximum load into a spreadsheet containing bin temperature data, the total accumulated year-round cooling and/or heating energy requirements were determined. Bin data for North Brunswick, NJ was not available; therefore, data from nearby Newark, NJ was used. The loads were then reconciled to the average yearly energy usage of the building for natural gas and electric. The bin temperature spreadsheets are included in Appendix E.

To determine the proposed energy usage in the garage area during temperature setback, a second bin spreadsheet was created for the new accumulated heating load, which was identical to the existing usage spreadsheet except the heating unoccupied temperature was lowered to 60°F. The difference in heating therms between the two models is taken as the savings. The same method was used to model the savings for night setback in the office area; for this calculation, however, the unoccupied cooling temperature was raised to 80°F in addition to lowering the unoccupied heating temperature to 60°F. The occupied cooling temperature was adjusted from 73 to 75°F to comply with the International Energy Conservation Code, which requires a minimum of 75°F for cooling load calculations.

Following implementation of this energy conservation measure, it is expected that the building's yearly natural gas and electricity consumption will be reduced by approximately 1,400 therms and 2,900 kWh, respectively.

To apply night setback, all existing wall-mounted thermostats controlling the unit heaters must be removed and the 10 thermostats replaced with one programmable thermostat to control all unit heaters. Control wiring will have to be run to each unit heater from the new thermostat. In addition, the thermostat serving the packaged rooftop unit in the office area will be replaced with a programmable thermostat with advanced control features.

HVAC controls have an expected life of 15 years, according to ASHRAE, and total energy savings over the life of the project are estimated at 16,500 kWh, 25,500 therms and $39,000.

The implementation cost and savings related to this ECM are presented in Appendix F and summarized below:

ECM-5 Apply Night Setback to Mechanical Systems

Budgetary Cost	Annual Utility Savings					Potential Incentive*	Payback (without incentive)	Payback (with incentive)
	Electricity		Natural Gas	Total	ROI			
$	kW	kWh	Therms	$		$	Years	Years
7,400	-	1,100	1,700	2,600	4.3	N/A	2.8	N/A

* There is no incentive available through the New Jersey Smart Start Program for this ECM.

This measure is recommended.

4.6 ECM-6 Replace Unit Heaters with Infrared Heaters

The garage area of the building is heated by ten natural gas unit heaters each with a burner efficiency of 77%. This ECM evaluates replacement of these unit heaters with infrared gas fired heaters. Infrared heaters distribute heat more effectively, have higher burner efficiencies, and do not require an air circulation fan.

The block load spreadsheet for the garage area, prepared in ECM-4, was used to determine the existing heating loads for the space. Using the block load spreadsheet and burner efficiency of 77%, it was determined that the unit heaters require 17,000 therms of energy per year to meet the heating load.

The proposed infrared heaters have a burner efficiency of 85% and will transfer heat more effectively via radiation. Infrared heaters are also very quiet because an air circulation fan is not required.

Using the block load spreadsheet and efficiency improvements, it was determined that the annual heating gas energy required using infrared heaters is 13,100 therms. Electrical energy savings will also be realized by eliminating the need to operate the air circulation fans on the existing unit heaters. The electrical energy saving was calculated by applying the annual heating operating hours from the bin data spreadsheet to the 11.0 kW motor load for the existing unit heaters and the 0.9 kW motor load for the proposed infrared heaters.

The total annual energy savings for this ECM will be 3,900 therms and 21,900 kWh, totaling $9,400.

Implementation of this ECM entails removal of the existing unit heaters and installation of infrared heaters throughout the garage area. Modifications to the natural gas piping exhaust flue stacks and electrical wiring will also be necessary. Flue vents for the heaters can be combined per the manufacturer's installation instructions and existing flue pipes may be utilized. To calculate the budgetary cost, eight, 60 foot long, 200 MBH infrared heaters were used. The quantity, size, and capacity of the heaters were used for estimate purposes only. Exact heater selection and sizing cannot be completed without generating a heating load profile for the space. An example of an infrared heater can be found in Appendix H.

Infrared heaters have an expected life of 20 years, according to ASHRAE, and total energy savings over the life of the project are estimated at 438,000 kWh and 78,000 therms, totaling $184,000.

The implementation cost and savings related to this ECM are presented in Appendix H and summarized below:

ECM-6 Replace Unit Heaters with Infrared Heaters

Budgetary Cost	Annual Utility Savings				ROI	Potential Incentive*	Payback (without incentive)	Payback (with incentive)
	Electricity		Natural Gas	Total				
$	kW	kWh	Therms	$		$	Years	Years
40,000	10.1	21,900	3,900	9,200	3.6	N/A	4.3	N/A

* There is no incentive available through the New Jersey Smart Start Program for this ECM.

This measure is recommended.

4.7 ECM-7 Replace Window Air Conditioner Unit with Ductless Split System AC Unit

Two window air conditioning units are utilized for space cooling of the enclosed offices located in the garage area. Each unit provides 10,000 Btus of cooling at an EER of about 7 and is operated throughout the cooling season. This ECM evaluates replacement of the window units with ductless split system AC units. Split system units have a much higher EER value, do not obstruct the windows, and are programmable to only operate when desired.

The energy savings were determined by comparing the existing units' EER of 7 to the EER of the proposed split system unit which is 14.4. It is assumed that the air conditioners run constantly when the

outdoor air temperature is above 70°F and weather bin data was used to determine the annual cooling operating hours. The existing energy usage was calculated to be 2,900 kWh and the proposed units will reduce the usage to 1,400 kWh.

To implement this measure, the two existing window AC units would be removed and each room requires a wall mounted cooling unit that shares a common outdoor condenser/compressor unit. The installation would also require liquid and gas piping between the wall units and outdoor condenser, and include a programmable controller for each unit. High initial cost and low hours of operation result in an unattractive payback for this measure.

Ductless split systems have an expected life of 20 years, according to ASHRAE, and total energy savings over the life of the project are estimated at 30,000 kWh and $4,000.

The implementation cost and savings related to this ECM are presented in Appendix I and summarized as follows:

ECM-7 Replace Window Air Conditioner with Ductless Split System AC Unit

Budgetary Cost	Annual Utility Savings					Potential Incentive*	Payback (without incentive)	Payback (with incentive)
	Electricity		Natural Gas	Total	ROI			
$	kW	kWh	Therms	$		$	Years	Years
11,500	-	1,500	-	200	(0.65)	200	>30	>30

* Incentive shown is per the New Jersey Smart Start Program, 2009 Gas Electric Unitary HVAC Application. Incentive is based on the installation of a Unitary HVAC/Split System unit < 5.4 tons in capacity.

This measure is not recommended.

4.8 ECM-8 Increase Wall Insulation

This ECM evaluates adding additional wall insulation throughout the building, which would increase the R-value.

The office and garage areas have different wall constructions; therefore, each area was analyzed separately and savings combined following the calculations. Using the block load previously developed for the two areas, the heat losses and gains were calculated for all occurring temperatures, according to bin weather data for Newark, NJ, and multiplied by corresponding annual hours. The amount of heat lost through the area's walls was totaled to determine the existing load on the heating system. In addition, for the office area, the heat gained through the exterior walls was totaled to determine the existing load on the cooling system.

The same process was applied when modeling the proposed conditions; however, the R-values of the exterior walls were adjusted to reflect added insulation. According to building drawings, there is a 5-1/2" air gap within the exterior walls of the office area. Filling this gap with blown-in, loose fill cellulose or fiberglass insulation will add an R-value of 19. In the garage area, it is anticipated that adding 3" expanded polystyrene board insulation will increase the R-value by 12. The combined annual energy savings of adding wall insulation to both the office and garage areas is expected to be 1,000 therms.

Insulation has an expected life of 24 years, according to ASHRAE, and total energy savings over the life of the project are estimated at 24,000 therms and $33,600.

The implementation cost and savings related to this ECM are presented in Appendix J and summarized as follows:

ECM-8 Increase Wall Insulation

Budgetary Cost	Annual Utility Savings				ROI	Potential Incentive*	Payback (without incentive)	Payback (with incentive)
	Electricity		Natural Gas	Total				
$	kW	kWh	Therms	$		$	Years	Years
20,500	-	-	1,000	1,400	0.64	N/A	14.6	N/A

* There is no incentive available through the New Jersey Smart Start Program for this ECM

This measure is not recommended.

4.9 ECM-9 Increase Roof Insulation

As discussed in ECM-8, adding insulation to the building's exterior walls can lower the amount of heat lost or gained to the space and reduces the overall heating and cooling loads. This concept is applicable to the building's roof. This ECM assesses adding 3", R-12 expanded polystyrene board insulation be added to the roof construction of both areas to reduce heat transfer.

To calculate the savings for this energy conservation measure, the same process used in ECM-9 was applied. The office and garage areas have different roof construction; therefore, each area was analyzed independently. Using the block load developed previously for the two areas, the heat losses and gains were calculated for all temperatures, according to bin weather data for Newark, NJ, and multiplied by their corresponding annual hours. The values were totaled to determine the existing load on the cooling and/or heating systems. This calculation was then developed using roof construction values which included the additional R-12 insulation.

The proposed insulation would be 3" of expanded polystyrene board insulation. Reroofing would not be necessary as the insulation board could be installed on the underside of the existing exposed batt roof insulation. It would be secured in place by attaching to the exposed roof purlins. The combined annual energy savings of adding roof insulation to the office and garage areas is expected to be 500 therms and 100 kWh.

The insulation has an expected life of 24 years, according to ASHRAE, and total energy savings over the life of the project are estimated at 2,400 kWh and 12,000 therms, totaling $16,800.

The implementation cost and savings related to this ECM are presented in Appendix K and summarized below:

ECM-9 Increase Roof Insulation

Budgetary Cost	Annual Utility Savings				ROI	Potential Incentive*	Payback (without incentive)	Payback (with incentive)
	Electricity		Natural Gas	Total				
$	kW	kWh	Therms	$		$	Years	Years
34,000	-	100	500	700	(0.51)	N/A	>30	N/A

* There is no incentive available through the New Jersey Smart Start Program for this ECM

This measure is not recommended.

4.10 ECM-10 Eliminate DHW Storage Tanks and Circulating Pump

The existing domestic hot water (DHW) generation system consists of a 65 gallon tank-style natural gas water heater and two 75 gallon storage tanks. Hot water is maintained at 120°F among all three tanks by use of a 1/25 HP circulating pump which runs constantly. Energy to maintain setpoint during times of zero or low demand is known as standby losses. According to building personnel, domestic hot water is used in restroom, kitchen, and janitor's utility sink; and occasionally the shower. With such a moderate demand, it was determined that the existing 65 gallon water heater is capable of maintaining the building's DHW requirements. This ECM evaluates the energy savings associated with discontinuing the use of the two 75 gallon storage tanks and circulating pump.

Natural gas utility bills were examined to estimate the average monthly and annual DHW energy consumption. Applying the existing hot water heater's efficiency to the energy consumed yielded the building's annual hot water demand including standby losses from the tanks. According to the U.S. Department of Energy, 2.5% of stored capacity is lost every hour for hot water heater standby. Therefore, the domestic hot water system is dissipating approximately 19,600,000 Btu of energy over a year. Removing the storage tanks could save about 200 therms per year.

In addition to the natural gas savings, electrical savings will be achieved by removing the circulating pump. This calculation was performed by determining the pump wattage from the manufacturer's cut sheet; the annual power consumed by the pump is equal to the annual savings, or about 600 kWh.

The ECM has an expected life of 30 years. Therefore, the total energy savings over the life of the project are estimated at 18,000 kWh and 6,000 therms, totaling $9,000.

The implementation cost and savings related to this ECM are presented in Appendix L and summarized below:

ECM-10 Eliminate DHW Storage Tanks and Circulating Pump

Budgetary Cost	Annual Utility Savings				ROI	Potential Incentive*	Payback (without incentive)	Payback (with incentive)
	Electricity		Natural Gas	Total				
$	kW	kWh	Therms	$		$	Years	Years
900	0.1	600	200	300	9.00	N/A	3.0	N/A

* There is no incentive available through the New Jersey Smart Start Program for this ECM

This measure is recommended.

4.11 Potential Incentives

The North Brunswick Department of Public Works building energy conservation project may be eligible for incentives by the New Jersey Office of Clean Energy. The largest incentives available will be for the New Jersey Pay for Performance (P4P) Program. The P4P program is designed for qualified energy conservation projects in facilities that consume a minimum average electric demand of 200 kW per month (total of 12 months peak demand/12). Facilities that meet this criterion must also achieve a minimum performance target of 15% by using an approved simulation modeling tool before and after construction. Implementing all of the measures identified in this report will allow the building to achieve this reduction. To utilize this program, a P4P Partner would need to be engaged. The 200 kW/month average minimum has currently been eliminated, and this new incentive structure will be in effect until December 31, 2009.

Incentives for this program include the following:

- Incentive #1: The P4P Program pays $0.10 per square foot to a maximum of $50,000 or 50% of facility annual energy cost for the P4P Partner to develop an Energy Reduction Plan (ERP). This incentive is paid after approval of the ERP and signed Installation Agreement. Applicant must agree to commit to implementation of the ERP within 6 months or the incentive must be returned to the state. For the 18,400 square foot DPW Building this corresponds to $1,840.

- Incentive #2: Paid after installation of recommended measures; base incentives deliver $0.11/kWh and $1.10/therm not to exceed 30% of total project cost.

- Incentive #3: Paid after acceptance of Post-Construction Benchmarking Report showing energy savings over one year utilizing the approved simulation modeling tool and EPA Portfolio Manager. Incentive #3 base incentives deliver $0.07/kWh and $0.70/therm not to exceed 20% of total project cost.

Combining Incentives #2 and #3 will deliver a total of $0.18/ kWh and $1.80/therm not to exceed 50% of total project cost. Incentives for #2 and #3 are increased by $0.005/kWh and $0.05/therm for each percentage increase above the minimum performance target calculated with the approved simulation modeling tool, not to exceed 50% of total project cost.

Incentives are also available for perspective measures for various types of equipment under the New Jersey SmartStart Buildings incentive program. Perspective measures are paid after installation and no energy savings verification will be required. There are incentives available under this program for lighting fixture retrofits (ECM-1), the installation of occupancy sensors for lighting controls (ECM-2), and window air conditioning unit replacement (ECM-8) suggested in this study. These incentives were calculated utilizing the New Jersey SmartStart Building Equipment incentive program. This program provides incentives dependent upon the existing equipment type and proposed equipment retrofit measure. If the North Brunswick Department of Public Works building qualifies and enters into the New Jersey Pay for Performance Program, then the savings from the previously noted ECMs, which qualify for New Jersey SmartStart incentive program, will be included in total building energy usage and savings. Applicants cannot apply for both programs for the same project.

When calculating the total incentive for the New Jersey Pay For Performance program, all energy conservation measures are applicable as the amount received is based on building wide energy improvements. Since the overall energy reduction for the building is estimated to exceed the 15% minimum, the building is eligible to receive monies based on Incentives #2 and #3 as discussed above. This would result in a total incentive of about $43,300 thus reducing the total project payback from 8.3 years to 5.9 years. See Appendix M for calculations.

5.0 ALTERNATIVE ENERGY SCREENING EVALUATION

5.1 Geothermal

Geothermal heat pumps (GHP) transfer heat between the constant temperature of the earth and the building to maintain the building's interior space conditions. Below the surface of the earth throughout New Jersey the temperature remains in the low 50°F range throughout the year. This stable temperature provides a source for heat in the winter and a means to reject excess heat in the summer. With GHP systems, water is circulated between the building and the piping buried in the ground. The ground heat exchanger in a GHP system is made up of a closed or open loop pipe system. Most common is the closed loop in which high density polyethylene pipe is buried horizontally at 4-6 feet deep or vertically at 100 to 400 feet deep. These pipes are filled with an environmentally friendly antifreeze/water solution that acts as a heat exchanger. In the summer, the water picks up heat from the building and moves it to the ground. In the winter the system reverses and fluid picks up heat from the ground and moves it to the building. Heat pumps make collection and transfer of this heat to and from the building possible.

The building has a mixture of HVAC systems including a rooftop packaged heating and cooling unit serving the office area and unit heaters for heating only in the garage area. To take advantage of a GHP system, the building would have to install a low temperature closed loop water source heat pump system to realize the benefit of the consistent temperature of the ground. This will also include removal of the existing heating and cooling systems.

This measure is not recommended due to the high cost to replace the existing systems.

5.2 Solar

5.2.1 Photovoltaic Rooftop Solar Power Generation

The municipal building was evaluated for the potential to install rooftop photovoltaic (PV) solar panels for power generation. Present technology incorporates the use of solar cell arrays that produce direct current (DC) electricity. This DC current is converted to alternating current (AC) with the use of an electrical device known as an inverter. The building's roof has sufficient room to install a large solar cell array. A structural analysis would be required to determine if the roof framing could support a cell array.

The PVWATTS solar power generation model was utilized to calculate PV power generation. The New Jersey Clean Power Estimator provided by the New Jersey Clean Energy Program is presently being updated; therefore, the site recommended use of the PVWAT solar grid analyzer version 1. The closest city available in the model is Newark, New Jersey and a fixed tilt array type was utilized to calculate energy production. The PVWAT solar power generation model is provided in Appendix J.

The State of New Jersey incentives for non-residential PV applications is $1.00/watt up to 50 kW of installed PV array. Federal tax credits are also available for renewable energy projects up to 30% of installation cost. Municipalities do not pay federal taxes; therefore, would not be able to utilize the federal tax credit incentive.

Installation of (PV) arrays in the state New Jersey will allow the owner to participate in the New Jersey solar renewable energy certificates program (SREC). This is a program that has been set up to allow entities with large amounts of environmentally unfriendly emissions to purchase credits from zero emission (PV) solar-producers. An alternative compliance penalty (ACP) is paid for by the high emission producers and is set each year on a declining scale of 3% per year. One SREC credit is equivalent to

1000 kilowatt hours of PV electrical production; these credits can be traded for period of 15 years from the date of installation. The cost of the ACP penalty for 2009 is $689; this is the amount that must be paid per SERC by the high emission producers. The expected dollar amount that will be paid to the PV producer for 2009 is expected to be $600/SREC credit. Payments that will be received from the PV producer will change from year to year dependent upon supply and demand. Renewable Energy Consultants is a third party SREC broker that has been approved by the New Jersey Clean Energy Program. As stated above there is no definitive way to calculate an exact price that will be received by the PV producer per SREC over the next 15 years. Renewable Energy Consultants estimated an average of $487/ SERC per year and this number was utilized in the cash flow for this report.

The building had a maximum kW demand of 45 kW and a minimum kW of 26 kW over the previous 12 months. The monthly average over the observed 12 month period was 34 kW. The facility's existing load will not justify the use of the maximum incentive cap of 50 kW of installed PV solar array; therefore, a 20 kW system size was selected for the calculations. The system costs for PV installations were derived from the most recent NYSERDA (New York State Energy Research and Development Agency) estimates of total cost of system installation. It should be noted that the cost of installation is currently $10 per watt or $10,000 per kW of installed system. This has increased in the past few years due to the rise in national demand for PV power generator systems. Other cost considerations will also need to be considered. PV panels have an approximate 20 year life span; however, the inverter device that converts DC electricity to AC has a life span of 10 to 12 years and will need to be replaced multiple times during the useful life of the PV system.

Photovoltaic (PV) Rooftop Solar Power Generation – 20 kW System

Budgetary Cost	Annual Utility Savings				Total Savings	New Jersey Renewable Energy Incentive*	New Jersey Renewable SREC**	Payback (without incentive)	Payback (with incentives)
	Electricity		Natural Gas	Total					
$	kW	kWh	Therms	$	$	$	$	Years	Years
200,000	0	23,700	0	3,800	3,800	20,000	11,500	>30	10.2

*Incentive based on New Jersey Renewable Energy Program for non-residential applications of $1.00 per Watt of installed capacity
** Estimated Solar Renewable Energy Certificate Program (SREC) for 15 years at $487/1000 kWh

This measure is not recommended at this time due to the long payback period; however, it could be a potentially viable renewable measure for the town to consider in the future if electricity rates continue to increase and if PV installation costs decline below $10 per watt.

5.2.2 Solar Thermal Domestic Hot Water Plant

Active solar thermal systems use solar collectors to gather the sun's energy to heat water, another fluid, or air. An absorber in the collector converts the sun's energy into heat. The heat is then transferred by circulating water, antifreeze, or sometimes air to another location for immediate use or storage for later utilization. Applications for active solar thermal energy include providing hot water, heating swimming pools, space heating, and preheating air in residential and commercial buildings.

A standard solar hot water system is typically composed of solar collectors, heat storage vessel, piping, circulators, and controls. Systems are typically integrated to work alongside a conventional heating system that provides heat when solar resources are not sufficient. The solar collectors are usually placed on the roof of the building, oriented south, and tilted around the site's latitude, to maximize the amount of radiation collected on a yearly basis.

Several options exist for using active solar thermal systems for space heating. The most common method involves using glazed collectors to heat a liquid held in a storage tank (similar to an active solar hot water system). The most practical system for the North Brunswick DPW building would transfer the heat from the panels to thermal storage tanks and transfer solar produced thermal energy to use for domestic hot water production. DHW is presently produced by a natural gas fired water heater and, therefore, this measure would not save site electricity.

Currently, an incentive is not available for installation of thermal solar systems. A Federal tax credit of 30% of installation cost for the thermal applications is available; however, the Township of North Brunswick does not pay Federal taxes and, therefore, would not benefit from this program.

The implementation cost and savings related to this ECM are presented in Appendix N and summarized as follows:

Solar Thermal Domestic Hot Water Plant

Budgetary Cost	Annual Utility Savings				Total Savings	New Jersey Renewable Energy Incentive	Payback (without incentive)	Payback (with incentive)
	Electricity		Natural Gas	Total				
$	kW	kWh	Therms	$	$	$	Years	Years
25,000	0	0	600	800	800	N/A	>30	N/A

* No incentive is available in New Jersey at this time.

This measure is not recommended.

5.3 Wind

Small wind turbines use a horizontal axis propeller, or rotor, to capture the kinetic energy of the wind and convert it into rotary motion to drive a generator which usually is designed specifically for the wind turbine. The rotor consists of two or three blades, usually made from wood or fiberglass. These materials give the turbine the needed strength and flexibility, and have the added advantage of not interfering with television signals. The structural backbone of the wind turbine is the mainframe, and includes the slip-rings that connect the wind turbine, which rotates as it points into changing wind directions, and the fixed tower wiring. The tail aligns the rotor into the wind.

To avoid turbulence and capture greater wind energy, turbines are mounted on towers. Turbines should be mounted at least 30 feet above any structure or natural feature within 300 feet of the installation. Smaller turbines can utilize shorter towers. For example, a 250-watt turbine may be mounted on a 30-50 foot tower, while a 10 kW turbine will usually need a tower of 80-120 feet. Tower designs include tubular or latticed, guyed or self-supporting. Wind turbine manufacturers also provide towers.

The New Jersey Clean Energy Program for small wind installations has designated numerous pre-approved wind turbines for installation in the State of New Jersey. Incentives for wind turbine installations are based on kilowatt hours saved in the first year. Systems sized under 16,000 kWh per year of production will receive a $3.20 per kWh incentive. Systems producing over 16,000 kWh will receive $51,200 for the first 16,000 kWh of production with an additional $0.50 per kWh up to a maximum cap of 750,000 kWh per year. Federal tax credits are also available for renewable energy projects up to 30% of installation cost for systems less than 100 kW. However, as noted previously, municipalities do not pay federal taxes and is, therefore, not eligible for the tax credit incentive.

The most important part of any small wind generation project is the mean annual wind speed at the height of which the turbine will be installed. In the North Brunswick area, the map indicates a mean annual wind speed of 10 miles per hour. For the DPW building, there are site restrictions. Parking lots, trees and local residential housing would greatly affect a tower location.

An aerial satellite image of the municipal site and wind speed map is included in Appendix O.

This measure is not recommended due to the low mean annual wind speed.

5.4 Combined Heat and Power Generation (CHP)

Combined heat and power, cogeneration, is self-production of electricity on-site with beneficial recovery of the heat byproduct from the electrical generator. Common CHP equipment includes reciprocating engine-driven, micro turbines, steam turbines, and fuel cells. Typical CHP customers include industrial, commercial, institutional, educational institutions, and multifamily residential facilities. CHP systems that are commercially viable at the present time are sized approximately 50 kW and above, with numerous options in blocks grouped around 300 kW, 800 kW, 1,200 kW and larger. Typically, CHP systems are used to produce a portion of the electricity needed by a facility some or all of the time, with the balance of electric needs satisfied by purchase from the grid.

Any proposed CHP project will need to consider many factors, such as existing system load, use of thermal energy produced, system size, natural gas fuel availability, and proposed plant location.

The North Brunswick DPW building had a maximum kW demand of 45 kW and a minimum kW of 26 kW over the previous 12 months. The monthly average over the observed 12 month period was 34 kW. The DPW building does not have need for electrical generation at the minimum cost viable level of 50 kW nor the ability to use most of the thermal byproduct during the winter. Thermal usage during the summer months is low, and thermal energy produced by the CHP plant will be wasted.

The most viable option for a CHP plant would be a reciprocating engine natural gas-fired unit. However, since the DPW building is located in a residential area, noise may be an issue.

This measure is not recommended.

5.5 Biomass Power Generation

Biomass power generation is a process in which waste organic materials are used to produce electricity or thermal energy. These materials would otherwise be sent to the landfill or expelled to the atmosphere. To participate in NJCEP's Customer On-Site Renewable Energy program, participants must install an on-site sustainable biomass or fuel cell energy generation system. Incentives for bio-power installations are available to support up to 1MW-dc of rated capacity.

*Class I organic residues are eligible for funding through the NJCEP CORE program. Class I wastes include the following renewable supply of organic material:

- Wood wastes not adulterated with chemicals, glues or adhesives
- Agricultural residues (corn stover, rice hulls or nut shells, manures, poultry litter, horse manure, etc) and/or methane gases from landfills
- Food wastes

- Municipal tree trimming and grass clipping wastes

- Paper and cardboard wastes
- Non adulterated construction wood wastes, pallets

The NJDEP evaluates biomass resources not identified in the RPS.

Examples of eligible facilities for a CORE incentive include:

- Digestion of sewage sludge
- Landfill gas facilities
- Combustion of wood wastes to steam turbine
- Gasification of wood wastes to reciprocating engine
- Gasification or pyrolysis of bio-solid wastes to generation equipment

* from NJOCE Website

This measure is not recommended because of noise issues, and potential zoning issues.

5.6 Demand Response Curtailment

Presently, electricity is delivered by PSE&G, which receives the electricity from regional power grid RFC. PSE&G is the regional transmission organization (RTO) that coordinates the movement of wholesale electricity in all or parts of 13 states and the District of Columbia including the State of New Jersey.

Utility Curtailment is an agreement with the PSE&G regional transmission organization and an approved Curtailment Service Provider (CSP) to shed electrical load by either turning major equipment off or energizing all or part of a facility utilizing an emergency generator; therefore, reducing the electrical demand on the utility grid. This program is to benefit the utility company during high demand periods and PJM offers incentives to the CSP to participate in this program. Enrolling in the program will require program participants to drop electrical load or turn on emergency generators during high electrical demand conditions or during emergencies. Part of the program also will require that program participants reduce their required load or run emergency generators with notice to test the system.

A PSE&G pre-approved CSP will require a minimum of 100 kW of load reduction to participate in any curtailment program. The North Brunswick DPW Building had a monthly average kW demand of 34 kW and a maximum demand of 45 kW over the previous 12 months.

This measure is not recommended because the facility does not have adequate load to meet the required minimum load reduction.

6.0 EPA PORTFOLIO MANAGER

The United States Energy Protection Agency (EPA) is a federal agency in charge of regulating environment waste and policy in the United States. The EPA has released the EPA Portfolio Manager for public use. The program is designed to allow property owners and managers to share, compare and improve upon their facility's energy consumption. Inputting such parameters at electricity, heating fuel, building characteristics and location into the website based program generates a naturalized energy rating score out of 100. Once an account is registered, monthly utility data can be entered to track the savings progress and retrieve an updated energy rating score on a monthly basis.

The DPW building includes areas for DPW office employees, vehicle repair/service and equipment storage and, therefore, does not fall under the listed space description categories needed to generate a full report and provide an energy star rating. The portfolio manager did provide energy intensity ratings of a site intensity of 137 kBtu/ft^2 and a source intensity of 194 kBtu/ft^2.

Reducing energy loss associated with lighting retrofit, occupancy sensor installation, applying night setback, equipment replacement, and DHW storage tank elimination will reduce the energy intensity. If all the recommended measures are implemented, it is projected that the site energy intensity would lower to 97 kBtu/ft^2 and the source energy intensity would lower to 137 kBtu/ft^2.

Information regarding the Energy Star Portfolio Manager is located in Appendix Q. The user name and password for the DPW Building's EPA Portfolio Manager Account was given to Glen Sandor, Director of Public Works.

7.0 CONCLUSIONS & RECOMMENDATIONS

The energy audit conducted by CHA at the North Brunswick Department of Public Works, in North Brunswick, New Jersey identified potential ECMs for lighting retrofits with occupancy sensors, night setback, photocells for outdoor lighting, and elimination of domestic hot water storage tanks and circulating pump. Potential annual savings of $15,200 may be realized for the recommended ECMs, with a summary of the costs, savings, and paybacks as follows:

ECM-3 T-12 Lighting Retrofit with Occupancy Sensors

Budgetary Cost	Annual Utility Savings					Potential Incentive*	Payback (without incentive)	Payback (with incentive)
	Electricity		Natural Gas	Total	ROI			
$	kW	kWh	Therms	$		$	Years	Years
14,200	4.9	15,600	0	2,600	1.8	1,700	5.6	4.9

* Incentive shown is per the New Jersey Smart Start Program, 2009 Lighting Controls Application. Incentive is based on the use of 11 wall-mounted, occupancy sensors. Incentive is based on the following: retrofitting 60, two-lamp T-12 fixtures < 250 watt with T-8 lamps; and retrofitting 48, three-lamp T-12 fixtures < 250 watt with T-8 lamps.

ECM-4 Use of Photocells for Pump Station Lighting

Budgetary Cost	Annual Utility Savings					Potential Incentive*	Payback (without incentive)	Payback (with incentive)
	Electricity		Natural Gas	Total	ROI			
$	kW	kWh	Therms	$		$	Years	Years
200	-	3,300	0	500	36.50	N/A	0.4	N/A

* There is no incentive available through the New Jersey Smart Start Program for this ECM.

ECM-5 Apply Night Setback to Mechanical Systems

Budgetary Cost	Annual Utility Savings					Potential Incentive*	Payback (without incentive)	Payback (with incentive)
	Electricity		Natural Gas	Total	ROI			
$	kW	kWh	Therms	$		$	Years	Years
7,400	-	1,100	1,700	2,600	4.3	N/A	2.8	N/A

* There is no incentive available through the New Jersey Smart Start Program for this ECM.

ECM-6 Replace Unit Heaters with Infrared Heaters

Budgetary Cost	Annual Utility Savings					Potential Incentive*	Payback (without incentive)	Payback (with incentive)
	Electricity		Natural Gas	Total	ROI			
$	kW	kWh	Therms	$		$	Years	Years
40,000	10.1	21,900	3,900	9,200	3.6	N/A	4.3	N/A

* There is no incentive available through the New Jersey Smart Start Program for this ECM.

ECM-10 Eliminate DHW Storage Tanks and Circulating Pump

Budgetary Cost	Annual Utility Savings					Potential Incentive*	Payback (without incentive)	Payback (with incentive)
	Electricity		Natural Gas	Total	ROI			
$	kW	kWh	Therms	$		$	Years	Years
900	0.1	600	200	300	9.00	N/A	3.0	N/A

* There is no incentive available through the New Jersey Smart Start Program for this ECM

APPENDIX A

Utility Usage Analysis

New Jersey BPU Energy Audit Program
CHA #20418
Building: North Brunswick Township DPW Building

Account Number: 62 864 489 18 Meter Number: 278005261 Rate: GLP
Public Service Electric & Gas Company (PSE&G)
Service: Garage & Office Building

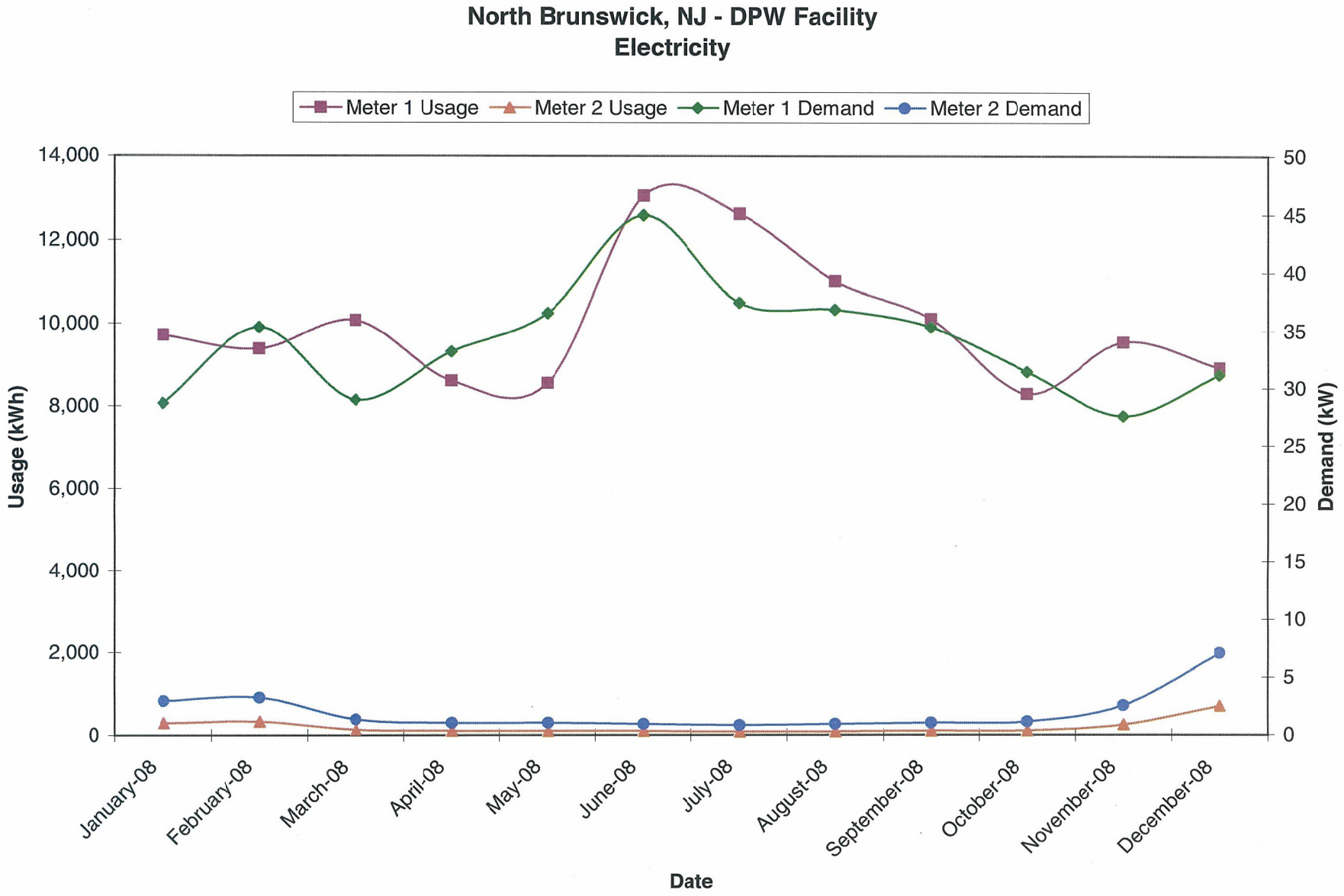
Electricity						
Period	kWh	kW	Cost	Demand Unit Cost	Supply Unit Cost	Blended Rate
			($)	($/kW)	($/kWh)	($/kWh)
Jan-08	9,720	28.80	1,244.07	6.61	0.1080	0.1280
Feb-08	9,390	35.40	1,268.28	6.11	0.1116	0.1351
Mar-08	10,080	29.10	1,290.81	6.59	0.1086	0.1281
Apr-08	8,610	33.30	1,131.41	6.25	0.1067	0.1314
May-08	8,550	36.60	1,151.06	6.04	0.1083	0.1346
Jun-08	13,050	45.00	2,538.55	15.62	0.1403	0.1945
Jul-08	12,630	37.50	2,439.28	16.62	0.1434	0.1931
Aug-08	11,010	36.90	2,268.50	16.71	0.1496	0.2060
Sep-08	10,110	35.40	2,054.51	16.95	0.1434	0.2032
Oct-08	8,280	31.50	1,291.71	10.49	0.1156	0.1560
Nov-08	9,540	27.60	1,393.96	11.43	0.1126	0.1461
Dec-08	8,910	31.20	1,324.32	10.56	0.1112	0.1486
Total	119,880	45.00	19,396.46		0.1235	0.1618
Monthly Ave.	9,990	34.03	1,616.37	10.83		

Electricity												
Sevice Charge	Annual Demand kW	Summer Demand kW	Delivery kWh	Societal Benefits kWh	Securitization Transition kWh	Delivery Total	Generation kW	Transmission kW	Supply kWh	Supply Total		Total
$4.24	$112.15	$0.00	$69.35	$58.19	$97.08	$341.01	$28.49	$49.83	$824.74	$903.06		$1,244.07
$4.24	$137.85	$0.00	$66.99	$56.22	$93.79	$359.09	$28.49	$50.00	$830.70	$909.19		$1,268.28
$4.24	$113.32	$0.00	$71.92	$60.35	$100.68	$350.51	$28.49	$50.00	$861.81	$940.30		$1,290.81
$4.24	$129.67	$0.00	$61.43	$51.55	$85.99	$332.88	$28.49	$50.00	$720.04	$798.53		$1,131.41
$4.24	$142.52	$0.00	$61.00	$51.19	$85.40	$344.35	$28.49	$50.00	$728.22	$806.71		$1,151.06
$4.24	$175.23	$325.22	$170.50	$78.13	$130.34	$883.66	$152.39	$49.97	$1,452.53	$1,654.89		$2,538.55
$4.24	$146.03	$271.01	$165.01	$75.62	$126.15	$788.06	$156.38	$49.97	$1,444.87	$1,651.22		$2,439.28
$4.24	$143.69	$266.68	$143.84	$65.92	$109.97	$734.34	$156.38	$49.97	$1,327.81	$1,534.16		$2,268.50
$4.24	$137.85	$255.84	$132.09	$60.53	$100.98	$691.53	$156.38	$49.97	$1,156.63	$1,362.98		$2,054.51
$4.24	$122.66	$0.00	$69.08	$49.81	$82.70	$318.49	$155.76	$52.09	$765.37	$973.22		$1,291.71
$4.24	$107.48	$0.00	$68.07	$63.10	$95.28	$338.17	$155.74	$52.17	$847.88	$1,055.79		$1,393.96
$4.24	$121.50	$0.00	$71.66	$64.67	$88.99	$351.06	$155.74	$52.17	$765.35	$973.26		$1,324.32
$50.88	$1,589.95	$1,118.75	$1,140.94	$735.28	$1,197.35	$5,833.15	$1,231.22	$606.14	$11,725.95	$13,563.31		

Account Number: 62 859 461 59 Meter Number: 126764283 Rate: GLP
Public Service Electric & Gas Company (PSE&G)
Service: Salt Storge Building

Electricity						
Period	kWh	kW	Cost	Demand Unit Cost	Supply Unit Cost	Blended Rate
			($)	($/kW)	($/kWh)	($/kWh)
Jan-08	300	3.00	50.15	3.89	0.1080	0.1672
Feb-08	334	3.30	56.18	4.45	0.1115	0.1682
Mar-08	135	1.40	26.20	5.21	0.1087	0.1941
Apr-08	112	1.10	22.32	5.56	0.1068	0.1993
May-08	109	1.10	22.14	5.56	0.1081	0.2031
Jun-08	104	1.00	34.69	15.86	0.1403	0.3336
Jul-08	90	0.90	31.98	16.48	0.1434	0.3553
Aug-08	95	1.00	34.41	15.95	0.1497	0.3622
Sep-08	114	1.10	37.64	15.51	0.1433	0.3302
Oct-08	119	1.20	27.54	7.95	0.1156	0.2314
Nov-08	264	2.60	48.59	5.77	0.1112	0.1841
Dec-08	713	7.10	118.65	4.60	0.1147	0.1664
Total	2,489	7.10	510.49		0.1091	0.2051
Monthly Ave.	207	2.07	42.54	8.90		

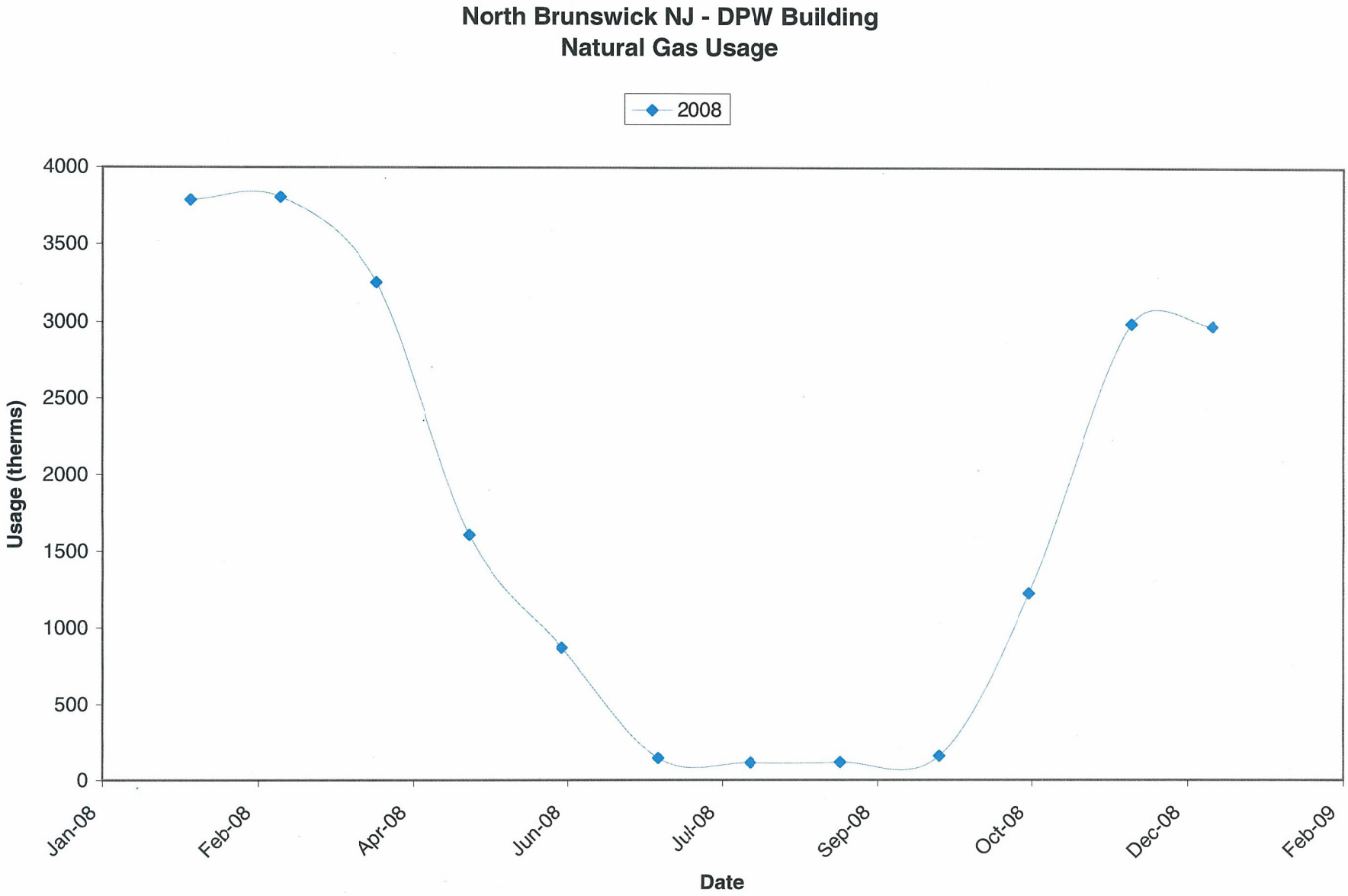
Electricity												
Sevice Charge	Annual Demand kW	Summer Demand kW	On-peak kWh	Societal Benefits kWh	Securitization Transition kWh	Delivery Total	Generation kW	Transmission kW	Supply kWh	Supply Total		Total
$4.24	$11.68	$0.00	$2.15	$1.80	$2.99	$22.86	$0.66	$1.18	$25.45	$27.29		$50.15
$4.24	$12.85	$0.00	$2.38	$2.00	$3.33	$24.80	$0.66	$1.18	$29.54	$31.38		$56.18
$4.24	$5.45	$0.00	$0.97	$0.81	$1.35	$12.82	$0.66	$1.18	$11.54	$13.38		$26.20
$4.24	$4.28	$0.00	$0.80	$0.67	$1.12	$11.11	$0.66	$1.18	$9.37	$11.21		$22.32
$4.24	$4.28	$0.00	$0.77	$0.65	$1.08	$11.02	$0.66	$1.18	$9.28	$11.12		$22.14
$4.24	$3.89	$7.23	$1.35	$0.62	$1.04	$18.37	$3.56	$1.18	$11.58	$16.32		$34.69
$4.24	$3.50	$6.50	$1.18	$0.54	$0.90	$16.86	$3.65	$1.18	$10.29	$15.12		$31.98
$4.24	$3.89	$7.23	$1.24	$0.57	$0.95	$18.12	$3.65	$1.18	$11.46	$16.29		$34.41
$4.24	$4.28	$7.95	$1.48	$0.68	$1.14	$19.77	$3.65	$1.18	$13.04	$17.87		$37.64
$4.24	$4.67	$0.00	$0.85	$0.72	$1.19	$11.67	$3.64	$1.23	$11.00	$15.87		$27.54
$4.24	$10.12	$0.00	$2.12	$1.92	$2.64	$21.04	$3.64	$1.23	$22.68	$27.55		$48.59
$4.24	$27.65	$0.00	$6.00	$5.35	$7.33	$50.57	$3.63	$1.35	$63.10	$68.08		$118.65
$50.88	$96.54	$28.91	$21.29	$16.33	$25.06	$239.01	$28.72	$14.43	$228.33	$271.48		


North Brunswick, NJ - DPW Facility
Electricity
Meter 1 Usage
Meter 2 Usage
Meter 1 Demand
Meter 2 Demand
Usage (kWh)
Demand (kW)
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
50
45
40
35
30
25
20
15
10
5
0
January-08
February-08
March-08
April-08
May-08
June-08
July-08
August-08
September-08
October-08
November-08
December-08
Date

New Jersey BPU Energy Audit Program
CHA #20418
Building: North Brunswick Township DPW Building

Account Number: 62 864 489 18 Meter Number: 2284005 Rate: LVG
Public Service Electric & Gas Company (PSE&G) Delivery & Supply

Natural Gas										
Delivery								Supply		
Period	Service Charge	Therms	Distribution	Demand	Balancing Charge	Societal Benefits	Total Demand	Total Supply	Total Cost	Blended Cost $/therm
Jan-08	$91.89	3,787.440	$189.60	$529.65	$347.66	$146.91	$1,305.71	$3,728.08	$5,033.79	
Feb-08	$91.89	3,805.656	$190.40	$460.50	$350.43	$147.62	$1,240.84	$4,102.59	$5,343.43	
Mar-08	$91.89	3,253.234	$166.07	$460.50	$295.90	$126.19	$1,140.55	$3,859.74	$5,000.29	
Apr-08	$91.89	1,608.880	$93.66	$0.00	$0.00	$62.40	$247.95	$2,018.66	$2,266.61	
May-08	$91.89	872.455	$58.31	$0.00	$0.00	$33.84	$184.04	$1,253.61	$1,437.65	
Jun-08	$91.89	146.973	$9.82	$0.00	$0.00	$5.71	$107.42	$222.11	$329.53	
Jul-08	$91.89	117.084	$7.83	$0.00	$0.00	$4.54	$104.26	$192.48	$296.74	
Aug-08	$91.89	119.521	$7.99	$0.00	$0.00	$4.63	$104.51	$145.67	$250.18	
Sep-08	$91.89	161.147	$10.77	$0.00	$0.00	$6.25	$108.91	$181.89	$290.80	
Oct-08	$91.89	1,228.340	$76.90	$0.00	$0.00	$48.66	$217.45	$1,253.15	$1,470.60	
Nov-08	$91.89	2,988.541	$154.42	$460.50	$272.20	$131.08	$1,110.09	$2,772.74	$3,882.83	
Dec-08	$91.89	2,971.272	$153.65	$460.50	$274.40	$141.39	$1,121.83	$2,872.84	$3,994.67	
		21,060.543					$6,993.56	$22,603.56	$29,597.12	$1.41


North Brunswick NJ - DPW Building
Natural Gas Usage
2008
4000
3500
3000
2500
2000
1500
1000
500
0
Usage (therms)
Jan-08
Feb-08
Apr-08
Jun-08
Jul-08
Sep-08
Oct-08
Dec-08
Feb-09
Date

APPENDIX B

ECM-1 Retrofit T-12 Lighting Fixtures

Energy Audit of North Brunswick Township

CHA Project No. 20418 DPW Building

ECM-1 Lighting Retrofit

Supply Cost of Electricity: **$0.124 $/kWh**

Demand Cost: **$10.83 $/kW**

		EXISTING CONDITIONS							RETROFIT CONDITIONS							COST & SAVINGS ANALYSIS					
	Area Description	**No. of Fixtures**	**NYSERDA Fixture Code**	**Watts per Fixture**	**kW/Space**	**Exist Control**	**Annual Hours**	**Annual kWh**	**Number of Fixtures**	**Fixture Code**	**Watts per Fixture**	**kW/Space**	**Exist Control**	**Annual Hours**	**Annual kWh**	**Annual kWh Saved**	**Annual $ Saved**	**Retrofit Cost**	**NJ Lighting Incentive**	**Simple Payback With Out Incentive**	**Simple Payback**
Field Code	Unique description of the location - Room number/Room name: Floor number (if applicable)	No. of fixtures before the retrofit	Code from Table of Standard Fixture Wattages	Value from Table of Standard Fixture Wattages	(Watts/Fixt) * (Fixt No.)	Pre-inst. control device	Estimated daily hours for the usage group	(kW/space) * (Annual Hours)	No. of fixtures after the retrofit	Code from Table of Standard Fixture Wattages	Value from Table of Standard Fixture Wattages	(Watts/Fixt) * (Number of Fixtures)	Retrofit control device	Estimated annual hours for the usage group	(kW/space) * (Annual Hours)	(Original Annual kWh) - (Retrofit Annual kWh)	(kWh Saved) * ($/kWh)	Cost for renovations to lighting system	Prescriptive Lighting Measures	Length of time for renovations cost to be recovered	Length of time for renovations cost to be recovered
	DPW Building - Interior																				
2	Garage Storage Area	29	F42SE	86	2.5	SW	2730	6,809	29	F42GL	63	1.8	SW	2,730	4,988	1,821	$ 312	$ 3,081	$290	9.9	9.0
2	Garage Vehilce Repair Area	19	F42SE	86	1.6	SW	2730	4,461	19	F42GL	63	1.2	SW	2,730	3,268	1,193	$ 204	$ 2,019	$190	9.9	9.0
6	Men's Locker Rm	4	F43SS	151	0.6	SW	2730	1,649	4	F43LL-R	76	0.3	SW	2,730	830	819	$ 140	$ 525	$80	3.7	3.2
4	Men's Bathroom	2	F42SE	86	0.2	SW	2730	470	2	F42LL-R	54	0.1	SW	2,730	295	175	$ 30	$ 203	$20	6.8	6.1
4	Women's Bathroom	2	F42SE	86	0.2	SW	2730	470	2	F42LL-R	54	0.1	SW	2,730	295	175	$ 30	$ 203	$20	6.8	6.1
6	Lunch Rm	2	F43SS	151	0.3	SW	2730	824	2	F43LL-R	76	0.2	SW	2,730	415	410	$ 70	$ 263	$40	3.7	3.2
6	Conference Rm	6	F43SS	151	0.9	SW	2340	2,120	6	F43LL-R	76	0.5	SW	2,340	1,067	1,053	$ 189	$ 788	$120	4.2	3.5
6	South Wall Offices	6	F43SS	151	0.9	SW	2340	2,120	6	F43LL-R	76	0.5	SW	2,340	1,067	1,053	$ 189	$ 788	$120	4.2	3.5
6	Supvs Office	4	F43SS	151	0.6	SW	2730	1,649	4	F43LL-R	76	0.3	SW	2,730	830	819	$ 140	$ 525	$80	3.7	3.2
6	Open Office Area	26	F43SS	151	3.9	SW	2340	9,187	26	F43LL-R	76	2.0	SW	2,340	4,624	4,563	$ 817	$ 3,413	$520	4.2	3.5
4	Lunch Room Hallway	2	F42SE	86	0.2	SW	2730	470	2	F42LL-R	54	0.1	SW	2,730	295	175	$ 30	$ 203	$20	6.8	6.1
	Total	**102**			**11.9**			**30,227**	**102**		**744**	**7**			**17,973**	**12,255**	**$2,150**	**$12,008**	**$1,500**		
															Demand Savings		**4.9**	**$636**			
															kWh Savings		**12,255**	**$1,513**			
															Total savings			**$2,150**		**5.6**	**4.9**

APPENDIX C

ECM-2 Install Occupancy Sensors for Interior Lighting

Energy Audit of North Brunswick Township

CHA Project No. 20418 DPW Building

ECM-2 Install Motion Sensors

Supply Cost of Electricity: **$0.124 $/kWh**

Demand Cost: **$10.83 $/kW**

									RETROFIT CONDITIONS							COST & SAVINGS ANALYSIS					
	Area Description	**No. of Fixtures**	**NYSERDA Fixture Code**	**Watts per Fixture**	**kW/Space**	**Exist Control**	**Annual Hours**	**Annual kWh**	**Number of Fixtures**	**Fixture Code**	**Watts per Fixture**	**kW/Space**	**Retrofit Control**	**Annual Hours**	**Annual kWh**	**Annual kWh Saved**	**Annual $ Saved**	**Retrofit Cost**	**NJ Lighting Incentive**	**Simple Payback With Out Incentive**	**Simple Payback**
Field Code	Unique description of the location - Room number/Room name: Floor number (if applicable)	No. of fixtures before the retrofit	Code from Table of Standard Fixture Wattages	Value from Table of Standard Fixture Wattages	(Watts/Fixt) * (Fixt No.)	Pre-Inst. control device	Estimated annual hours for the usage group	(kW/space) * (Annual Hours)	No. of fixtures after the retrofit	Code from Table of Standard Fixture Wattages	Value from Table of Standard Fixture Wattages	(Watts/Fixt) * (Number of Fixtures)	Retrofit control device	Estimated annual hours for the usage group	(kW/space) * (Annual Hours)	(Original Annual kWh) - (Retrofit Annual kWh)	(kW Saved) * ($/kWh)	Cost for renovations to lighting system		Length of time for renovations cost to be recovered	Length of time for renovations cost to be recovered
	DPW Building - Interior																				
2	Garage Storage Area	29	F42SE	86	2.5	SW	2730	6,808.6	29	F42SE	86	2.5	C-OCC	2080	5,188	1,621	$ 200	$447	$35	2.2	2.1
2	Garage Vehilce Repair Area	19	F42SE	86	1.6	SW	2730	4,460.8	19	F42SE	86	1.6	None	2730	4,461	0	$ -	$0	$0		
6	Men's Locker Rm	4	F43SS	151	0.6	SW	2730	1,648.9	4	F43SS	151	0.6	OCC	1040	628	1,021	$ 126	$224	$20	1.8	1.6
4	Men's Bathroom	2	F42SE	86	0.2	SW	2730	469.6	2	F42SE	86	0.2	OCC	1040	179	291	$ 36	$224	$20	6.2	5.7
4	Women's Bathroom	2	F42SE	86	0.2	SW	2730	469.6	2	F42SE	86	0.2	OCC	1040	179	291	$ 36	$224	$20	6.2	5.7
6	Lunch Rm	2	F43SS	151	0.3	SW	2730	824.5	2	F43SS	151	0.3	OCC	1040	314	510	$ 63	$224	$20	3.6	3.2
6	Conference Rm	6	F43SS	151	0.9	SW	2340	2,120.0	6	F43SS	151	0.9	OCC	1040	942	1,178	$ 145	$224	$20	1.5	1.4
6	South Wall Offices	6	F43SS	151	0.9	SW	2340	2,120.0	6	F43SS	151	0.9	OCC	2080	1,884	236	$ 29	$224	$20	7.7	7.0
6	Supvs Office	4	F43SS	151	0.6	SW	2730	1,648.9	4	F43SS	151	0.6	OCC	2080	1,256	393	$ 48	$224	$20	4.6	4.2
6	Open Office Area	26	F43SS	151	3.9	SW	2340	9,186.8	26	F43SS	151	3.9	None	2340	9,187	0	$ -	$0	$0		
4	Lunch Room Hallway	2	F42SE	86	0.2	SW	2730	469.6	2	F42SE	86	0.2	OCC	1560	268	201	$ 25	$224	$20	9.0	8.2
	Total	**102**			**11.9**			**30,227**	**102**			**12**			**24,487**	**5,741**	**$ 709**	**$2,239**	**$195**		
															Demand Savings		**0.0**	**$0**			
															kWh Savings		**5,741**	**$709**			
															Total Savings			**$709**		**3.2**	**2.9**

APPENDIX D

ECM-3 Lighting Retrofits with Occupancy Sensors

Energy Audit of North Brunswick Township

CHA Project No. 20418 DPW Building

ECM-3 Lighting Retrofit with Occupancy Sensors

Supply Cost of Electricity: $0.124 $/kWh

Demand Cost: $10.83 $/kW

		EXISTING CONDITIONS							RETROFIT CONDITIONS							COST & SAVINGS ANALYSIS					
	Area Description	**No. of Fixtures**	**NYSERDA Fixture Code**	**Watts per Fixture**	**kW/Space**	**Exist Control**	**Annual Hours**	**Annual kWh**	**No. of Fixtures**	**Fixture Code**	**Watts per Fixture**	**kW/Space**	**Retrofit Control**	**Annual Hours**	**Annual kWh**	**Annual kWh Saved**	**Annual $ Saved**	**Retrofit Cost**	**NJ Lighting Incentive**	**Simple Payback With Out Incentive**	**Simple Payback**
Field Code	Unique description of the location - Room number/Room name: Floor number (if applicable)	No. of fixtures before the retrofit	Code from Table of Standard Fixture Wattages	Value from Table of Standard Fixture Wattages	(Watts/Fixt) * (Fixt No.)	Pre-inst. control device	Estimated annual hours for the usage group	(kW/space) * (Annual Hours)	No. of fixtures after the retrofit	Code from Table of Standard Fixture Wattages	Value from Table of Standard Fixture Wattages	(Watts/Fixt) * (Number of Fixtures)	Retrofit control device	Estimated annual hours for the usage group	(kW/space) * (Annual Hours)	(Original Annual kWh) - (Retrofit Annual kWh)	(kW Saved) * ($/kWh)	Cost for renovations to lighting system		Length of time for renovations cost to be recovered	Length of time for renovations cost to be recovered
	DPW Building - Interior																				
2	Garage Storage Area	29	F42SE	86	2.5	SW	2730	6,809	29	F42GL	63	1.8	C-OCC	2,080	3,800	3,008	$ 458	$ 3,528	$ 325	7.7	7.0
2	Garage Vehilce Repair Area	19	F42SE	86	1.6	SW	2730	4,461	19	F42GL	63	1.2	None	2,730	3,268	1,193	$ 204	$ 2,019	$ 190	9.9	9.0
6	Men's Locker Rm	4	F43SS	151	0.6	SW	2730	1,649	4	F43LL-R	76	0.3	OCC	1,040	316	1,333	$ 204	$ 749	$ 100	3.7	3.2
4	Men's Bathroom	2	F42SE	86	0.2	SW	2730	470	2	F42LL-R	54	0.1	OCC	1,040	112	357	$ 52	$ 427	$ 40	8.1	7.4
4	Women's Bathroom	2	F42SE	86	0.2	SW	2730	470	2	F42LL-R	54	0.1	OCC	1,040	112	357	$ 52	$ 427	$ 40	8.1	7.4
6	Lunch Rm	2	F43SS	151	0.3	SW	2730	824	2	F43LL-R	76	0.2	OCC	1,040	158	666	$ 102	$ 487	$ 60	4.8	4.2
6	Conference Rm	6	F43SS	151	0.9	SW	2340	2,120	6	F43LL-R	76	0.5	OCC	1,040	474	1,646	$ 262	$ 1,012	$ 140	3.9	3.3
6	South Wall Offices	6	F43SS	151	0.9	SW	2340	2,120	6	F43LL-R	76	0.5	OCC	2,080	948	1,172	$ 203	$ 1,012	$ 140	5.0	4.3
6	Supvs Office	4	F43SS	151	0.6	SW	2730	1,649	4	F43LL-R	76	0.3	OCC	2,080	632	1,017	$ 165	$ 749	$ 100	4.6	3.9
6	Open Office Area	26	F43SS	151	3.9	SW	2340	9,187	26	F43LL-R	76	2.0	None	2,340	4,624	4,563	$ 817	$ 3,413	$ 520	4.2	3.5
4	Lunch Room Hallway	2	F42SE	86	0.2	SW	2730	470	2	F42LL-R	54	0.1	OCC	1,560	168	301	$ 46	$ 427	$ 40	9.4	8.5
	Total	**102**			**11.9**			**30,227**	**102**			**7.0**			**14,614**		**$ 2,565**	**$ 14,247**	**$ 1,695**		
															Demand Savings		**4.9**	**$636**			
															kWh Savings		**15,613**	**$1,928**			
															Total Savings			**$2,565**		**5.6**	**4.9**

APPENDIX E

ECM-4 Use of Photo Cells for Fuel Station Lighting

North Brunswick
CHA #20418
Building: Department of Public Works

ECM-4: Use of photo cells for exterior lighting

Building Schedule:
Existing conditions (master switch): 24 hrs/day
Retrofit conditions (photo cells): 12 hrs/day

Supply Cost of Electricity: 0.1235 $/kWh

Instructions and notes:
Input all applicable fixture codes from Light Table (hidden sheet). In retrofit conditions indicate "Yes" if photo cell is applicable
Use weekly hours if all fixtures on this sheet can be retrofitted with photo cells, else use columns for Daily Hours
*Photo Cells = Dusk to dawn lights operate approx. 4100 hour per year (this is average over a year that is independent of latitude)
If the existing light fixture is utilized less than stated above photo cell will not save energy
Make sure that security reason does not prevent installation of photo cells
Make judgment when using Cost Tables

	EXISTING CONDITIONS								RETROFIT CONDITION			COST ANALYSIS			
Area Description	Number of Fixtures	Fixture Code	Watts per Fixture	Number of Non-Operational Fixtures	Watts per Non-Operational Fixtures	kW/Space	Annual Hours	Annual kWh	Photo-Cell Yes or No	Annual Hours	Annual kWh	Annual kWh Saved	Annual $ Saved	Retrofit Cost	Simple Payback
Pump Station	4	MH150/1	190	0	193.8	0.76	8,760	6,658	Yes	4,380	3,329	3,329	$ 411	$ 150	0.4
TOTALS -	**4.0**			**0.0**		**0.8**		**6,658**		**4,380**	**3,329**	3,329	**$ 411**	**$150**	0.4

APPENDIX F

ECM-5 Apply Night Setback to Mechanical Systems

North Brunswick
CHA #20418
Building: Department of Public Works

ECM-5A: Night Setback In Office Area

Building Footprint	4,000	SF	Ex Occupied Clng Temp.	73	°F	Ex Occupied Htg Temp.	70	°F	
Natural Gas Heat Content	100,000	Btu/Therm	Ex Unoccupied Clng Temp.	73	°F	Ex Unoccupied Htg Temp.	70	°F	
Building Balance Temp.	60	°F	Prop Occupied Clng Temp.	75	°F	Prop Occupied Htg Temp.	70	°F	
Internal Gains	42,985	btu/h	Prop Unoccupied Clng Temp.	80	°F	Prop Unoccupied Htg Temp.	60	°F	
Unoc Internal Gain factor	0.03		Occupied Cooling UA	-1,829	btu/hr/°F	Occupied Heating UA	604	btu/hr/°F	
Ave Occ Internal Gain Factor	0.5		Unoccupied Cooling UA	-1,056	btu/hr/°F	Unoccupied Heating UA	604	btu/hr/°F	
Existing Equipment EER	8	btu/wh	Cooling Occ Enthalpy Setpoint	26.75	Btu/lb				
Existing Burner Efficiency	83%		Cooling Unocc Enthalpy Setpoint	26.75	Btu/lb				

Heating Energy Savings	**433 Therms**
Cooling Energy Savings	**1,138 kWh**

Heating and cooling energy are unrelated in this model. If the building being analyzed is not cooled, disregard cooling energy calculations

					EXISTING LOADS						PROPOSED LOADS									
					Occupied			Unoccupied			Occupied			Unoccupied						
Avg Outdoor Air Temp. Bins °F	Avg Outdoor Air Enthalpy	Existing Equipment Bin Hours	Occupied Equipment Bin Hours	Unoccupied Equipment Bin Hours	Envelope Load BTUH	Ventilation Load BTUH	Internal Gain BTUH	Unoccupied Envelope Load BTUH	Ventilation Load BTUH	Internal Gain BTUH	Envelope Load BTUH	Ventilation Load BTUH	Internal Gain BTUH	Unoccupied Envelope Load BTUH	Ventilation Load BTUH	Internal Gain BTUH	Existing Cooling Energy kWh	Proposed Cooling Energy kWh	Existing Heating Energy Therms	Proposed Heating Energy Therms
A		B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	K	L	M	N
102.5	49.1	0	0	0	-53,964	-154,368	-21,493	-31,153	-41,221	-1,290	-50,306	-154,368	-21,493	-23,761	-41,221	-1,290	0	0	0	0
97.5	42.5	3	1	2	-44,818	-108,782	-21,493	-25,873	-29,048	-1,290	-41,159	-108,782	-21,493	-18,481	-29,048	-1,290	35	33	0	0
92.5	39.5	34	11	23	-35,671	-88,062	-21,493	-20,593	-23,515	-1,290	-32,013	-88,062	-21,493	-13,201	-23,515	-1,290	327	300	0	0
87.5	36.6	131	41	90	-26,525	-68,032	-21,493	-15,313	-18,167	-1,290	-22,866	-68,032	-21,493	-7,920	-18,167	-1,290	989	887	0	0
82.5	34	500	158	342	-17,378	-50,074	-21,493	-10,032	-13,371	-1,290	-13,720	-50,074	-21,493	-2,640	-13,371	-1,290	2,810	2,422	0	0
77.5	31.6	620	196	424	-8,232	-33,498	-21,493	-4,752	-8,945	-1,290	-4,573	-33,498	-21,493	0	0	-1,290	2,341	1,525	0	0
72.5	29.2	664	209	455	0	0	-21,493	0	0	-1,290	0	0	-21,493	0	0	-1,290	636	636	0	0
67.5	27	854	269	585	1,511	4,144	-21,493	1,511	1,107	-1,290	1,511	4,144	-21,493	0	0	-1,290	533	628	0	0
62.5	24.5	927	292	635	4,533	12,432	-21,493	4,533	3,320	-1,290	4,533	12,432	-21,493	0	0	-1,290	166	268	0	0
57.5	21.4	600	189	411	7,554	20,720	-21,493	7,554	5,533	-1,290	7,554	20,720	-21,493	1,511	1,107	-1,290	0	0	74	22
52.5	18.7	610	192	418	10,576	29,009	-21,493	10,576	7,746	-1,290	10,576	29,009	-21,493	4,533	3,320	-1,290	0	0	127	75
47.5	16.2	611	193	418	13,598	37,297	-21,493	13,598	9,959	-1,290	13,598	37,297	-21,493	7,554	5,533	-1,290	0	0	180	128
42.5	14.4	656	207	449	16,620	45,585	-21,493	16,620	12,173	-1,290	16,620	45,585	-21,493	10,576	7,746	-1,290	0	0	250	193
37.5	12.6	1,023	323	700	19,641	53,873	-21,493	19,641	14,386	-1,290	19,641	53,873	-21,493	13,598	9,959	-1,290	0	0	478	390
32.5	10.7	734	232	502	22,663	62,161	-21,493	22,663	16,599	-1,290	22,663	62,161	-21,493	16,620	12,173	-1,290	0	0	406	343
27.5	8.6	334	105	229	25,685	70,450	-21,493	25,685	18,812	-1,290	25,685	70,450	-21,493	19,641	14,386	-1,290	0	0	213	185
22.5	6.8	252	80	173	28,707	78,738	-21,493	28,707	21,025	-1,290	28,707	78,738	-21,493	22,663	16,599	-1,290	0	0	183	161
17.5	5.5	125	39	86	31,728	87,026	-21,493	31,728	23,238	-1,290	31,728	87,026	-21,493	25,685	18,812	-1,290	0	0	101	91
12.5	4.1	47	15	32	34,750	95,314	-21,493	34,750	25,452	-1,290	34,750	95,314	-21,493	28,707	21,025	-1,290	0	0	42	38
7.5	2.6	22	7	15	37,772	103,602	-21,493	37,772	27,665	-1,290	37,772	103,602	-21,493	31,728	23,238	-1,290	0	0	22	20
2.5	1	13	4	9	40,794	111,891	-21,493	40,794	29,878	-1,290	40,794	111,891	-21,493	34,750	25,452	-1,290	0	0	14	13
-2.5	0	0	0	0	43,815	120,179	-21,493	43,815	32,091	-1,290	43,815	120,179	-21,493	37,772	27,665	-1,290	0	0	0	0
-7.5	-1.5	0	0	0	46,837	128,467	-21,493	46,837	34,304	-1,290	46,837	128,467	-21,493	40,794	29,878	-1,290	0	0	0	0
TOTALS		**8,760**	**2,764**	**5,996**													**7,837**	**6,699**	**2,091**	**1,657**

Existing Building Ventilation & Infiltration (occ)	**1,535 cfm**
Overheat Ventilation Factor	**1.00**
Additional ventilation to offset overheat	**0 cfm**
Existing Building Ventilation & Infiltration (unocc)	**410 cfm**

North Brunswick
CHA #20418
Building: Department of Public Works

ECM-5B: Night Setback In Garage Area

Building Footprint	14,400 SF	Ex Occupied Clng Temp.	74 °F	Ex Occupied Htg Temp.	65 °F	Heating Energy Savings	1,257 Therms
Natural Gas Heat Content	100,000 Btu/Therm	Ex Unoccupied Clng Temp.	74 °F	Ex Unoccupied Htg Temp.	65 °F	Cooling Energy Savings	11,712 kWh
Building Balance Temp.	60 °F	Prop Occupied Clng Temp.	74 °F	Prop Occupied Htg Temp.	65 °F		
Internal Gains	29,128 btu/h	Prop Unoccupied Clng Temp.	80 °F	Prop Unoccupied Htg Temp.	60 °F		
Unoc Internal Gain factor	0.03	Occupied Cooling UA	-4,412 btu/hr/°F	Occupied Heating UA	2,210 btu/hr/°F		
Ave Occ Internal Gain Factor	0.5	Unoccupied Cooling UA	-4,412 btu/hr/°F	Unoccupied Heating UA	2,210 btu/hr/°F		
Avg. Equip Burner Efficiency	77%	Cooling Occ Enthalpy Setpoint	27.5 Btu/lb				
		Cooling Unocc Enthalpy Setpoint	27.5 Btu/lb				

Heating and cooling energy are unrelated in this model. If the building being analyzed is not cooled, disregard cooling energy calculations

					EXISTING LOADS						PROPOSED LOADS									
					Occupied			Unoccupied			Occupied			Unoccupied						
Avg Outdoor Air Temp. Bins °F	Avg Outdoor Air Enthalpy	Existing Equipment Bin Hours	Occupied Equipment Bin Hours	Unoccupied Equipment Bin Hours	Envelope Load BTUH	Ventilation Load BTUH	Internal Gain BTUH	Unoccupied Envelope Load BTUH	Ventilation Load BTUH	Internal Gain BTUH	Envelope Load BTUH	Ventilation Load BTUH	Internal Gain BTUH	Unoccupied Envelope Load BTUH	Ventilation Load BTUH	Internal Gain BTUH	Existing Cooling Energy kWh	Proposed Cooling Energy kWh	Existing Heating Energy Therms	Proposed Heating Energy Therms
A		B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	K	L	M	N
102.5	49.1	0	0	0	-125,752	-1,399,237	-14,564	-125,752	-264,552	-874	-125,752	-1,399,237	-14,564	-99,278	-264,552	-874	0	0	0	0
97.5	42.5	3	1	2	-103,691	-971,692	-14,564	-103,691	-183,717	-874	-103,691	-971,692	-14,564	-77,216	-183,717	-874	476	460	0	0
92.5	39.5	34	11	23	-81,629	-777,354	-14,564	-81,629	-146,973	-874	-81,629	-777,354	-14,564	-55,155	-146,973	-874	4,310	4,130	0	0
87.5	36.6	131	41	90	-59,567	-589,493	-14,564	-59,567	-111,455	-874	-59,567	-589,493	-14,564	-33,093	-111,455	-874	12,552	11,856	0	0
82.5	34	500	158	342	-37,505	-421,067	-14,564	-37,505	-79,611	-874	-37,505	-421,067	-14,564	-11,031	-79,611	-874	33,699	31,044	0	0
77.5	31.6	620	196	424	-15,443	-265,596	-14,564	-15,443	-50,216	-874	-15,443	-265,596	-14,564	0	0	-874	25,214	17,040	0	0
72.5	29.2	664	209	455	0	0	-14,564	0	0	-874	0	0	-14,564	0	0	-874	1,010	1,010	0	0
67.5	27	854	269	585	0	0	-14,564	0	0	-874	0	0	-14,564	0	0	-874	1,299	1,299	0	0
62.5	24.5	927	292	635	5,524	38,868	-14,564	5,524	7,349	-874	5,524	38,868	-14,564	0	0	-874	0	0	212	106
57.5	21.4	600	189	411	16,572	116,603	-14,564	16,572	22,046	-874	16,572	116,603	-14,564	5,524	7,349	-874	0	0	493	356
52.5	18.7	610	192	418	27,620	194,338	-14,564	27,620	36,743	-874	27,620	194,338	-14,564	16,572	22,046	-874	0	0	863	723
47.5	16.2	611	193	418	38,668	272,074	-14,564	38,668	51,441	-874	38,668	272,074	-14,564	27,620	36,743	-874	0	0	1,226	1,086
42.5	14.4	656	207	449	49,716	349,809	-14,564	49,716	66,138	-874	49,716	349,809	-14,564	38,668	51,441	-874	0	0	1,705	1,555
37.5	12.6	1,023	323	700	60,765	427,545	-14,564	60,765	80,835	-874	60,765	427,545	-14,564	49,716	66,138	-874	0	0	3,265	3,031
32.5	10.7	734	232	502	71,813	505,280	-14,564	71,813	95,533	-874	71,813	505,280	-14,564	60,765	80,835	-874	0	0	2,778	2,610
27.5	8.6	334	105	229	82,861	583,015	-14,564	82,861	110,230	-874	82,861	583,015	-14,564	71,813	95,533	-874	0	0	1,462	1,386
22.5	6.8	252	80	173	93,909	660,751	-14,564	93,909	124,927	-874	93,909	660,751	-14,564	82,861	110,230	-874	0	0	1,252	1,195
17.5	5.5	125	39	86	104,957	738,486	-14,564	104,957	139,625	-874	104,957	738,486	-14,564	93,909	124,927	-874	0	0	695	667
12.5	4.1	47	15	32	116,005	816,222	-14,564	116,005	154,322	-874	116,005	816,222	-14,564	104,957	139,625	-874	0	0	289	279
7.5	2.6	22	7	15	127,053	893,957	-14,564	127,053	169,019	-874	127,053	893,957	-14,564	116,005	154,322	-874	0	0	148	143
2.5	1	13	4	9	138,101	971,692	-14,564	138,101	183,717	-874	138,101	971,692	-14,564	127,053	169,019	-874	0	0	95	92
-2.5	0	0	0	0	149,149	1,049,428	-14,564	149,149	198,414	-874	149,149	1,049,428	-14,564	138,101	183,717	-874	0	0	0	0
-7.5	-1.5	0	0	0	160,197	1,127,163	-14,564	160,197	213,111	-874	160,197	1,127,163	-14,564	149,149	198,414	-874	0	0	0	0
TOTALS		8,760	2,764	5,996													78,561	66,849	14,485	13,229

Existing Building Ventilation & Infiltration (occ)	**11,609 cfm**	
Overheat Ventilation Factor	**1.24**	Due to opening garage doors
Additional ventilation to offset overheat	**2,786 cfm**	
Existing Building Ventilation & Infiltration (unocc)	**2,722 cfm**	

HEAT GAIN/LOSS WORKSHEET

Project Name:	North Brunswick	**Project No.:**	CHA #20418		
Location		**Site Elevation:**	460 **Feet**	**Specific Volume**	13.50 CF/#
Building Name	Department of Public Works	**Date:**			
Engineer:	CAA				

Building/Facility Designation Office Area for Public Works Building

Outdoor Winter Design DB Temperature	14 *F	**Indoor Winter Design DB Temperature**	70 *F
Outdoor Summer Design DB Temperature	91 *F	**Indoor Summer Design DB Temperature**	73 *F
Outdoor Summer Design WB Temperature	73 *F	**Indoor Summer Design WB Temperature**	60 *F
Outdoor Summer Humidity Ratio	0.0121 #/#	**Indoor Air (70*F) Humidity Ratio**	0.0078 #/#

ENVELOPE DESCRIPTIONS (Descriptions are from Interior to Exterior)

Walls (Select One - Type X)		R Value	Wall Type
	Steel Siding, 4" Insulation, Steel Siding	15.2	1
	Plaster or Gypsum, frame construction, 5" Insulation, 1" stucco	18.2	1
	4" WH CMU, 1" Insulation, Finished Exterior	5.2	2
	Plaster or Gypsum, frame construction, 3" Insulation, 8" LW CMU	7.8	5
	4" Face Brick, 2" Concrete, 1" Insulation, Exterior Finish	5.1	12
	4" Face Brick, 4" Concrete, 1" Insulation, Exterior Finish	4.0	11
	Interior Finish, 2" Insulation, 8" CMU, 4" Face Brick	10.9	16
	Finished Surface, 8" LW CMU (filled), Air Space, 4" Face Brick	11.1	16
	Stucco or Gypsum, 2.5" Insul, Face Brick	14.3	10
	4" Block, 1" insulation, 8" Block	19.9	16
x	1/2" Gyp, R-11 Batt, 5-1/2" Air Gap, Metal Panel	15.3	

Roofs (Select One)		R Value	Roof Type
	Tectum Deck, 3.3" Insul., BU Roof	13.0	1
	Steel Deck, 5" Insul., BU Roof	18.2	1
	Attic Roof with 6" Insul.	25.0	4
	4" HW Concrete Deck, BU Roof	2.7	2
	Ceiling, 3" Insulation, 4" Concrete Deck, BU Roof	14.9	4
	Ceiling, 4" Concrete Deck, 3" Insulation, BU Roof	18.5	13
	Ceiling, 4" Concrete Deck, 6" Insulation, BU Roof	21.7	14
	Ceiling, Wood Deck, 6" Insulation, Felt & Membrane	22.7	10
	Wood Deck, 6" insulation, Felt & Membrane	18.0	
x	Acoustic Panel, 6" R-19, Steel Deck	23.5	

Windows (Select One)		U Value
	Aluminum Frame, 1/8" SP Glazing	1.05
x	Aluminum Frame, 1/4" DP Glazing	0.60
	Aluminum Frame, 3/16" DP Glazing	0.62
	Aluminum Frame, 1/2" DP Glazing	0.50
	Skylights	0.90
	Other	

			Frame (multiply by)	
	No Storm	Storm	Metal	Thermal
Flat Glass	1.05	0.50	1.05	0.95
Flat Glass (e=.6)	1.00	0.55	1.05	0.95
Flat Glass (e=0.4)	0.90	0.54	1.05	0.95
Flat Glass (e=0.2)	0.77	0.45	1.05	0.95
Double Glaze (3/16 in air)	0.63	0.38	1.25	1.05
Double Glaze (1/4 in air)	0.60	0.37	1.25	1.05
Double Glaze (1/2 in air)	0.53	0.36	1.25	1.05
Double Glaze (e=.6)	0.50	0.35	1.25	1.05
Double Glaze (e=0.4)	0.42	0.33	1.25	1.05
Double Glaze (e=0.2)	0.35	0.29	1.25	1.05
Triple Glaze (1/4 in air)	0.42	0.30	1.40	1.15
Triple Glaze (1/2 in air)	0.35	0.27	1.40	1.15

BUILDING CHARACTERISTICS

Roof Area	4,000 SF		
Occupied Area	4,000 SF	**Return Plenum?**	N

	Gross Wall Length	Average Wall Height	Ceiling Height	Window Area	Door Area	Net Wall Area	Net Wall Area Below Ceiling
North Exposure	0 Ft	0.0 Ft	8.0 Ft	0 SF	0 SF	0 SF	0 SF
East Exposure	40 Ft	12.0 Ft	8.0 Ft	64 SF	21 SF	395 SF	235 SF
South Exposure	100 Ft	12.0 Ft	8.0 Ft	144 SF	0 SF	1,056 SF	656 SF
West Exposure	40 Ft	12.0 Ft	8.0 Ft	64 SF	42 SF	374 SF	214 SF

Forced Ventilation 1,125 cfm Assumes 30% OA

HEAT GAIN/LOSS WORKSHEET

Project Name:	North Brunswick	**Project No.:**	CHA #20418		
Location		**Site Elevation:**	460 Feet	**Specific Volume**	13.50 CF/#
Building Name	Department of Public Works	**Date:**			
Engineer:	CAA				

Building/Facility Designation Office Area for Public Works Building

COOLING HEAT GAINS TO THE ROOM - SENSIBLE

SOLAR GAINS

WINDOWS	AREA (SF)	SHGF	Shade Coef	Cooling Load Factor		Solar Heat Gain	
North Exposure	0	38 btu/h/sf	0.8	0.75	Glass Type C	0 Btu/hr	
East Exposure	64	216 btu/h/sf	0.8	0.31	Glass Type C	3,428 Btu/hr	
South Exposure	144	109 btu/h/sf	0.8	0.58	Glass Type C	7,283 Btu/hr	
West Exposure	64	216 btu/h/sf	0.8	0.29	Glass Type C	3,207 Btu/hr	
							13,918 Btu/h

CONDUCTION

	NET AREA (SF)	U-VALUE	Cooling Load Temp. Dif.	Return Air Factor	Room Heat Gain	
North Exposure	0	0.07	20 °F	1.0	0 Btu/hr	
East Exposure	235	0.07	39 °F	1.0	599 Btu/hr	
South Exposure	656	0.07	27 °F	1.0	1,158 Btu/hr	
West Exposure	214	0.07	22 °F	1.0	308 Btu/hr	
Roof	4,000	0.04	73 °F	1.0	12,426 Btu/hr	
Fenestration	272	0.60	18 °F		2,938 Btu/hr	
Doors	63	0.14	27 °F		238 Btu/hr	
Ceiling	4,000	0.14	0 °F		0 Btu/hr	
Partition		0.05	0 °F		0 Btu/hr	
Floor	4,000	0.04	0 °F		0 Btu/hr	
						17,665 Btu/h

INTERNAL HEAT GAINS

							Room Heat Gain	
Lights	2.00 w/sf x	4,000 Occ Area =	8.0 kW x 3.4x		1.0 RAF =		27,304 Btu/h	
Plug Load	0.25 w/sf x	4,000 Occ Area =	1.0 kW x 3.4x		1.0 RAF =		3,413 Btu/h	
People	16 people x	255 btu/person x	33% time in space =				1,346 Btu/h	
Computer Work Stations		10 Units x	120 W/Unit x	3414 =			4,096 Btu/h	
Equipment	2.0 kW x 3.413 =						6,826 Btu/h	
Misc.							0 Btu/h	
								42,985 Btu/h

VENTILATION AND INFILTRATION

		Infiltration Factor	Perimeter Ratio	Coef	Temp. Diff.	Room Heat Gain	
Walls	1,105 SF	0.17 CFM/SF		1.08	18 °F	3,952 Btu/h	
Doors	63 SF	0.30 CFM/LF	0.95 LF/SF	1.08	18 °F	379 Btu/h	
Windows	272 SF	0.30 CFM/LF	1.00 LF/SF	1.08	18 °F	1,717 Btu/h	
Ventilation	1,125 cfm			1.08	18 °F	23,669 Btu/h	
							29,717 Btu/h

COOLING HEAT GAINS TO THE RA PLENUM - SENSIBLE 4,950

CONDUCTION

	NET AREA (SF)	U-VALUE	Cooling Load Temp. Dif.	Return Air Factor	Room Heat Gain	
North Exposure	0	0.07	20	1.0	0 Btu/hr	
East Exposure	160	0.07	39	1.0	408 Btu/hr	
South Exposure	400	0.07	27	1.0	706 Btu/hr	
West Exposure	160	0.07	22	1.0	230 Btu/hr	
Roof	4,000	0.04	73	0.0	0 Btu/hr	
						1,344 Btu/h

INTERNAL HEAT GAINS

Lights	2.00 w/sf x	4,000 Occ Area =	8.0 kW x3413x	0.00 RAF =	0 Btu/h	
Misc.					0 Btu/h	
						0 Btu/h

SENSIBLE HEAT GAINS - TEMP. DEPENDENT	
Solar	13,918
Conduction to Room	17,665
Conduction to Plenum	1,344
Ventilation and Infiltration	29,717
Sub Total	62,644

SENSIBLE HEAT GAINS - TEMP. INDEPENDENT	
Internal Gains to Room	42,985
Internal Gains to Plenum	0
Sub Total	42,985

HEAT GAIN/LOSS WORKSHEET

Project Name:	North Brunswick	**Project No.:**	CHA #20418		
Location		**Site Elevation:**	460 Feet	**Specific Volume**	13.50 CF/#
Building Name	Department of Public Works	**Date:**			
Engineer:	CAA				

Building/Facility Designation Office Area for Public Works Building

LATENT COOLING LOADS

Infiltration

		Infiltration Factor	Air Density	Humidity Ratio Dif.	Room Heat Gain	
Walls	4,720 SF	0.17 CFM/SF	4,800	0.0043 ##	16,727	Btu/h
Doors	63 SF	0.30 CFM/LF	4,800	0.0043 ##	375	Btu/h
Windows	272 SF	0.30 CFM/LF	4,800	0.0043 ##	1,701	Btu/h
Ventilation	1,125 cfm		4,800	0.0043 ##	23,451	Btu/h
People	16 people	0.33 time in space		250 Btu/hr/person	1,320	Btu/h
						43,574 Btu/h

Cooling Load Summary

	Sensible	Latent	Total		
Temperature Dependent Gains	62,644	43,574	106,219		
Temperature Indep. Gains	42,985		42,985	SHR=	0.71
Total	105,629	43,574	149,204		

Building Cooling Load 12.4 Tons at 322 SF/Ton

Building Air Flow to Condition Space based on a 12°F Temp Rise is **8,030 CFM**, **2.01 CFM/sf**

HEATING CALCULATION

CONDUCTION

	NET AREA (SF)	U-VALUE	Heating Load Temp. Dif.	Room Heat Gain	
North Exposure	0	0.07	56	0	Btu/h
East Exposure	395	0.07	56	1,446	Btu/h
South Exposure	1,056	0.07	56	3,865	Btu/h
West Exposure	374	0.07	56	1,369	Btu/h
Fenestration	272	0.60	56	9,139	Btu/h
Roof	4,000	0.04	56	9,532	Btu/h
Doors	63	0.14	56	493	Btu/h
Ceiling	4,000	0.14	0	0	Btu/h
Partition	0	0.05	0	0	Btu/h
Floor	4,000	0.04	50	8,000	Btu/h

Ventilation and Infiltration

		Infiltration Factor	Coef	Temp. Difference	Air Flow	Room Heat Gain	
Walls	1,825 SF	0.17 CFM/SF	1.08	56	310 cfm	18,803	Btu/h
Doors	63 SF	0.30 CFM/LF	1.08	56	18 cfm	1,091	Btu/h
Windows	272 SF	0.30 CFM/LF	1.08	56	82 cfm	4,946	Btu/h
Ventilation Load	1,125 cfm		1.08	56	1,125 cfm	73,637	Btu/h
Total Ventilation & Infiltration Load					1,535 cfm	98,477	Btu/h

Building Heating Load	**132,321**	**btu/h**
		33.1 btu/sf

HEAT GAIN/LOSS WORKSHEET

Project Name:	North Brunswick	**Project No.:**	CHA #20418		
Location		**Site Elevation:**	460 **Feet**	**Specific Volume**	13.50 CF/#
Building Name	Department of Public Works	**Date:**			
Engineer:	CAA				

Building/Facility Designation Garage Area for Public Works Building

Outdoor Winter Design DB Temperature	14 *F		**Indoor Winter Design DB Temperature**	65 *F	
Outdoor Summer Design DB Temperature	91 *F		**Indoor Summer Design DB Temperature**	74 *F	
Outdoor Summer Design WB Temperature	73 *F		**Indoor Summer Design WB Temperature**	60 *F	
Outdoor Summer Humidity Ratio	0.0121 #/#		**Indoor Air (70*F) Humidity Ratio**	0.0078 #/#	

ENVELOPE DESCRIPTIONS (Descriptions are from Interior to Exterior)

Walls (Select One - Type X)		R Value	Wall Type
	Steel Siding, 4" Insulation, Steel Siding	15.2	1
	Plaster or Gypsum, frame construction, 5" Insulation, 1" stucco	18.2	1
	4" WH CMU, 1" Insulation, Finished Exterior	5.2	2
	Plaster or Gypsum, frame construction, 3" Insulation, 8" LW CMU	7.8	5
	4" Face Brick, 2" Concrete, 1" Insulation, Exterior Finish	5.1	12
	4" Face Brick, 4" Concrete, 1" Insulation, Exterior Finish	4.0	11
	Interior Finish, 2" Insulation, 8" CMU, 4" Face Brick	10.9	16
	Finished Surface, 8" LW CMU (filled), Air Space, 4" Face Brick	11.1	16
	Stucco or Gypsum, 2.5" Insul, Face Brick	14.3	10
	4" Block, 1" insulation, 8" Block	19.9	16
x	Wall Liner, R-11 Batt, Metal Panel	12.3	

Roofs (Select One)		R Value	Roof Type
	Tectum Deck, 3.3" Insul., BU Roof	13.0	1
	Steel Deck, 5" Insul., BU Roof	18.2	1
	Attic Roof with 6" Insul.	25.0	4
	4" HW Concrete Deck, BU Roof	2.7	2
	Ceiling, 3" Insulation, 4" Concrete Deck, BU Roof	14.9	4
	Ceiling, 4" Concrete Deck, 3" Insulation, BU Roof	18.5	13
	Ceiling, 4" Concrete Deck, 6" Insulation, BU Roof	21.7	14
	Ceiling, Wood Deck, 6" Insulation, Felt & Membrane	22.7	10
	Wood Deck, 6" insulation, Felt & Membrane	18.0	
x	6" R-19, Steel Deck	21.0	

Windows (Select One)		U Value
	Aluminum Frame, 1/8" SP Glazing	1.05
	Aluminum Frame, 1/4" DP Glazing	0.60
	Aluminum Frame, 3/16" DP Glazing	0.62
	Aluminum Frame, 1/2" DP Glazing	0.50
	Skylights	0.90
	Other	

		Frame (multiply by)	
	No Storm	Storm	Metal	Thermal
Flat Glass	1.05	0.50	1.05	0.95
Flat Glass (e=.6)	1.00	0.55	1.05	0.95
Flat Glass (e=0.4)	0.90	0.54	1.05	0.95
Flat Glass (e=0.2)	0.77	0.45	1.05	0.95
Double Glaze (3/16 in air)	0.63	0.38	1.25	1.05
Double Glaze (1/4 in air)	0.60	0.37	1.25	1.05
Double Glaze (1/2 in air)	0.53	0.36	1.25	1.05
Double Glaze (e=.6)	0.50	0.35	1.25	1.05
Double Glaze (e=0.4)	0.42	0.33	1.25	1.05
Double Glaze (e=0.2)	0.35	0.29	1.25	1.05
Triple Glaze (1/4 in air)	0.42	0.30	1.40	1.15
Triple Glaze (1/2 in air)	0.35	0.27	1.40	1.15

BUILDING CHARACTERISTICS

Roof Area	14,400 SF		
Occupied Area	14,400 SF	**Return Plenum?**	No

	Gross Wall Length	Average Wall Height	Ceiling Height	Window Area	Door Area	Net Wall Area	Net Wall Area Below Ceiling
North Exposure	180 Ft	23.8 Ft	23.0 Ft	0 SF	714 SF	3,561 SF	3,426 SF
East Exposure	80 Ft	23.8 Ft	23.0 Ft	0 SF	0 SF	1,900 SF	1,840 SF
South Exposure	129 Ft	23.8 Ft	23.0 Ft	0 SF	189 SF	2,886 SF	2,789 SF
West Exposure	80 Ft	23.8 Ft	23.0 Ft	0 SF	0 SF	1,900 SF	1,840 SF

Forced Ventilation 8,888 cfm Assumes only one make-up air unit running 75% of time (on average)

HEAT GAIN/LOSS WORKSHEET

Project Name:	North Brunswick	**Project No.:**	CHA #20418		
Location		**Site Elevation:**	460 Feet	**Specific Volume**	13.50 CF/#
Building Name	Department of Public Works	**Date:**			
Engineer:	CAA				

Building/Facility Designation Garage Area for Public Works Building

COOLING HEAT GAINS TO THE ROOM - SENSIBLE

SOLAR GAINS

WINDOWS	AREA (SF)	SHGF	Shade Coef	Cooling Load Factor		Solar Heat Gain
North Exposure	0	38 btu/h/sf	0.8	0.75	Glass Type C	0 Btu/hr
East Exposure	0	216 btu/h/sf	0.8	0.31	Glass Type C	0 Btu/hr
South Exposure	0	109 btu/h/sf	0.8	0.58	Glass Type C	0 Btu/hr
West Exposure	0	216 btu/h/sf	0.8	0.29	Glass Type C	0 Btu/hr
						0 Btu/h

CONDUCTION

	NET AREA (SF)	U-VALUE	Cooling Load Temp. Dif.	Return Air Factor	Room Heat Gain
North Exposure	3,426	0.08	20 °F	1.0	5,571 Btu/hr
East Exposure	1,840	0.08	39 °F	1.0	5,834 Btu/hr
South Exposure	2,789	0.08	27 °F	1.0	6,122 Btu/hr
West Exposure	1,840	0.08	22 °F	1.0	3,291 Btu/hr
Roof	14,400	0.05	73 °F	1.0	50,057 Btu/hr
Fenestration	0	0.00	17 °F		0 Btu/hr
Doors	903	0.14	27 °F		3,405 Btu/hr
Ceiling	14,400	0.14	0 °F		0 Btu/hr
Partition		0.05	0 °F		0 Btu/hr
Floor	14,400	0.04	0 °F		0 Btu/hr
					74,280 Btu/h

INTERNAL HEAT GAINS

							Room Heat Gain
Lights	0.27 w/sf x	14,400 Occ Area =	3.9 kW x 3.4x		1.0 RAF =		13,270 Btu/h
Plug Load	0.15 w/sf x	14,400 Occ Area =	2.2 kW x 3.4x		1.0 RAF =		7,372 Btu/h
People	10 people x	255 btu/person x	33% time in space =				842 Btu/h
Computer Work Stations		2 Units x	120 W/Unit x	3414 =			819 Btu/h
Equipment	2.0 kW x 3,413 =						6,826 Btu/h
Misc.							0 Btu/h
							29,128 Btu/h

VENTILATION AND INFILTRATION

		Infiltration Factor	Perimeter Ratio	Coef	Temp. Diff.	Room Heat Gain
Walls	9,895 SF	0.25 CFM/SF		1.08	17 °F	49,153 Btu/h
Doors	903 SF	0.50 CFM/LF	0.35 LF/SF	1.08	17 °F	3,179 Btu/h
Windows	0 SF	0.25 CFM/LF	0.00 LF/SF	1.08	17 °F	0 Btu/h
Ventilation	8,888 cfm			1.08	17 °F	176,598 Btu/h
						228,931 Btu/h

COOLING HEAT GAINS TO THE RA PLENUM - SENSIBLE 4,950

CONDUCTION

	NET AREA (SF)	U-VALUE	Cooling Load Temp. Dif.	Return Air Factor	Room Heat Gain
North Exposure	135	0.08	20	1.0	220 Btu/hr
East Exposure	60	0.08	39	1.0	190 Btu/hr
South Exposure	97	0.08	27	1.0	213 Btu/hr
West Exposure	60	0.08	22	1.0	107 Btu/hr
Roof	14,400	0.05	73	0.0	0 Btu/hr
					730 Btu/h

INTERNAL HEAT GAINS

					Room Heat Gain
Lights	0.27 w/sf x	14,400 Occ Area =	3.9 kW x3413x	0.00 RAF =	0 Btu/h
Misc.					0 Btu/h
					0 Btu/h

SENSIBLE HEAT GAINS - TEMP. DEPENDENT	
Solar	0
Conduction to Room	74,280
Conduction to Plenum	730
Ventilation and Infiltration	228,931
Sub Total	**303,941**

SENSIBLE HEAT GAINS - TEMP. INDEPENDENT	
Internal Gains to Room	29,128
Internal Gains to Plenum	0
Sub Total	**29,128**

HEAT GAIN/LOSS WORKSHEET

Project Name:	North Brunswick	**Project No.:**	CHA #20418		
Location		**Site Elevation:**	460 Feet	**Specific Volume**	13.50 CF/#
Building Name	Department of Public Works	**Date:**			
Engineer:	CAA				

Building/Facility Designation Garage Area for Public Works Building

LATENT COOLING LOADS

Infiltration

		Infiltration Factor	Air Density	Humidity Ratio Dif.	Room Heat Gain
Walls	14,752 SF	0.25 CFM/SF	4,800	0.0043 ##/	76,880 Btu/h
Doors	903 SF	0.50 CFM/LF	4,800	0.0043 ##/	3,335 Btu/h
Windows	0 SF	0.25 CFM/LF	4,800	0.0043 ##/	0 Btu/h
Ventilation	8,888 cfm		4,800	0.0043 ##/	185,266 Btu/h
People	10 people	0.33 time in space		250 Btu/hr/person	825 Btu/h
					266,306 Btu/h

Cooling Load Summary

	Sensible	Latent	Total		
Temperature Dependent Gains	303,941	266,306	570,247		
Temperature Indep. Gains	29,128		29,128	SHR=	0.56
Total	333,070	266,306	599,376		

Building Cooling Load 49.9 Tons at 288 SF/Ton

Building Air Flow to Condition Space based on a 12°F Temp Rise is **25,590 CFM** / **1.78 CFM/sf**

HEATING CALCULATION

CONDUCTION

	NET AREA (SF)	U-VALUE	Heating Load Temp. Dif.	Room Heat Gain
North Exposure	3,561	0.08	51	14,765 Btu/h
East Exposure	1,900	0.08	51	7,878 Btu/h
South Exposure	2,886	0.08	51	11,966 Btu/h
West Exposure	1,900	0.08	51	7,878 Btu/h
Fenestration	0	0.00	51	0 Btu/h
Roof	14,400	0.05	51	34,971 Btu/h
Doors	903	0.14	51	6,432 Btu/h
Ceiling	14,400	0.14	0	0 Btu/h
Partition	0	0.05	0	0 Btu/h
Floor	14,400	0.04	50	28,800 Btu/h

Ventilation and Infiltration

		Infiltration Factor	Coef	Temp. Difference	Air Flow	Room Heat Gain
Walls	10,247 SF	0.25 CFM/SF	1.08	51	2,562 cfm	141,396 Btu/h
Doors	903 SF	0.50 CFM/LF	1.08	51	160 cfm	8,831 Btu/h
Windows	0 SF	0.25 CFM/LF	1.08	51	0 cfm	0 Btu/h
Ventilation Load	8,888 cfm		1.08	51	8,888 cfm	529,795 Btu/h
Total Ventilation & Infiltration Load					11,609 cfm	680,022 Btu/h

Building Heating Load 792,713 btu/h

55.0 btu/sf

North Brunswick
CHA #20418
Building: Department of Public Works

Multipliers	
Material:	0.98
Labor:	1.21
Equipment:	1.09

ECM-5A: Night Setback In Office Area
ECM-5B: Night Setback In Garage Area

Description	QTY	UNIT	UNIT COSTS			SUBTOTAL COSTS			TOTAL COST	REMARKS
			MAT.	LABOR	EQUIP.	MAT.	LABOR	EQUIP.		
						$ -	$ -	$ -	$ -	
Thermostat Removal	11	LS		$ 50		$ -	$ 666	$ -	$ 666	
Programmable thermostat	2	EA	$ 210	$ 50		$ 412	$ 121	$ -	$ 533	2 set back
Miscellaneous Electrical	1	LS	$ 2,000	$ 2,000		$ 1,960	$ 2,420	$ -	$ 4,380	
						$ -	$ -	$ -	$ -	
						$ -	$ -	$ -	$ -	
						$ -	$ -	$ -	$ -	
						$ -	$ -	$ -	$ -	
						$ -	$ -	$ -	$ -	
						$ -	$ -	$ -	$ -	
						$ -	$ -	$ -	$ -	

$ 5,578	Subtotal
$ 836.72	15% Contingency
$ 962.22	15% Contractor O&P
$ -	0% Engineering
$ 7,377	**Total**

APPENDIX G

ECM-6 Replace Unit Heaters with Infrared Heaters

North Brunswick
CHA #20418
Building: Department of Public Works

ECM-6: Replace Unit Heaters in Garage Area with Infrared Heaters

Building Footprint	14,400	SF	Ex Occupied Htg Temp.	65	°F
Steam Heat Content	100,000	Btu/Therm	Ex Unoccupied Htg Temp.	65	°F
Building Balance Temp.	60	°F	Occupied Heating UA	2,210	btu/hr/°F
Internal Gains	29,128	btu/h	Unoccupied Heating UA	2,210	btu/hr/°F
Unoc Internal Gain factor	0.03				
Ave Occ Internal Gain Factor	0.5				

Heating Energy Savings	**3,920**	**Therms/yr**
Electric Energy Savings	**21,869**	**kWh/yr**

Existing Burner Efficiency	77%	Existing Unit Heater burner efficiency
Existing Heat Distribution Effectiveness	85%	Heat Distribution Factor per ASHRAE Handbook - Fundamentals for Unit Heaters
Proposed Burner Efficiency	85%	Based on Dayton Infrared Tube Heaters
Proposed Heat Distribution Effectiveness	100%	Heat Distribution Factor per ASHRAE Handbook - Fundamentals for Infrared Heaters

					EXISTING LOADS						PROPOSED LOADS							
					Occupied			Unoccupied			Occupied			Unoccupied				
Avg Outdoor Air Temp. Bins °F	Avg Outdoor Air Enthalpy	Existing Equipment Bin Hours	Occupied Equipment Bin Hours	Unoccupied Equipment Bin Hours	Envelope Load BTUH	Ventilation Load BTUH	Internal Gain BTUH	Unoccupied Envelope Load BTUH	Ventilation Load BTUH	Internal Gain BTUH	Envelope Load BTUH	Ventilation Load BTUH	Internal Gain BTUH	Unoccupied Envelope Load BTUH	Ventilation Load BTUH	Internal Gain BTUH	Existing Heating Energy Therms	Proposed Heating Energy Therms
A		B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	M	N
102.5	49.1	0	0	0	0	0	-14,564	0	0	-874	0	0	-14,564	0	0	-874	0	0
97.5	42.5	3	1	2	0	0	-14,564	0	0	-874	0	0	-14,564	0	0	-874	0	0
92.5	39.5	34	11	23	0	0	-14,564	0	0	-874	0	0	-14,564	0	0	-874	0	0
87.5	36.6	131	41	90	0	0	-14,564	0	0	-874	0	0	-14,564	0	0	-874	0	0
82.5	34	500	158	342	0	0	-14,564	0	0	-874	0	0	-14,564	0	0	-874	0	0
77.5	31.6	620	196	424	0	0	-14,564	0	0	-874	0	0	-14,564	0	0	-874	0	0
72.5	29.2	664	209	455	0	0	-14,564	0	0	-874	0	0	-14,564	0	0	-874	0	0
67.5	27	854	269	585	0	0	-14,564	0	0	-874	0	0	-14,564	0	0	-874	0	0
62.5	24.5	927	292	635	5,524	38,868	-14,564	5,524	7,349	-874	5,524	38,868	-14,564	5,524	7,349	-874	250	192
57.5	21.4	600	189	411	16,572	116,603	-14,564	16,572	22,046	-874	16,572	116,603	-14,564	16,572	22,046	-874	580	447
52.5	18.7	610	192	418	27,620	194,338	-14,564	27,620	36,743	-874	27,620	194,338	-14,564	27,620	36,743	-874	1,015	781
47.5	16.2	611	193	418	38,668	272,074	-14,564	38,668	51,441	-874	38,668	272,074	-14,564	38,668	51,441	-874	1,443	1,111
42.5	14.4	656	207	449	49,716	349,809	-14,564	49,716	66,138	-874	49,716	349,809	-14,564	49,716	66,138	-874	2,006	1,545
37.5	12.6	1,023	323	700	60,765	427,545	-14,564	60,765	80,835	-874	60,765	427,545	-14,564	60,765	80,835	-874	3,842	2,958
32.5	10.7	734	232	502	71,813	505,280	-14,564	71,813	95,533	-874	71,813	505,280	-14,564	71,813	95,533	-874	3,268	2,516
27.5	8.6	334	105	229	82,861	583,015	-14,564	82,861	110,230	-874	82,861	583,015	-14,564	82,861	110,230	-874	1,720	1,324
22.5	6.8	252	80	173	93,909	660,751	-14,564	93,909	124,927	-874	93,909	660,751	-14,564	93,909	124,927	-874	1,473	1,135
17.5	5.5	125	39	86	104,957	738,486	-14,564	104,957	139,625	-874	104,957	738,486	-14,564	104,957	139,625	-874	818	630
12.5	4.1	47	15	32	116,005	816,222	-14,564	116,005	154,322	-874	116,005	816,222	-14,564	116,005	154,322	-874	340	262
7.5	2.6	22	7	15	127,053	893,957	-14,564	127,053	169,019	-874	127,053	893,957	-14,564	127,053	169,019	-874	175	134
2.5	1	13	4	9	138,101	971,692	-14,564	138,101	183,717	-874	138,101	971,692	-14,564	138,101	183,717	-874	112	86
-2.5	0	0	0	0	149,149	1,049,428	-14,564	149,149	198,414	-874	149,149	1,049,428	-14,564	149,149	198,414	-874	0	0
-7.5	-1.5	0	0	0	160,197	1,127,163	-14,564	160,197	213,111	-874	160,197	1,127,163	-14,564	160,197	213,111	-874	0	0
TOTALS		8,760	2,764	5,996													17,042	13,122

Existing Building Ventilation & Infiltration (occ)	**11,609 cfm**	
Overheat Ventilation Factor	**1.24**	Due to opening garage doors
Additional ventilation to offset overheat	**2,786 cfm**	
Existing Building Ventilation & Infiltration (unocc)	**2,722 cfm**	

Unit Heater Fan Savings

#	Description	Location	Voltage	Load Factor	Existing FLA	Proposed FLA	Existing # of Units	Proposed # of Units	Existing kW	Proposed kW	Annual Hours	Existing Use kWh	Proposed Use kWh	Savings kWh
1	Blower Motor	Garage Area	120	0.8	11.5	1.2	10	8	11.0	0.9	2,161	23,861	1,992	21,869

Heating Hrs	Assumed % Time of Operation	hrs of Operation
0	0%	0
0	0%	0
0	0%	0
0	0%	0
0	0%	0
0	0%	0
0	0%	0
0	0%	0
927	8%	71
600	15%	92
610	23%	141
611	31%	188
656	38%	252
1023	46%	472
734	54%	395
334	62%	206
252	69%	174
125	77%	96
47	85%	40
22	92%	20
13	100%	13
0	100%	0
0	100%	0
5,954	36%	2161

North Brunswick
CHA #20418
Building: Department of Public Works

Multipliers	
Material:	0.98
Labor:	1.21
Equipment:	1.09

ECM-6: Replace Unit Heaters in Garage Area with Infrared Heaters

Description	QTY	UNIT	UNIT COSTS			SUBTOTAL COSTS			TOTAL COST	REMARKS
			MAT.	LABOR	EQUIP.	MAT.	LABOR	EQUIP.		
						$ -	$ -	$ -	$ -	
Unit Heater Removal	10	EA		$ 200		$ -	$ 2,420	$ -	$ 2,420	
60' NG Infrared Tube Heater 200 MBH *	8	EA	$ 2,000	$ 600		$ 15,680	$ 5,808	$ -	$ 21,488	per temperature program
						$ -	$ -	$ -	$ -	
Miscellaneous Gas Piping & Valves	1	LS	$ 2,000			$ 1,960	$ -	$ -	$ 1,960	
Flue Pipe Modifications	8	EA	$ 250	$ 250		$ 1,960	$ 2,420	$ -	$ 4,380	2 units per flue
						$ -	$ -	$ -	$ -	
						$ -	$ -	$ -	$ -	
						$ -	$ -	$ -	$ -	
						$ -	$ -	$ -	$ -	
						$ -	$ -	$ -	$ -	

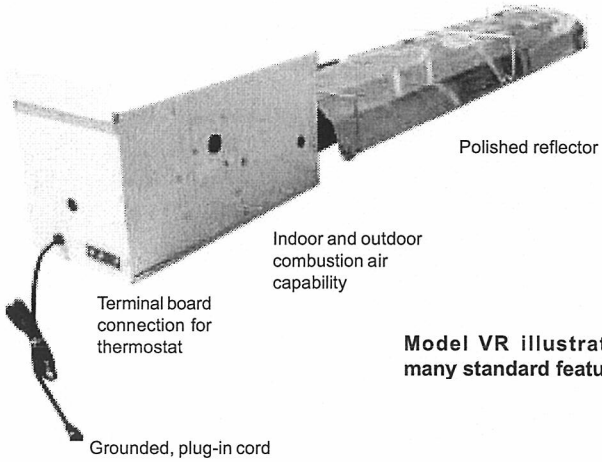
* Vendor quoted price is $2000 per heater

$30,248	Subtotal
$4,537	15% Contingency
$5,218	15% Contractor O&P
$0	0% Engineering
$40,003	**Total**

Sample

REZNOR®

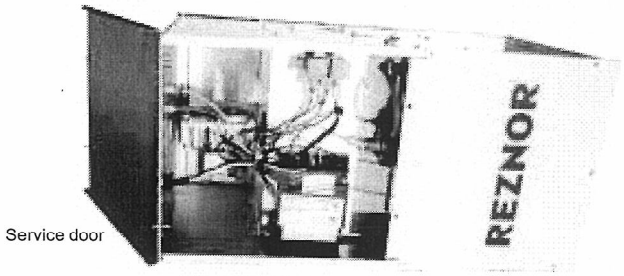
Model VR Gas-Fired Tubular Radiant, Low Intensity Heater for Indoor Commercial-Industrial Use



Model VR illustrating many standard features.

24 volt controls

NOTE: Not approved for residential use.



Differential air pressure switch to verify combustion air flow

ANSI Z83.20 CSA2.34

DESCRIPTION

Model VR tubular radiant heaters are available in BTUH inputs of 50,000 to 200,000 and in tube lengths from 20 to 70 feet (see the Technical Data Table for BTUH/length combinations). All sizes are available for use with natural gas or optional propane gas. Model VR heaters provide full input rate heating capacity to 2,000 feet elevation. Tubular radiant heaters are engineered to provide quiet, reliable, energy-efficient, comfort level heating for both spot and space applications.

Model VR is designed with a burner/control box housing a power burner that fires into a 4" diameter tube, 20 to 70 feet in length. The burner is equipped with a blower for supplying combustion air and a multi-try direct ignition with 100% lockout. Controls include a single-stage gas valve and a pressure switch to verify combustion air flow.

The tubes are in 10-foot sections with each section having a polished reflector. The tube attached to the burner is the combustion chamber, all other sections are highly emissive heat exchanger tubes. The standard configuration is straight, but optional "L" shaped, "U" shaped and 5-foot straight heat exchanger tubes are available to change the configuration to adapt to various applications. A tubular system including an optional "U" tube provides the best balance of radiant emission over the length of any system. For maximum efficiency, the exhaust end of all systems is equipped with an aluminized steel turbulator strip.

Combustion air can either come from the heated space or be piped from the outside. Outside combustion air should be supplied (1) if the building atmosphere has negative pressure; (2) if the building atmosphere is dirty or dusty; (3) if the building atmosphere contains substances that will cause toxic gas when combined with flame or flue products; or (4) if the heater is being installed in a tightly closed room that does not provide required air for combustion.

Venting may be either vertical or horizontal. Dual venting of two units is permissible when using a Reznor Optional Dual Vent Kit.

Model VR tubular heater systems are shipped in modular packages requiring field assembly and installation. Standard features, such as wire form hangers for chain suspension, compression coupling tube connections, and terminal board thermostat connection, are designed to facilitate installation.

These heaters are approved for use in the United States and Canada by the Canadian Standards Association (CSA). Reznor provides a five-year limited warranty on the burner and a ten-year limited warranty on all tubes.

STANDARD FEATURES

- Natural gas operation
- Full input rate for elevations to 2,000 ft.
- 115/1 supply voltage
- Multi-try direct ignition with 100% lockout
- Single-stage combination gas valve (field adjustable for operation to 10,000 ft. elevation)
- Pre-purge and post-purge
- Differential air pressure switch to verify combustion air flow
- Diagnostic indicator light
- Sight glass for burner observation
- External terminal board connection for 24-volt thermostat
- Grounded, plug-in cord
- 16-gauge aluminized steel combustion chamber (10 ft. length)
- High emissivity radiant tubes, 16-gauge HRS (10 ft. lengths)
- Compression coupling tube connections
- Wire form hangers
- Polished aluminum reflectors (10 ft. lengths) that overlap for continuous reflector system
- Aluminized steel flue gas turbulators for maximum efficiency
- Horizontal or vertical venting
- Painted Cabinet
- Transformer for 24-volt controls

OPTIONAL FEATURES - Factory Installed

- Single stage propane gas valve (field adjustable for operation to 10,000 ft. elevation)
- 208/1 Supply Voltage (Models 50 - 175)
- 230/1 Supply Voltage (Models 50 - 175)

OPTIONAL FEATURES - Field Installed

- "U" Heat Exchanger Tube with Reflector
- "L" Heat Exchanger Tube(s) with Reflector
- 5-ft. Heat Exchanger Tube with Reflector
- Reflector End Covers
- Side Shield
- Hanger Kit
- Outdoor Combustion Air Inlet Kit
- Dual Vent Kit
- Multiple Heater Control for zoning up to 6 units
- Flexible Gas Connector
- High Altitude Field Conversion Kits (6,000 - 10,000 ft.)
- Unit-Mounted Thermostat Bracket
- Gas conversion kits (natural & propane)
- Vent Cap
- Manual shutoff valve & union
- Thermostat

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Technical Data and Options

Model VR

TECHNICAL DATA

Model No.			50-20	50-30	50-40	75-20	75-30	75-40	100-30	100-40	100-50	125-30	125-40	125-50	125-60
Heating Capacity		BTUH	50,000			75,000			100,000			125,000			
Input		kW	14.7			22.0			29.3			36.6			
No. of 10-ft (3m) Tubes			2	3	4	2	3	4	3	4	5	3	4	5	6
Gas Supply Pressure	Natural	"w.c.	4.5"-14"			4.5"-14"			4.5"-14"			4.5"-14"			
		mbar	11.2 - 34.9			11.2 - 34.9			11.2 - 34.9			11.2 - 34.9			
	Propane	"w.c.	11"-14"			11"-14"			11"-14"			11"-14"			
		mbar	27.4 - 34.9			27.4 - 34.9			27.4 - 34.9			27.4 - 34.9			
Gas Manifold Pressure	Natural	"w.c.	3.5"			3.5"			3.5"			3.5"			
		mbar	8.72			8.72			8.72			8.72			
	Propane	"w.c.	10"			10"			10"			10"			
		mbar	24.9			24.9			24.9			24.9			
Voltage/Phase			115/1			115/1			115/1			115/1			
Frequency (hertz)			60			60			60			60			
Control Amps (24V)			0.8			0.8			0.8			0.8			
Full Load Amps (115V)			1.1			1.1			1.1			0.8			
Net Weight		lbs	121	154	200	121	154	200	154	200	241	154	200	241	274
		kg	55	70	91	55	70	91	70	91	109	70	91	109	124
Ship Weight		lbs	153	186	255	153	186	255	186	255	293	186	255	293	326
		kg	69	84	116	69	84	116	84	116	133	84	116	133	148

Model No.			150-40	150-50	150-60	175-40	175-50	175-60	175-70	200-50	200-60	200-70
Heating Capacity		BTUH	150,000			175,000				200,000		
Input		kW	44.0			51.3				58.6		
No. of 10-ft (3m) Tubes			4	5	6	4	5	6	7	5	6	7
Gas Supply Pressure	Natural	"w.c.	4.5"-14"			6"-14"				6"-14"		
		mbar	11.2 - 34.9			14.9 - 34.9				14.9 - 34.9		
	Propane	"w.c.	11"-14"			11"-14"				11"-14"		
		mbar	27.4 - 34.9			27.4 - 34.9				27.4 - 34.9		
Gas Manifold Pressure	Natural	"w.c.	3.5"			5"				5"		
		mbar	8.72			12.5				125		
	Propane	"w.c.	10"			10"				10"		
		mbar	24.9			24.9				24.9		
Voltage/Phase			115/1			115/1				115/1		
Frequency (hertz)			60			60				60		
Control Amps (24V)			0.8			0.8				0.8		
Full Load Amps (115V)			0.8			1.2				1.2		
Net Weight		lbs	200	241	274	200	241	274	312	241	274	312
		kg	91	109	124	91	109	124	142	109	124	142
Ship Weight		lbs	255	293	326	255	293	326	390	293	326	390
		kg	116	133	148	116	133	148	177	133	148	177

OPTIONS

Reflector End Covers

End caps vertically "close" both the combustion chamber end and the exhaust end heat exchanger of the reflector system.

Side Shield

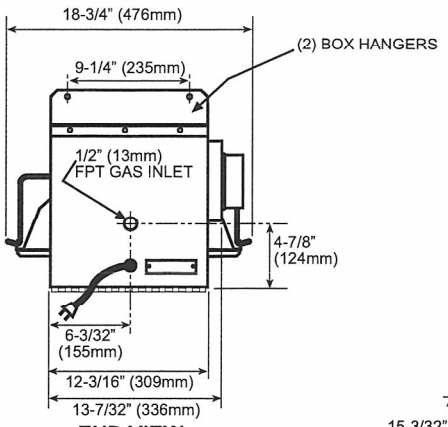
An optional side shield may be added to Model VR heaters. With an optional side shield installed along one side of the length of a straight tubular system, the heater may be installed with much less clearance to combustibles.

The aluminum side shield is a modular design with two sections per 10-ft. tube. The modular sections hang from the tube reflector brackets. Reflector brackets, reflectors, and optional side shield are designed for easy installation.

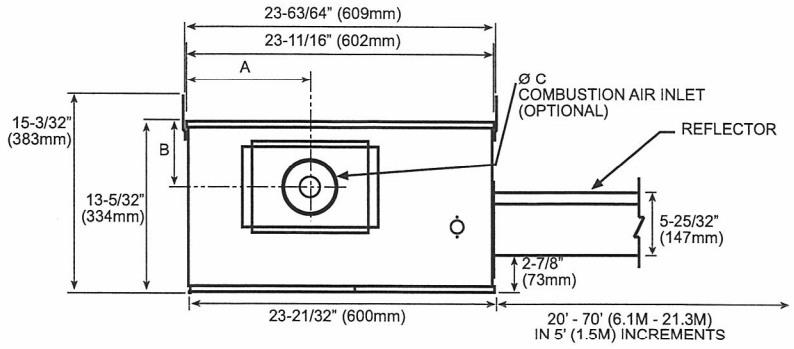
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Dimensions

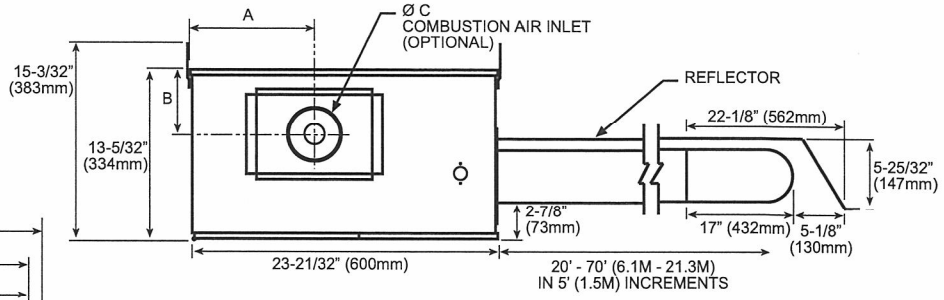
Model VR



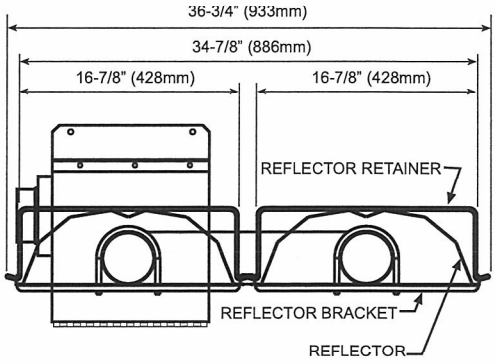
END VIEW



SIDE VIEW



SIDE VIEW
WITH OPTIONAL "U" TUBE



END VIEW
WITH OPTIONAL "U" TUBE

Size	A		B		C	
	in.	mm	in.	mm	in.	mm
50, 75, 100	9 17/32	242	5 1/32	128	4	102
125, 150	9 5/8	244	5 1/16	129	4	102
175, 200	9 5/8	244	5 1/16	129	5	127

5-Foot Heat Exchanger

Five-foot heat exchanger tubes are available to customize a tubular system to "fit" the area needing heat.

Overall minimum and maximum lengths by size do not change:

Order the shorter length system plus the needed quantity of 5-ft. heat exchanger tubes (Option UA1); or, see the "Ordering Methods" section of this catalog for information on how to order and stock the components to build a modular system. Whether ordered as an option or a part, the 5-ft. tube, its reflector, and hardware will arrive in a separately-marked carton.

Note: A 10 ft. tube must always be placed at the exhaust end of the unit.

Size	Alternate Tube Lengths							
50	**Feet**	20	25	30	35	40	--	--
	Meters	6.1	7.6	9.1	10.7	12.2	--	--
75	**Feet**	20	25	30	35	40	--	--
	Meters	6.1	7.6	9.1	10.7	12.2	--	--
100	**Feet**	30	35	40	45	50	--	--
	Meters	9.1	10.7	12.2	13.7	15.2	--	--
125	**Feet**	30	35	40	45	50	55	60
	Meters	9.1	10.7	12.2	13.7	15.2	16.8	18.3
150	**Feet**	40	45	50	55	60	--	--
	Meters	12.2	13.7	15.2	16.8	18.3	--	--
175	**Feet**	40	45	50	55	60	65	70
	Meters	12.2	13.7	15.2	16.8	18.3	19.8	21.3
200	**Feet**	50	55	60	65	70	--	--
	Meters	15.2	16.8	18.3	19.8	21.3	--	--

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Venting Requirements

Model VR

- Compliance with National and Local Codes
- 4" Vent Pipe (26-gauge single-wall galvanized metal)
- Terminal Vent Cap - use Reznor vent cap or equivalent
- Vent Length - see table below

SINGLE WALL METAL VENT PIPE

Model No.			50					75					100					125						
Length		Feet	20	25	30	35	40	20	25	30	35	40	30	35	40	45	50	30	35	40	45	50	55	60
		Meters	6.1	7.6	9.1	10.7	12.2	6.1	7.6	9.1	10.7	12.2	9.1	10.7	12.2	13.7	15.2	9.1	10.7	12.2	13.7	15.2	16.8	18.3
Vent Diameter		in.	4					4					4					4						
		mm	102					102					102					102						
Vent Length	Minimum	Feet	5					5					5					5.0						
		Meters	1.5					1.5					1.5					1.5						
	Maximum	Feet	20					45		35		20	45		35		20	60						
		Meters	6.1					13.7		10.7		6.1	13.7		10.7		6.1	18.3						
Equivalent Length for	90° Elbow	Feet	3					6		5		3	6		5		3	12						
		Meters	0.9					1.8		1.5		0.9	1.8		1.5		0.9	3.7						
	45° Elbow	Feet	1.5					3.0		2.5		1.5	3.0		2.5		1.5	6						
		Meters	0.5					0.9		0.8		0.5	0.9		0.8		0.5	1.8						
	Dual Vent Adapter*	Feet	3					6		5		3	6		5		3	12						
		Meters	0.9					1.8		1.5		0.9	1.8		1.5		0.9	3.7						

Model No.			150					175							200				
Length		Feet	40	45	50	55	60	40	45	50	55	60	65	70	50	55	60	65	70
		Meters	12.2	13.7	15.2	16.8	18.3	12.2	13.7	15.2	16.8	18.3	19.8	21.3	15.2	16.8	18.3	19.8	21.3
Vent Diameter		in.	4					4							4				
		mm	102					102							102				
Vent Length	Minimum	Feet	5					5							5				
		Meters	1.5					1.5							1.5				
	Maximum	Feet	60					60							60				
		Meters	18.3					18.3							18.3				
Equivalent Length for	90° Elbow	Feet	12					12							12				
		Meters	3.7					3.7							3.7				
	45° Elbow	Feet	6.0					6.0							6.0				
		Meters	1.8					1.8							1.8				
	Dual Vent Adapter*	Feet	12					12							12				
		Meters	3.7					3.7							3.7				

- Vent Terminal Direction - Horizontal or Vertical
- Dual Venting - with Optional Dual Vent Kit only**
- Unvented - Approved for Unvented Operation

Factors to Consider for Unvented Operation

- **Check local codes**
- **Fresh Air Requirements - Natural gas, 4 CFM/1000 BTUH; Propane gas, 5 CFM/1000 BTUH**
- **Unvented operation may cause excessive condensation inside the building**
- **Do not operate unvented in dusty or dirty atmosphere**
- **Do not operate unvented in a building where contaminants in the air will produce a toxic gas when burned or exposed to high temperature**
- **Do not operate unvented with outside combustion air**
- **Reznor STRONGLY recommends venting to the outdoors in any applicaton that does not have independent exhaust systems and/or high volumes of dilution with outside air. See installation manuals for unvented operation requirements.**

** Technical data for these options is found elsewhere in this catalog.

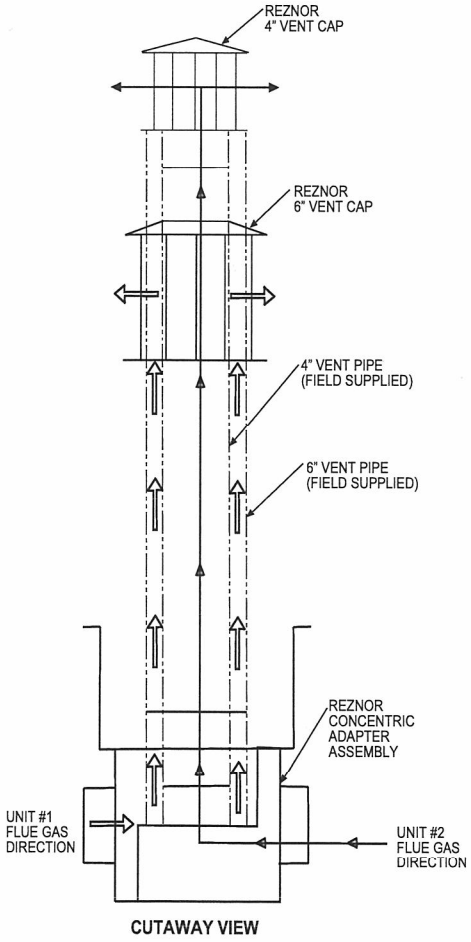
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Venting Requirements and Outside Air Combustion

Model VR

Dual Venting

This design (U.S. Patent No. 5,421,774) allows dual venting of two Model VR heaters. The concentric design of the vent allows each of the two heaters to be safely operated totally independent of the other. Heaters vented through the optional dual vent do not have to match in capacity, length, or configuration and may be controlled by the same or different thermostats.



CUTAWAY VIEW

Outside Combustion Air

Model VR heaters may be operated with combustion air from the heated space or with combustion air piped from outside. If outside combustion air is selected, a Reznor outside combustion air kit must be installed, Outside combustion air may be supplied in any vented application but should always be supplied (1) if the building atmosphere has negative pressure; (2) if the building atmosphere is dirty or dusty; (3) if the building atmosphere contains substances that will cause toxic gas when combined with flame or flue products; (4) if the heater is installed in a tightly closed room that does not provide required air for combustion.

The outside combustion air kit for Model VR heaters includes a section of 4" (5" on sizes 175 & 200) flexible pipe expandable to three feet, a special designed inlet air cap, an air inlet cover with collar, relay with wiring, and two clamps. The maximum length of the field-supplied combustion air pipe depends on the size and length of heater and the type of pipe.

Combustion Air Inlet Length Table

NOTE: Do not install an outside combustion air inlet on an unvented heater.

MAXIMUM LENGTH OF OUTSIDE COMBUSTION AIR INLET PIPE							
TYPE OF INLET PIPE	SIZE	MAXIMUM LENGTH		EQUIVALENT LENGTH FOR 90° Elbow		EQUIVALENT LENGTH FOR 45° Elbow	
	MBH	Feet	Meters	Feet	Meters	Feet	Meters
Smooth Wall[A]	50	80	24.4	10	3.0	5	1.5
	75						
	100						
	125	60	18.3	10	3.0	5	1.5
	150						
	175						
	200						
Corrugated or Flexible	50	40	12.2	N/A	N/A	N/A	N/A
	75						
	100						
	125	30	9.1	N/A	N/A	N/A	N/A
	150						
	175						
	200						

[A] Assumes the use of three feet of flexible pipe at the combustion air inlet on the burner/control box

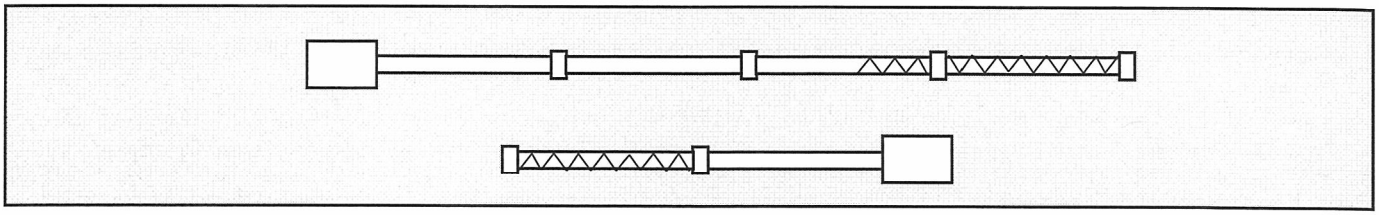
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Heater Configurations

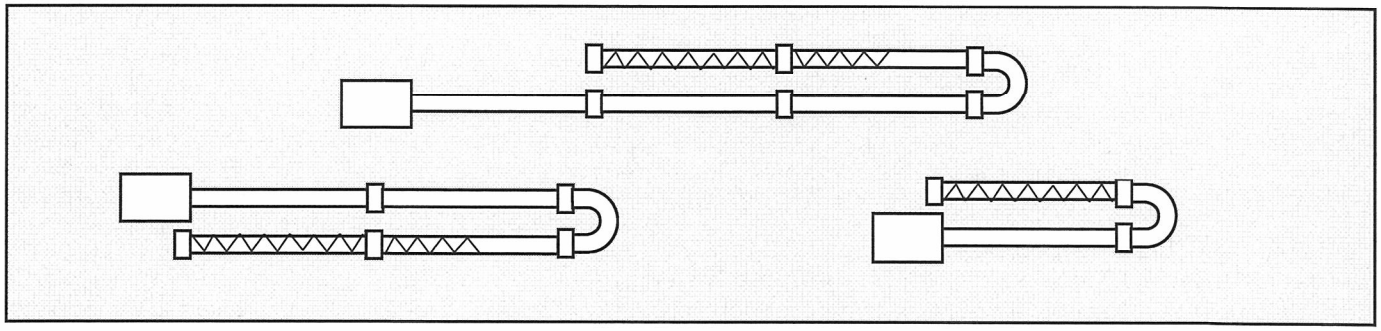
Model VR

An advantage of tubular infrared heating is its versatility in configuration layout. A booklet illustrating all permissible configurations, is available for designing applications. See sample diagrams below. For even harder-to-fit areas, 5-ft. Heat Exchanger Tubes (Option UA1) are available. All configurations require a modular turbulator strip (⧋).

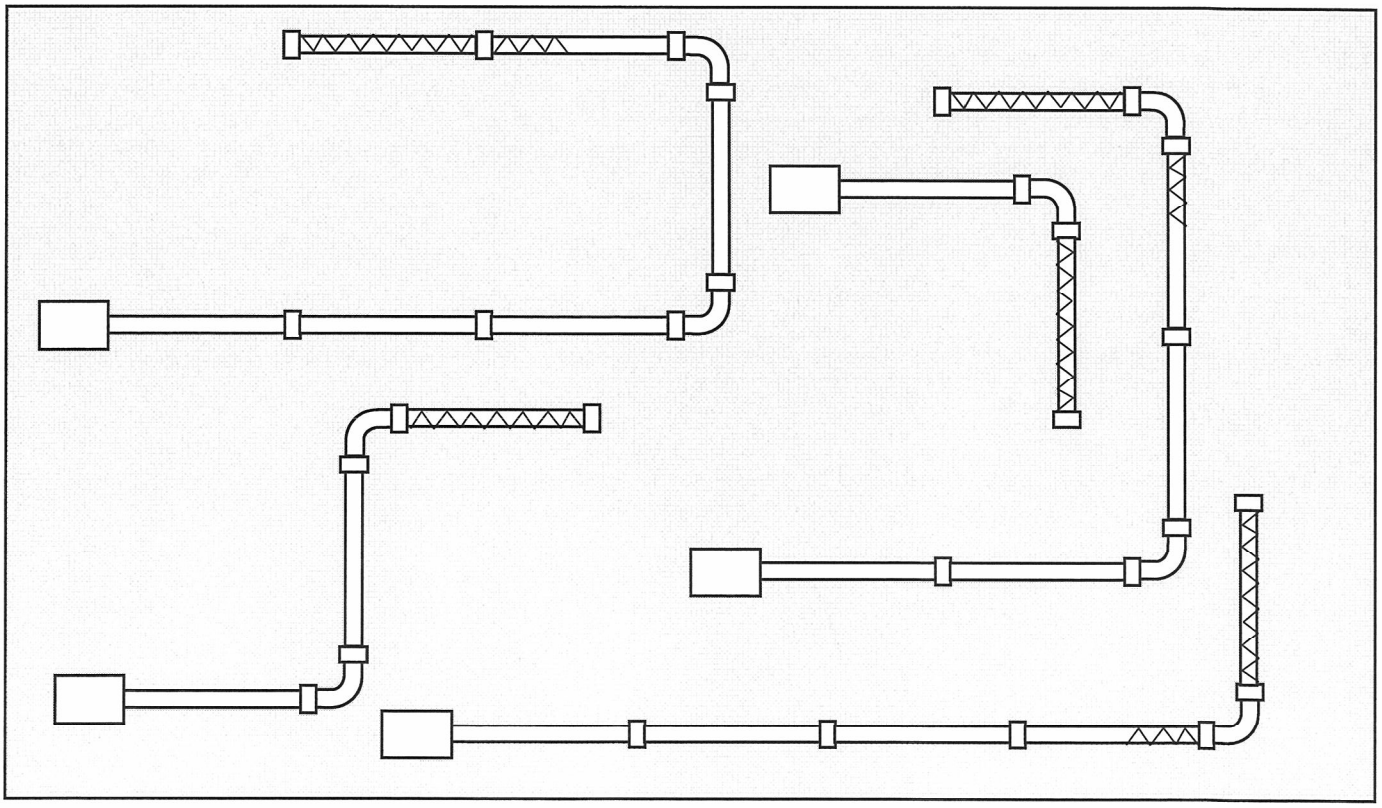
Straight-Standard Configuration for All Sizes and Lengths



"U"-Model VR with a "U" Heat Exchanger Tube, Option UB3



"L"-Model VR with one or two "L" Heat Exchanger Tube(s), Option UC2



IMPORTANT: Do not install an Model VR tubular radiant heater in any configuration other than those intended. For more information, see your Reznor Representative.

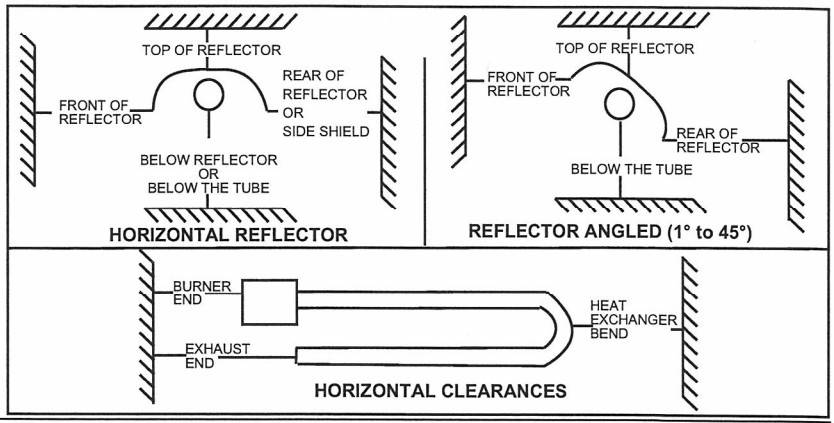
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Clearances to Combustibles

Model VR

Required clearances depend on the size of the heater (BTUH input), the position of the reflector, and the addition of an optional side shield. The side shield is a field-installed, modular shield (2 pieces per 10 ft. tube length). The shield hangs vertically on the "rear" side only, along the entire length of a straight tubular system. Refer to Clearance Orientation Illustrations to define "Top", "Below", "Front", and "Rear" clearances.

The clearances listed are installation requirements. In addition, ANSI Z-223.1, Section 6.18, requires that signs be posted specifying the maximum permissible stacking heights to assure that the required clearances from the heater to combustibles are maintained.



Location Recommendations for Efficient Application

When selecting the installation location, major factors to consider are (1) Personal and Property Safety, (2) Personal Comfort, and (3) Heating Efficiency. Because of the unique features of radiant heat transfer, selecting the most efficient location for infrared equipment depends on the "floor" coverage of the emitted heat rays. Floor coverage distance can be figured as approximately two times the mounting height of the unit. However, comfort level heating depends on the infrared intensity and on the balance of the radiant emission over the length of the system. Infrared intensity decreases with higher mounting heights and greater floor coverage. **IMPORTANT: Another factor when locating the heater in relation to people is that the heat emitted from the burner/combustion chamber end of a tubular infrared heater is more intense that the heat emitted from the exhaust end.** Configurations including an optional "U" tube provide the best balance of radiant emission over the length of the system.

CLEARANCES TO COMBUSTIBLES

SIZE				50	75	100	125	150	175	200
ALL HEATERS	BELOW		in.	66	66	66	78	78	84	84
			mm	1,676	1,676	1,676	1,981	1,981	2,134	2,134
	TOP*		in.	12	12	12	12	12	12	12
			mm	305	305	305	305	305	305	305
	HORIZONTAL CLEARANCES	BURNER END	in.	24	24	24	30	30	30	30
			mm	610	610	610	762	762	762	762
		HEAT EXCHANGER	in.	36	36	36	48	48	48	48
			mm	914	914	914	1,219	1,219	1,219	1,219
		EXHAUST END	in.	24	24	24	24	24	24	24
			mm	610	610	610	610	610	610	610
	VENT		in.	6	6	6	6	6	6	6
			mm	152	152	152	152	152	152	152
WITH REFLECTOR POSITIONED	0 -30°	FRONT	in.	30	30	30	42	42	54	54
			mm	762	762	762	1,067	1,067	1,372	1,372
		REAR	in.	30	30	30	42	42	54	54
			mm	762	762	762	1,067	1,067	1,372	1,372
	31 - 45°	FRONT	in.	48	48	48	66	66	78	78
			mm	1,219	1,219	1,219	1,676	1,676	1,981	1,981
		REAR	in.	18	18	18	32	32	36	36
			mm	457	457	457	813	813	914	914
	0 - 30° WITH SIDE SHIELD	FRONT	in.	36	36	36	42	42	54	54
			mm	914	914	914	1,067	1,067	1,372	1,372
		REAR	in.	12	12	12	12	12	12	12
			mm	305	305	305	305	305	305	305

* If Model VR is unvented, top clearance is 18 inches (457mm).

For space heating infrared applications, the location of the unit must be evaluated as part of the heater size selection. In order to select the proper heater size, determine the total BTUs required, the floor coverage required, and the mounting height. From this information, design a heater size and location plan that will provide the most complete floor coverage without excessive overlapping. In most cases, perimeter heaters should be located parallel to the wall. The distance from the wall to the unit is determined by whether the reflectors will be angled, horizontal, or with side shields.

For spot heating applications, the tubular system should be located to direct the rays toward the area requiring heat. Depending on the installation, this can be done from directly overhead or reflector angled from the side. U-tube configurations are often best suited to overhead spot heating applications. Use the mounting height, the size of the heater, the heater configuration, and the application conditions to determine the most efficient location for the heater.

WARNING: GAS-FIRED APPLIANCES ARE NOT DESIGNED FOR USE IN HAZARDOUS ATMOSPHERES CONTAINING FLAMMABLE VAPORS OR COMBUSTIBLE DUST, OR ATMOSPHERES CONTAINING CHLORINATED OR HALOGENATED HYDROCARBONS. INSTALLATIONS IN PUBLIC GARAGES OR AIRPLANE HANGARS ARE PERMITTED WHEN IN ACCORDANCE WITH ANSI Z83.20/ CSA2.34 AND NFPA-408 AND 88 CODES OR CANI-B149 CODES AND ENFORCING AUTHORITIES.

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Installation

Model VR

Installations of Model VR heaters in the United States must be in accordance with the National Fuel Gas Code ANSI Z-223.1 (latest edition) and all local codes. In Canada, installations must be in accordance with the latest edition of CAN/CSA B149.1 and B149.2 and any local authorities having jurisdiction.

To allow for thermal expansion, Model VR heaters must be suspended with chain and must have flexible gas and electric connections.

Chain must have a minimum load-carrying capacity of 200 lbs. Depending on the type of building construction, the installer may either attach the chain support directly to the building or attach and extend a support to the location needed (all chain supporting tube sections must be plumb). SUPERSTRUT® brackets or a comparable metal strut material is well suited as a support structure that requires numerous suspension points. Model VR heaters must be level. The use of turnbuckles is not required but is recommended to assist in leveling the heater. If used, turnbuckles must be of steel or malleable iron. Optional chain kits and turnbuckle kits are available from Reznor.

Each burner/control box is equipped with a grounded, plug-in electrical cord. Gas connection must be with either an expansion coil or an approved stainless steel flexible connector. Optional flexible connectors are available from Reznor. Flexible connectors do affect gas pressure. Pressure drops for flexible connectors available from Reznor are listed below. (Required gas pressures found in Technical Data Tables.)

Model VR heaters are designed with these installation advantages:

-Modular turbulator strips with interlocking connections

All tube packages include a field-installed turbulator strip. The turbulator strip is slid into the tube in small, easy-to-handle sections. By interlocking the sections as they are installed, the required number of sections can be slid into the tube creating the full-sized turbulator strip.

-Reflector retainers/hangers

Reflectors are required to direct radiant heat. Reflectors, reflector brackets, and hardware "kits" are included in the tube packages. The reflector retainers extend over the installed reflectors securing the reflector to the tube and act as a hanger connection.

-Terminal strip for thermostat connection

The burner/control box is equipped with a terminal strip for connection of a remote thermostat, or the thermostat may be attached to the heater by using an optional thermostat bracket. Up to six heaters may be controlled by one thermostat or time clock by installing a multiple heater control option.

- Tube connections

All tubes are joined by a compression coupling. All required parts for each tube connection are shipped in the tube carton.

RECOMMENDED MINIMUM MOUNTING HEIGHTS								
Reflector Position		Model (000 BTUH Input)						
		50	75	100	125	150	175	200
Horizontal	Feet	11	12	13	15	16	17	18
	Meters	3.4	3.7	4.0	4.6	4.9	5.2	5.5
30° Angle	Feet	9	10	11	13	14	15	16
	Meters	2.7	3.0	3.4	4.0	4.3	4.6	4.9
45° Angle	Feet	8	9	10	11	13	14	15
	Meters	2.4	2.7	3.0	3.4	4.0	4.3	4.6

GAS PRESSURE DROP ("W.C.) THROUGH 24" STAINLESS STEEL FLEXIBLE CONNECTORS AVAILABLE FROM REZNOR								
Size		50	75	100	125	150	175	200
13 mm (1/2") I.D.	in. w.c.	0.25	0.25	0.25	0.50	0.75	0.80	0.90
	mbar	0.62	0.62	0.62	1.25	1.87	1.99	2.24
19 mm (3/4") I.D.	in. w.c.	0.05	0.05	0.10	0.15	0.20	0.40	0.50
	mbar	0.12	0.12	0.25	0.37	0.50	1.00	1.25

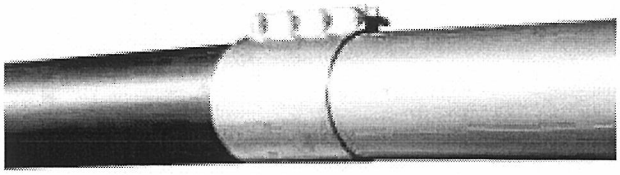
Step 1

Align tubes and insert into compression coupler.



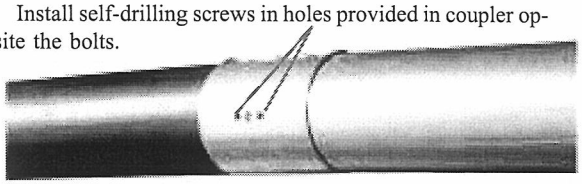
Step 2

Tighten bolts on compression coupler.



Step 3

Install self-drilling screws in holes provided in coupler opposite the bolts.



REZNOR® Packaging Scheme and Ordering

Model VR

Burner Box Packaging Scheme

- **Ordering for a Specific Job -** Burner boxes are factory-built and shipped in the sizes indicated in the table below.
  Tube lengths ordered should match the capacity of the heater ordered.
- **Ordering Burner Boxes for Stock** - Burner boxes are designed for convenience of the stocking distributor.

Tubes for any standard length of heater are packaged in a maximum of only four carton types. The Packaging Scheme allows the stocking distributors to inventory the tube packages in whatever lengths meet their most frequent requirements.

By matching the burner/control boxes and the tube packaging scheme, a variety of heater sizes and lengths are "in stock" with minimum inventory.

Desired MBH Input	Model Number	Heater Tube Length Range
50	VR50	20 - 40 ft.
75	VR75/100	20 - 40 ft.
100	VR75/100[A]	30 - 50 ft.
125	VR125/150	30 - 60 ft.
150	VR125/150[B]	40 - 60 ft.
175	VR175/200	40 - 70 ft.
200	VR175/200[C]	50 - 70 ft.

[A] **VR75/100** - is factory-built as 75 MBH and includes a conversion kit to field-convert to 100 MBH.

[B] **VR125/150** - is factory-built as 125 MBH and includes a conversion kit to field-convert to 150 MBH.

[C] **VR175/200** - is factory-built as 175 MBH and includes a conversion kit to field-convert to 200 MBH.

Tube Packaging Scheme

All cartons include the hardware required for assembly. Each tube package includes the equipment necessary to assemble that section including reflectors, reflector brackets, compression couplings, and turbulator strips.

Packaging of Burner/Control Boxes - Burner/control boxes are shipped in individual cartons. Each carton is identified by the Order No. and the Model and Serial No. of the heater.

Packaging Scheme for Tubes - A maximum of only three packages is required to "build" any standard length of straight tubular system. All packages are identified by No. and contents. Cartons are engineered and packaged to allow for normal freight handling.

Packaging Scheme by Size for Straight Tubes

Contents of Tube Packages				
Part Number	205204	205205	205206	205151
10 ft. (3M) Combustion Chamber Tube	(1)	(1)	-	-
10 ft. (3M) Heat Exchanger Tube	(1)	(2)	(2)	(3)
Turbulators	(4)	(3)	(1)	(2)

Optional tubes are shipped separately in individually labeled cartons.

Shape	Option Number
5 ft. Straight	UA1
"U" Bend	UB3
"L" Bend	UC2

Reznor's packaging scheme keeps the number and variety of packages to a minimum. By limiting the number of different cartons, the packaging scheme is designed to be beneficial for both maintaining inventory and ordering for a specific job.

All Model VR Heaters require a burner/control box, and a combustion chamber tube. The "length" of the system is determined by the number of straight heat exchanger tubes that are positioned after the combustion chamber tube.

Refer to the installation manual to determine correct number of turbulator strips to be installed.

TOTAL SYSTEM LENGTH		REQUIRED COMPONENTS		REQUIRES THE FOLLOWING PART NUMBERS	
		COMBUSTION	HEAT		
Feet	Meters	CHAMBER	EXCHANGERS	1 EACH	2 EACH
20	6.1	1	1	205204	-
30	9.1	1	2	205205	-
40	12.2	1	3	205204 & 205206	-
50	15.2	1	4	205204 & 205151	-
60	18.3	1	5	205205 & 205151	-
70	21.3	1	6	205205	205056

APPENDIX H

ECM-7 Replace Window AC Units with Ductless Split System

North Brunswick

CHA #20418

Building: Department of Public Works

ECM-7: Replace Window AC units w/ Ductless Splits (Electric Efficiency savings sheet)
(utilize remote outdoor condensers)

ASSUMPTIONS				Comments
Electric Cost		$0.162	/ kWh	
Annual Cooling Hours / Year		1,003	Hours/yr	(Assumed to run when outdoor temp. is 70°F or above)
Avg. BTU / Hr Rating of existing AC unit		10,000	Btu / Hr	(typical size for cooling office spaces in this type of building)
Average EER		7.0		Units appear to average 10 years old, EER was 8 when new

Item		Value	Units	Comments
Total Number of Units		2		
Existing Annual Electric Usage		2,864	kWh	
Annual Cooling Hours / Year		1,003	Hours	(Assumed to run when outdoor temp. is 70°F or above)
Proposed EER		14.4		New ductless mini-splits (per manufacturer)
Proposed Annual Electric Usage		1,392	kWh	Unit will cycle on w/ temp of room. Possible operating time shown below

ANNUAL SAVINGS			
Annual Savings		1,472	kWh
Annual Cost Savings		$238	

Set Point		70	deg F

OAT - DB Bin Temp F	Hrs of Occurrence Annually	Cooling Hrs at Temp Above set point	Assumed % of time of operation	Assumed hrs of Operation
102.5	0	0	100%	0
97.5	3	3	100%	3
92.5	34	34	88%	30
87.5	131	131	75%	98
82.5	500	500	63%	313
77.5	620	620	50%	310
72.5	664	664	38%	249
67.5	854	0	25%	0
62.5	927	0	13%	0
57.5	600	0	0%	0
52.5	610	0	0%	0
47.5	611	0	0%	0
42.5	656	0	0%	0
37.5	1,023	0	0%	0
32.5	734	0	0%	0
27.5	334	0	0%	0
22.5	252	0	0%	0
17.5	125	0	0%	0
12.5	47	0	0%	0
7.5	22	0	0%	0
2.5	13	0	0%	0
-2.5	0	0	0%	0
-7.5	0	0	0%	0
Total	8,760	1,952	51%	1003

North Brunswick

CHA #20418

Building: Department of Public Works

ECM-7: Replace Window AC units w/ Ductless Splits (Electric Efficiency savings sheet)

Multipliers	
Material:	0.98
Labor:	1.21
Equipment:	1.09

Description	QTY	UNIT	UNIT COSTS			SUBTOTAL COSTS			TOTAL COST	REMARKS
			MAT.	LABOR	EQUIP.	MAT.	LABOR	EQUIP.		
						$ -	$ -	$ -	$ -	
Window AC Unit Removal	2	LS	$ 75			$ 147	$ -	$ -	$ 147	
						$ -	$ -	$ -	$ -	
Rooftop Condenser	1	LS	$ 5,180			$ 5,076	$ -	$ -	$ 5,076	Includes Labor
Indoor Wall Unit	2	LS	$ 1,310			$ 2,568	$ -	$ -	$ 2,568	Includes Labor & Piping kit
Unit Controllers	2	LS	$ 285			$ 559	$ -	$ -	$ 559	Includes Labor
						$ -	$ -	$ -	$ -	
						$ -	$ -	$ -	$ -	
						$ -	$ -	$ -	$ -	

$	8,350	Subtotal
$	1,670	20% Contingency
$	1,503	15% Contractor O&P
$	-	0% Engineering
$	11,522	**Total**

New Jersey Smart Start Incentive	QTY	UNIT	$ / UNIT	TOTAL SAVINGS	Cost W/O INCENTIV	Cost W/ INCENTIVE
					$ -	$ -
Unitary Split System < 5.4 tons	2	Tons	$92	$184	$ 7,644	$ 7,460
					$ -	$ -
				$184	$7,644	$7,460

Total ECM Cost w/ Incentives	**$11,338**

APPENDIX I

ECM-8 Increase Wall Insulation

North Brunswick
CHA #20418
Building: Department of Public Works

ECM-8A: Increase Wall Insulation in Office Area

Total Existing Wall Area	1,825	sf	
Existing U-value	0.07	Btu/hr/(sf*F)	
Proposed Added Insulation	19	R-Value	5-3/16" R-19 Blown-In, Loose-Fill Insulation
Proposed U-value	0.03	Btu/hr/(sf*F)	
Natural Gas Heat Content	100,000	Btu/Therm	
Heating Equipment Efficiency	83%		
Cooling Equipment EER	8		

Existing Cooling		
Max. North Wall Cooling Load	0	Btu/hr
Max. East Wall Cooling Load	599	Btu/hr
Max. South Wall Cooling Load	1,159	Btu/hr
Max. West Wall Cooling Load	306	Btu/hr

Existing Heating		
Existing Heating Load Temp Diff.	56	F
Existing Max. Wall Heating Load	6,680	Btu/hr

Proposed Cooling		
Max. North Wall Cooling Load	-	Btu/hr
Max. East Wall Cooling Load	267	Btu/hr
Max. South Wall Cooling Load	516	Btu/hr
Max. West Wall Cooling Load	137	Btu/hr

Proposed Heating		
Proposed Max. Heating Load	2,980	Btu/hr

Occupied Cooling Setpoint	73	F
Unoccupied Cooling Setpoint	73	F

Occupied Heating Setpoint	70	F
Unoccupied Heating Setpoint	70	F

Existing Cooling Total	43	kWh/yr
Proposed Cooling Total	19	kWh/yr
Savings	24	**kWh/yr**

Existing Heating Total	277	Therm/yr
Proposed Heating Total	124	Therm/yr
Savings	154	**Therm/yr**

				Occupied				Unoccupied							
Avg Outdoor Air Temp. Bins °F	**Existing Equipment Bin Hours**	**Occupied Equipment Bin Hours**	**Unoccupied Equipment Bin Hours**	**Existing Heat Gain**	**Proposed Heat Gain**	**Existing Heat Loss**	**Proposed Heat Loss**	**Existing Heat Gain**	**Proposed Heat Gain**	**Existing Heat Loss**	**Proposed Heat Loss**	**Existing Cooling Load**	**Existing Heating Load**	**Proposed Cooling Load**	**Proposed Heating Load**
				(Btu/hr)	(Btu/hr)	(Btu/hr)	(Btu/hr)	(Btu/hr)	(Btu/hr)	(Btu/hr)	(Btu/hr)	(kWh/yr)	(Therm/yr)	(kWh/yr)	(Therm/yr)
97.5	0	0	0	2,064	921	-	-	2,064	921	-	-	-	-	-	-
92.5	3	1	2	1,643	733	-	-	1,643	733	-	-	1	-	0	-
87.5	34	11	23	1,222	545	-	-	1,222	545	-	-	5	-	2	-
82.5	131	41	90	800	357	-	-	800	357	-	-	13	-	6	-
77.5	500	158	342	379	169	-	-	379	169	-	-	24	-	11	-
72.5	620	196	424	-	-	-	-	-	-	-	-	-	-	-	-
67.5	664	209	455	-	-	298	133	-	-	298	133	-	2	-	1
62.5	854	269	585	-	-	895	399	-	-	895	399	-	9	-	4
57.5	927	292	635	-	-	1,491	665	-	-	1,491	665	-	17	-	7
52.5	600	189	411	-	-	2,087	931	-	-	2,087	931	-	15	-	7
47.5	610	192	418	-	-	2,684	1,197	-	-	2,684	1,197	-	20	-	9
42.5	611	193	418	-	-	3,280	1,463	-	-	3,280	1,463	-	24	-	11
37.5	656	207	449	-	-	3,877	1,729	-	-	3,877	1,729	-	31	-	14
32.5	1,023	323	700	-	-	4,473	1,995	-	-	4,473	1,995	-	55	-	25
27.5	734	232	502	-	-	5,069	2,261	-	-	5,069	2,261	-	45	-	20
22.5	334	105	229	-	-	5,666	2,527	-	-	5,666	2,527	-	23	-	10
17.5	252	80	173	-	-	6,262	2,793	-	-	6,262	2,793	-	19	-	8
12.5	125	39	86	-	-	6,859	3,059	-	-	6,859	3,059	-	10	-	5
7.5	47	15	32	-	-	7,455	3,325	-	-	7,455	3,325	-	4	-	2
2.5	22	7	15	-	-	8,051	3,591	-	-	8,051	3,591	-	2	-	1
-2.5	13	4	9	-	-	8,648	3,858	-	-	8,648	3,858	-	1	-	1
-7.5	0	0	0	-	-	9,244	4,124	-	-	9,244	4,124	-	-	-	-
TOTALS	**8,760**	**2,764**	**5,996**									**43**	**277**	**19**	**124**

North Brunswick
CHA #20418
Building: Department of Public Works

ECM-8B: Increase Wall Insulation in Garage Area

Total Existing Wall Area	10,247	sf	
Existing U-value	0.08	Btu/hr/(sf*F)	
Proposed Added Insulation	12	R-Value	3" R-12 Expanded Polystyrene Board Insulation
Proposed U-value	0.04	Btu/hr/(sf*F)	
Natural Gas Heat Content	100,000	Btu/Therm	
Heating Equipment Efficiency	77%		

Existing Cooling		
Max. North Wall Cooling Load	5,571	Btu/hr
Max. East Wall Cooling Load	5,834	Btu/hr
Max. South Wall Cooling Load	6,122	Btu/hr
Max. West Wall Cooling Load	3,251	Btu/hr
Proposed Cooling		
Max. North Wall Cooling Load	2,820	Btu/hr
Max. East Wall Cooling Load	2,953	Btu/hr
Max. South Wall Cooling Load	3,099	Btu/hr
Max. West Wall Cooling Load	1,666	Btu/hr
Occupied Cooling Setpoint	74	F
Unoccupied Cooling Setpoint	74	F
Existing Cooling Total	877	kWh/yr
Proposed Cooling Total	444	kWh/yr
Savings	433	kWh/yr

Existing Heating		
Existing Heating Load Temp Diff.	51	F
Existing Max. Wall Heating Load	42,487	Btu/hr
Proposed Heating		
Proposed Max. Heating Load	21,506	Btu/hr
Occupied Heating Setpoint	65	F
Unoccupied Heating Setpoint	65	F
Existing Heating Total	1,704	Therm/yr
Proposed Heating Total	863	Therm/yr
Savings	842	Therm/yr

				Occupied				Unoccupied							
Avg Outdoor Air Temp. Bins °F	Existing Equipment Bin Hours	Occupied Equipment Bin Hours	Unoccupied Equipment Bin Hours	Existing Heat Gain (Btu/hr)	Proposed Heat Gain (Btu/hr)	Existing Heat Loss (Btu/hr)	Proposed Heat Loss (Btu/hr)	Existing Heat Gain (Btu/hr)	Proposed Heat Gain (Btu/hr)	Existing Heat Loss (Btu/hr)	Proposed Heat Loss (Btu/hr)	Existing Cooling Load (kWh/yr)	Existing Heating Load (Therm/yr)	Proposed Cooling Load (kWh/yr)	Proposed Heating Load (Therm/yr)
97.5	0	0	0	20,818	10,537	-	-	20,818	10,537	-	-	-	-	-	-
92.5	3	1	2	16,388	8,295	-	-	16,388	8,295	-	-	14	-	7	-
87.5	34	11	23	11,959	6,053	-	-	11,959	6,053	-	-	119	-	60	-
82.5	131	41	90	7,530	3,811	-	-	7,530	3,811	-	-	289	-	146	-
77.5	500	158	342	3,101	1,569	-	-	3,101	1,569	-	-	454	-	230	-
72.5	620	196	424	-	-	-	-	-	-	-	-	-	-	-	-
67.5	664	209	455	-	-	-	-	-	-	-	-	-	-	-	-
62.5	854	269	585	-	-	2,083	1,054	-	-	2,083	1,054	-	23	-	12
57.5	927	292	635	-	-	6,248	3,163	-	-	6,248	3,163	-	75	-	38
52.5	600	189	411	-	-	10,414	5,271	-	-	10,414	5,271	-	81	-	41
47.5	610	192	418	-	-	14,579	7,379	-	-	14,579	7,379	-	115	-	58
42.5	611	193	418	-	-	18,744	9,488	-	-	18,744	9,488	-	149	-	75
37.5	656	207	449	-	-	22,910	11,596	-	-	22,910	11,596	-	195	-	99
32.5	1,023	323	700	-	-	27,075	13,705	-	-	27,075	13,705	-	360	-	182
27.5	734	232	502	-	-	31,241	15,813	-	-	31,241	15,813	-	298	-	151
22.5	334	105	229	-	-	35,406	17,922	-	-	35,406	17,922	-	154	-	78
17.5	252	80	173	-	-	39,571	20,030	-	-	39,571	20,030	-	130	-	66
12.5	125	39	86	-	-	43,737	22,138	-	-	43,737	22,138	-	71	-	36
7.5	47	15	32	-	-	47,902	24,247	-	-	47,902	24,247	-	29	-	15
2.5	22	7	15	-	-	52,068	26,355	-	-	52,068	26,355	-	15	-	8
-2.5	13	4	9	-	-	56,233	28,464	-	-	56,233	28,464	-	9	-	5
-7.5	0	0	0	-	-	60,398	30,572	-	-	60,398	30,572	-	-	-	-
TOTALS	**8,760**	**2,764**	**5,996**									**877**	**1,704**	**444**	**863**

North Brunswick
CHA #20418
Building: Department of Public Works

ECM-8A: Increase Wall Insulation in Office Area
ECM-8B: Increase Wall Insulation in Garage Area

Multipliers	
Material:	0.98
Labor:	1.21
Equipment:	1.09

Description	QTY	UNIT	UNIT COSTS			SUBTOTAL COSTS			TOTAL COST	REMARKS
			MAT.	LABOR	EQUIP.	MAT.	LABOR	EQUIP.		
						$ -	$ -	$ -	$ -	
5-3/16" R-19 Blown-In, Loose-Fill Insulation	1,825	SQFT	$0.28	$0.20	$0.09	$ 501	$ 442	$ 179	$ 1,121	Office Area
3" R-12 Expanded Polystyrene Board Insulation	10,247	SQFT	$0.83	$0.44		$ 8,285	$ 5,455	$ -	$ 13,740	Garage Area
						$ -	$ -	$ -	$ -	
						$ -	$ -	$ -	$ -	
						$ -	$ -	$ -	$ -	
						$ -	$ -	$ -	$ -	
						$ -	$ -	$ -	$ -	
						$ -	$ -	$ -	$ -	
						$ -	$ -	$ -	$ -	
						$ -	$ -	$ -	$ -	

$14,862	Subtotal
$2,972	20% Contingency
$2,675	15% Contractor O&P
$0	Engineering
$20,509	**Total**

APPENDIX J

ECM-9 Increase Roof Insulation

North Brunswick
CHA #20418
Building: Department of Public Works

ECM-9A: Install Roof Insulation in Office Area

Existing Roof Area	4,000	sf	
Existing U-value	0.04	Btu/hr/(sf*F)	
Proposed Added Insulation	12	R-Value	3" R-12 Expanded Polystyrene Board Insulation
Proposed U-value	0.03	Btu/hr/(sf*F)	
NG Heat Content	100,000	Btu/Therm	
Heating Equipment Efficiency	83%		
Cooling Equipment EER	8		

Existing Cooling			Existing Heating		
Existing Cooling Load Temp Diff.	73	F	Existing Heating Load Temp Diff.	56	F
Existing Max. Roof Cooling Load	12,426	Btu/hr	Existing Max. Roof Heating Load	9,532	Btu/hr
Proposed Cooling			Proposed Heating		
Proposed Cooling Load	8,225	Btu/hr	Proposed Heating Load	6,310	Btu/hr
Occupied Cooling Setpoint	73	F	Occupied Heating Setpoint	70	F
Unoccupied Cooling Setpoint	73	F	Unoccupied Heating Setpoint	70	F

Existing Heating Total	323	Therms/yr
Proposed Heating Total	214	Therms/yr
Savings	109	**Therms/yr**
Existing Cooling Total	217	kWh/yr
Proposed Cooling Total	143	kWh/yr
Savings	73	**kWh/yr**

				Occupied				Unoccupied							
Avg Outdoor Air Temp. Bins °F	Existing Equipment Bin Hours	Occupied Equipment Bin Hours	Unoccupied Equipment Bin Hours	Existing Heat Gain	Proposed Heat Gain	Existing Heat Loss	Proposed Heat Loss	Existing Heat Gain	Proposed Heat Gain	Existing Heat Loss	Proposed Heat Loss	Existing Cooling Load	Existing Heating Load	Proposed Cooling Load	Proposed Heating Load
				(Btu/hr)	(Btu/hr)	(Btu/hr)	(Btu/hr)	(Btu/hr)	(Btu/hr)	(Btu/hr)	(Btu/hr)	(kWh/yr)	(Therms/yr)	(kWh/yr)	(Therms/yr)
102.5	0	0	0	5,021	3,324	-	-	5,021	3,324	-	-	-	-	-	-
97.5	3	1	2	4,170	2,761	-	-	4,170	2,761	-	-	2	-	1	-
92.5	34	11	23	3,319	2,197	-	-	3,319	2,197	-	-	14	-	9	-
87.5	131	41	90	2,468	1,634	-	-	2,468	1,634	-	-	40	-	27	-
82.5	500	158	342	1,617	1,070	-	-	1,617	1,070	-	-	101	-	67	-
77.5	620	196	424	766	507	-	-	766	507	-	-	59	-	39	-
72.5	664	209	455	-	-	-	-	-	-	-	-	-	-	-	-
67.5	854	269	585	-	-	426	282	-	-	426	282	-	4	-	3
62.5	927	292	635	-	-	1,277	845	-	-	1,277	845	-	14	-	9
57.5	600	189	411	-	-	2,128	1,408	-	-	2,128	1,408	-	15	-	10
52.5	610	192	418	-	-	2,979	1,972	-	-	2,979	1,972	-	22	-	14
47.5	611	193	418	-	-	3,830	2,535	-	-	3,830	2,535	-	28	-	19
42.5	656	207	449	-	-	4,681	3,099	-	-	4,681	3,099	-	37	-	24
37.5	1,023	323	700	-	-	5,532	3,662	-	-	5,532	3,662	-	68	-	45
32.5	734	232	502	-	-	6,383	4,225	-	-	6,383	4,225	-	56	-	37
27.5	334	105	229	-	-	7,234	4,789	-	-	7,234	4,789	-	29	-	19
22.5	252	80	173	-	-	8,085	5,352	-	-	8,085	5,352	-	25	-	16
17.5	125	39	86	-	-	8,936	5,915	-	-	8,936	5,915	-	13	-	9
12.5	47	15	32	-	-	9,787	6,479	-	-	9,787	6,479	-	6	-	4
7.5	22	7	15	-	-	10,638	7,042	-	-	10,638	7,042	-	3	-	2
2.5	13	4	9	-	-	11,489	7,606	-	-	11,489	7,606	-	2	-	1
-2.5	0	0	0	-	-	12,340	8,169	-	-	12,340	8,169	-	-	-	-
-7.5	0	0	0	-	-	13,191	8,732	-	-	13,191	8,732	-	-	-	-
TOTALS	**8,760**	**2,764**	**5,996**									**217**	**323**	**143**	**214**

North Brunswick
CHA #20418
Building: Department of Public Works

ECM-9B: Install Roof Insulation in Garage Area

Existing Roof Area	14,400	sf	
Existing U-value	0.05	Btu/hr/(sf*F)	
Proposed Added Insulation	12	R-Value	3" R-12 Expanded Polystyrene Board Insulation
Proposed U-value	0.03	Btu/hr/(sf*F)	
NG Heat Content	100,000	Btu/Therm	
Heating Equipment Efficiency	77%		

Existing Cooling		
Existing Cooling Load Temp Diff.	73	F
Existing Max. Roof Cooling Load	50,057	Btu/hr
Proposed Cooling		
Proposed Cooling Load	31,855	Btu/hr
Occupied Cooling Setpoint	74	F
Unoccupied Cooling Setpoint	74	F

Existing Heating		
Existing Heating Load Temp Diff.	51	F
Existing Max. Roof Heating Load	34,971	Btu/hr
Proposed Heating		
Proposed Heating Load	22,255	Btu/hr
Occupied Heating Setpoint	65	F
Unoccupied Heating Setpoint	65	F

Existing Heating Total	1,119	Therms/yr
Proposed Heating Total	712	Therms/yr
Savings	**407**	**Therms/yr**
Existing Cooling Total	1,786	kWh/yr
Proposed Cooling Total	1,136	kWh/yr
Savings	**649**	**kWh/yr**

				Occupied				Unoccupied							
Avg Outdoor Air Temp. Bins °F	Existing Equipment Bin Hours	Occupied Equipment Bin Hours	Unoccupied Equipment Bin Hours	Existing Heat Gain	Proposed Heat Gain	Existing Heat Loss	Proposed Heat Loss	Existing Heat Gain	Proposed Heat Gain	Existing Heat Loss	Proposed Heat Loss	Existing Cooling Load	Existing Heating Load	Proposed Cooling Load	Proposed Heating Load
				(Btu/hr)	(Btu/hr)	(Btu/hr)	(Btu/hr)	(Btu/hr)	(Btu/hr)	(Btu/hr)	(Btu/hr)	(kWh/yr)	(Therms/yr)	(kWh/yr)	(Therms/yr)
102.5	0	0	0	19543	12436	0	0	19543	12436	0	0	-	-	-	-
97.5	3	1	2	16114	10255	0	0	16114	10255	0	0	14	-	9	-
92.5	34	11	23	12686	8073	0	0	12686	8073	0	0	126	-	80	-
87.5	131	41	90	9257	5891	0	0	9257	5891	0	0	355	-	226	-
82.5	500	158	342	5829	3709	0	0	5829	3709	0	0	854	-	543	-
77.5	620	196	424	2400	1527	0	0	2400	1527	0	0	436	-	277	-
72.5	664	209	455	0	0	0	0	0	0	0	0	-	-	-	-
67.5	854	269	585	0	0	0	0	0	0	0	0	-	-	-	-
62.5	927	292	635	0	0	1714	1091	0	0	1714	1091	-	21	-	13
57.5	600	189	411	0	0	5143	3273	0	0	5143	3273	-	40	-	26
52.5	610	192	418	0	0	8571	5455	0	0	8571	5455	-	68	-	43
47.5	611	193	418	0	0	12000	7636	0	0	12000	7636	-	95	-	61
42.5	656	207	449	0	0	15429	9818	0	0	15429	9818	-	131	-	84
37.5	1,023	323	700	0	0	18857	12000	0	0	18857	12000	-	251	-	159
32.5	734	232	502	0	0	22286	14182	0	0	22286	14182	-	212	-	135
27.5	334	105	229	0	0	25714	16364	0	0	25714	16364	-	112	-	71
22.5	252	80	173	0	0	29143	18545	0	0	29143	18545	-	95	-	61
17.5	125	39	86	0	0	32571	20727	0	0	32571	20727	-	53	-	34
12.5	47	15	32	0	0	36000	22909	0	0	36000	22909	-	22	-	14
7.5	22	7	15	0	0	39429	25091	0	0	39429	25091	-	11	-	7
2.5	13	4	9	0	0	42857	27273	0	0	42857	27273	-	7	-	5
-2.5	0	0	0	0	0	46286	29455	0	0	46286	29455	-	-	-	-
-7.5	0	0	0	0	0	49714	31636	0	0	49714	31636	-	-	-	-
TOTALS	**8,760**	**2,764**	**5,996**									**1,786**	**1,119**	**1,136**	**712**

North Brunswick
CHA #20418
Building: Department of Public Works

ECM-9A: Install Roof Insulation in Office Area
ECM-9B: Install Roof Insulation in Garage Area

Multipliers	
Material:	0.98
Labor:	1.21
Equipment:	1.09

Description	QTY	UNIT	UNIT COSTS			SUBTOTAL COSTS			TOTAL COST	REMARKS
			MAT.	LABOR	EQUIP.	MAT.	LABOR	EQUIP.		
						$ -	$ -	$ -	$ -	
3" R-12 Expanded Polystyrene Board Insulation	4,000	SQFT	$0.83	$0.44		$ 3,234	$ 2,130	$ -	$ 5,364	Office Area
3" R-12 Expanded Polystyrene Board Insulation	14,400	SQFT	$0.83	$0.44		$ 11,642	$ 7,667	$ -	$ 19,309	Garage Area
						$ -	$ -	$ -	$ -	
						$ -	$ -	$ -	$ -	
						$ -	$ -	$ -	$ -	
						$ -	$ -	$ -	$ -	
						$ -	$ -	$ -	$ -	
						$ -	$ -	$ -	$ -	
						$ -	$ -	$ -	$ -	
						$ -	$ -	$ -	$ -	

$24,673	Subtotal
$4,935	20% Contingency
$4,441	15% Contractor O&P
$0	Engineering
$34,048	**Total**

APPENDIX K

ECM- 10 Eliminate DHW Storage Tanks and Circulating Pump

North Brunswick
CHA #20418
Building: Department of Public Works

ECM-10A: Eliminate DHW Storage Tanks

Summary

Remove from service two 75 gallon hot water storage tanks

Item	Value	Units	Formula/Comments
Avg. Monthly Utility Demand by Water Heater	**130**	Therms/month	Calculated from utility bill
Total Annual Utility Demand by Water Heater	156,000	MBTU/yr	1therm = 100 MBTU
Existing DHW Heater Efficiency	80%		Per manufacturer nameplate
Total Annual Hot Water Demand (w/ standby losses)	124,800	MBTU/yr	
Existing Tank Size	215	Gallons	65 Gal DHW Heater tank plus two 75 Gal storage tanks
Hot Water Piping System Capacity	0	Gallons	Piping is negligible for this calculation
Hot Water Temperature	120	°F	Per building personnel
Room Temperature	70	°F	
Standby Losses (% by Volume)	2.5%		(2.5% of stored capacity per hour, per U.S. Department of Energy)
Standby Losses (Heat Loss)	2.2	MBH	
Annual Standby Hot Water Load	19,619	MBTU/yr	
New Tank Size	65	Gallons	Just Existing DHW Heater Tank. Removed storage tanks
Hot Water Piping System Capacity	0	Gallons	Piping is negligible for this calculation
Hot Water Temperature	120	°F	Reduced DHW temperature
Room Temperature	70	°F	
Standby Losses (% by Volume)	2.5%		(2.5% of stored capacity per hour, per U.S. Department of Energy)
Standby Losses (Heat Loss)	0.7	MBH	
Annual Standby Hot Water Load	5,931	MBTU/yr	
Total Annual Hot Water Demand	111,113	MBTU/yr	
Proposed Avg. Hot water heater efficiency	80%		Same as above. Not Changing DHW Heater
Proposed Fuel Use	1,389	Therms	Standby Losses and inefficient DHW heater eliminated
Utility Cost	$1.41	$/Therm	
Existing Operating Cost of DHW	$2,200	$/yr	
Proposed Operating Cost of DHW	$1,958	$/yr	

Savings Summary:

Utility	Energy Savings	Cost Savings
Therms/yr	171	$241

North Brunswick
CHA #20418
Building: Department of Public Works

ECM-10B: Remove Domestic Hot Water Circulation Pump

Savings Analysis

		Operating Values						Annual	kWh	
#	Description	HP	Efficiency	Volts	Amps	Load Factor	Watts	Hours	Savings	Remarks
1	DHW Circ Pump	1/25	-	115	0.760	0.8	69.9	8,760	612	Circulating pump to be removed w/o replacement
2										
		0.04			**0.76**		**69.9**		**612**	

Annual Savings
612 kWh

North Brunswick
CHA #20418
Building: Department of Public Works

ECM-10A: Eliminate DHW Storage Tanks
ECM-10B: Remove Domestic Hot Water Circulation Pump

Multipliers	
Material:	0.98
Labor:	1.21
Equipment:	1.09

Description	QTY	UNIT	UNIT COSTS			SUBTOTAL COSTS			TOTAL COST	REMARKS
			MAT.	LABOR	EQUIP.	MAT.	LABOR	EQUIP.		
						$ -	$ -	$ -	$ -	
DHW Storage Tank Removal	2	LS		$ 50		$ -	$ 121	$ -	$ 121	
DHW Circulator Pump Removal	1	LS		$ 60		$ -	$ 73	$ -	$ 73	
Miscellaneous Piping and Valves	1	LS	$ 500			$ 490	$ -	$ -	$ 490	
						$ -	$ -	$ -	$ -	
						$ -	$ -	$ -	$ -	
						$ -	$ -	$ -	$ -	
						$ -	$ -	$ -	$ -	
						$ -	$ -	$ -	$ -	
						$ -	$ -	$ -	$ -	
						$ -	$ -	$ -	$ -	

$	684	Subtotal
$	103	15% Contingency
$	118	15% Contractor O&P
$	-	0% Engineering
$	**904**	**Total**

APPENDIX L

New Jersey Pay For Performance Inventive Program

North Brunswick
CHA #20418
Department of Public Works

New Jersey Pay For Performance Incentive Program

Note: The following calculation is based on the New Jersey Pay For Performance Incentive Program per September, 2009. The values represented below are only applicable through December 31, 2009.

	Annual Utilities	
	kWh	Therms
Existing Usage	119,880	21,060
Proposed Savings	44,131	7,292
Existing Total MMBtus	2,515	
Proposed Savings MMBtus	880	
% Reduction	35.0%	
Proposed Annual Savings	$17,448	

	≥%15 - < 20%	
	$/kWh	$/therm
Incentive #2	$0.11	$1.10
Incentive #3	$0.07	$0.70

	≥20%	
	$/kWh	$/therm
Incentive #2	$0.22	$2.20
Incentive #3	$0.14	$1.40

	Incentives $		
	Elec	Gas	Total
Incentive #2	$9,709	$16,042	$25,750
Incentive #3	$6,178	$10,208	$16,387
Totals	**$15,887**	**$26,250**	**$42,137**

Total Project Cost	$128,760
% Incentives of Project Cost*	32.7%
Project Cost w/ Incentives*	$86,623

Project Payback (years)	
w/o Incentives	w/ Incentives
7.4	5.0

* Maximum allowable incentive is 80% of total project cost, or
$2 million per gas account and $2 million per electric account

Note: Savings and project cost includes ECM-3 and not ECM-1 and ECM-2.

APPENDIX M

Photovoltaic (PV) Rooftop Solar Power Generation

PVWatts * * * AC Energy & Cost Savings

Cautions for Interpreting the Results

Station Identification	
City:	Newark
State:	New_Jersey
Latitude:	40.70° N
Longitude:	74.17° W
Elevation:	9 m
PV System Specifications	
DC Rating:	20.0 kW
DC to AC Derate Factor:	0.770
AC Rating:	15.4 kW
Array Type:	Fixed Tilt
Array Tilt:	40.7°
Array Azimuth:	180.0°
Energy Specifications	
Cost of Electricity:	16.2 ¢/kWh

Results			
Month	Solar Radiation (kWh/m^2/day)	AC Energy (kWh)	Energy Value ($)
1	3.36	1656	268.27
2	4.05	1788	289.66
3	4.58	2169	351.38
4	4.84	2119	343.28
5	5.30	2335	378.27
6	5.33	2202	356.72
7	5.27	2224	360.29
8	5.25	2201	356.56
9	5.06	2135	345.87
10	4.46	2011	325.78
11	3.15	1435	232.47
12	2.87	1384	224.21
Year	4.46	23660	3832.92

Output Hourly Performance Data

About the Hourly Performance Data

*

Output Results as Text

Saving Text from a Browser

Run PVWATTS v.1 for another US location or an International location
Run PVWATTS v.2 (US only)

Please send questions and comments regarding PVWATTS to Webmaster

Disclaimer and copyright notice

Cautions for Interpreting the Results

The monthly and yearly energy production are modeled using the PV system parameters you selected and weather data that are typical or representative of long-term averages. For reference, or comparison with local information, the solar radiation values modeled for the PV array are included in the performance results.

Because weather patterns vary from year-to-year, the values in the tables are better indicators of long-term performance than performance for a particular month or year. PV performance is largely proportional to the amount of solar radiation received, which may vary from the long-term average by ± 30% for monthly values and ± 10% for yearly values. How the solar radiation might vary for your location may be evaluated by examining the tables in the *Solar Radiation Data Manual for Flat-Plate and Concentrating Collectors* (*http://rredc.nrel.gov/solar/old_data/nsrdb/redbook/*).

For these variations and the uncertainties associated with the weather data and the model used to model the PV performance, future months and years may be encountered where the actual PV performance is less than or greater than the values shown in the table. The variations may be as much as 40% for individual months and up to 20% for individual years. Compared to long-term performance over many years, the values in the table are accurate to within 10% to 12%.

If the default overall DC to AC derate factor is used, the energy values in the table will overestimate the actual energy production if nearby buildings, objects, or other PV modules and array structure shade the PV modules; if tracking mechanisms for one- and two-axis tracking systems do not keep the PV arrays at the optimum orientation with respect to the sun's position; if soiling or snow cover related losses exceed 5%; or if the system performance has degraded from new. (PV performance typically degrades 1% per year.) If any of these situations exist, an overall DC to AC derate factor should be used with PVWATTS that was calculated using system specific component derate factors for *shading*, *sun-tracking*, *soiling*, and *age*.

The PV system size is the nameplate DC power rating. The energy production values in the table are valid only for crystalline silicon PV systems.

The cost savings are determined as the product of the number of kilowatt hours (kWh) and the cost of electricity per kWh. These cost savings occur if the owner uses all the electricity produced by the PV system, or if the owner has a net-metering agreement with the utility. With net-metering, the utility bills the owner for the net electricity consumed. When electricity flows from the utility to the owner, the meter spins forward. When electricity flows from the PV system to the utility, the meter spins backwards.

If net-metering isn't available and the PV system sends surplus electricity to the utility grid, the utility generally buys the electricity from the owner at a lower price than the owner pays the utility for electricity. In this case, the cost savings shown in the table should be reduced.

Besides the cost savings shown in the table, other benefits of PV systems include greater energy independence and a reduction in fossil fuel usage and air pollution. For commercial customers, additional cost savings may come from reducing demand charges. Homeowners can often include the cost of the PV system in their home mortgage as a way of accommodating the PV system's initial cost.

To accelerate the use of PV systems, many state and local governments offer financial incentives and programs. Go to http://www.nrel.gov/stateandlocal for more information.

bing
Cherry Ln
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APPENDIX N

Solar Thermal Domestic Hot Water Plant

Home

What Can I Do?

Electric Choice

Home Energy

FAQs

LEARN
Fact Sheets
Lesson Plans

PLAY
Calculators

NETWORK
Organizations
Businesses
Events Calendar

BROWSE
Resources
Solar
Wind
Biomass
Geothermal
Water

Projects

TX Energy - Past and Present

Financial Help

About Us

About SECO

RARE

Interactive Energy Calculators

RENEWABLE ENERGY
THE INFINITE POWER OF TEXAS

Our calculators help you understand energy production and consumption in a whole new way. Use them to develop a personal profile of your own energy use.

Carbon Pollution Calculator
Electric Power Pollution Calculator
PV System Economics
Solar Water Heating
What's a Watt?

Solar Water Heating Calculator

Water heating is a major energy consumer. Although the energy consumed daily is often less than for air conditioning or heating, it is required year round, making it a good application of solar energy. Use this calculator to explore the energy usage of your water heater, and to estimate whether a solar water heater could save you money.

Water Heater Characteristics			
Physical		**Thermal**	
? Diameter (feet)	1.5	? Water Inlet Temperature (Degrees F)	55
? Capacity (gallons)	65	? Ambient Temperature (Degrees F)	70
? Surface Area (calculated - sq ft)	26.71	? Hot Water Temperature (Degrees F)	135
? Effective R-value	NaN	? Hot Water Usage (Gallons per Day)	200
Energy Use			
5473		? Heat Delivered in Hot Water (BTU/hr)	
0		? Heat loss through insulation (BTU/hr)	

Gas vs. Electric Water Heating		
Gas		**Electric**
0.8	? Overall Efficiency	0.98
0.8	? Conversion Efficiency	0.98
6841 BTU/hr	? Power Into Water Heater	5585 BTU/hr
Cost		
$ 1.41 /Therm	? Utility Rates	$ 0.08 /kWh
$ 844.972	? Yearly Water Heating Cost	$ 1146.30
How Does Solar Compare?		
? Solar Water Heater Cost: $ 25374		? Percentage Solar: 70
42.8990 years for gas	? Payback Time for Solar System	31.6221 years for electric

More information on solar water heating:

Fact sheet - Solar Water Heaters
Fact sheet - Solar Water Heaters for Swimming Pools
Kids fact sheet - Heat from the Sun

Return to Top of Page

NJBPU Energy Audits
CHA #20418
Building: North Brunswick DPW Building

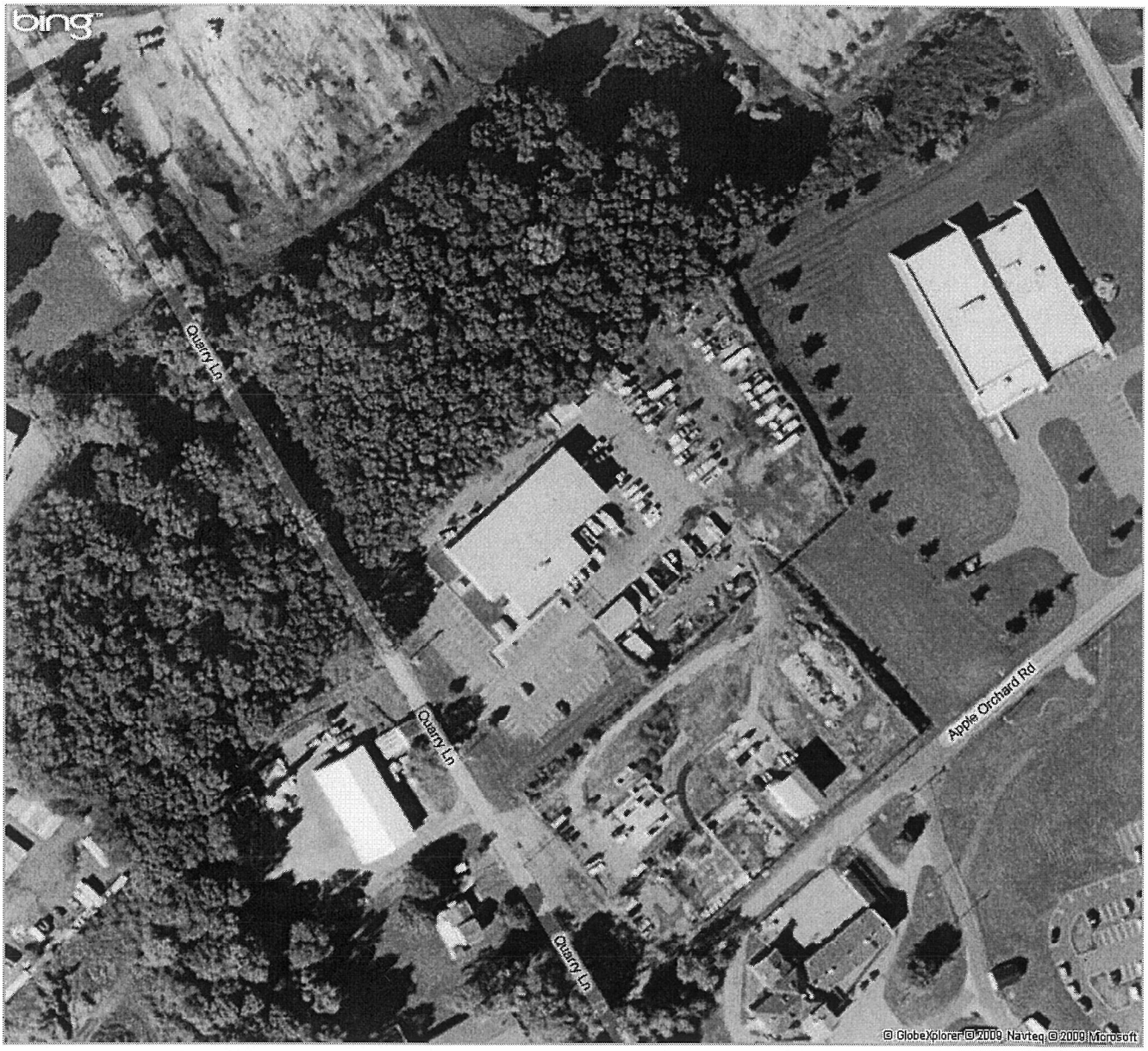
Multipliers	
Material:	0.99
Labor:	1.22
Equipment:	1.09

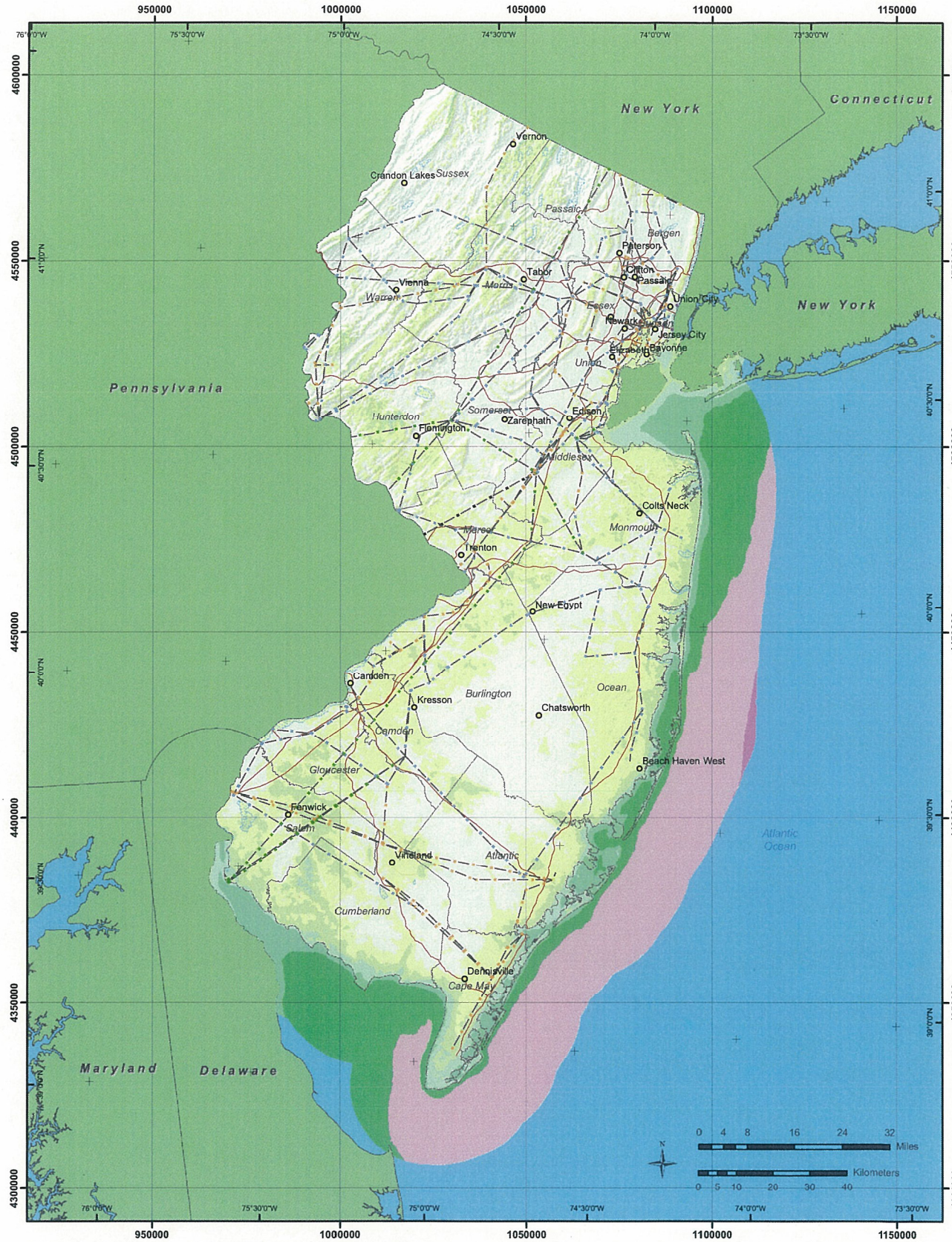
Description	QTY	UNIT	UNIT COSTS			SUBTOTAL COSTS			TOTAL COST	REMARKS
			MAT.	LABOR	EQUIP.	MAT.	LABOR	EQUIP.		
Synergy Solar Thermal System	2	ea				$ -	$ -	$ 3,600	$ 7,200	
Piping modifications	1	ls	$ 2,000	$ 3,500		$ 1,980	$ 4,270	$ -	$ 6,250	
Electrical modifications	1	ls	$ 1,000	$ 1,000		$ 990	$ 1,220	$ -	$ 2,210	
65 GallonStorage Tanks	2	ea	$ 200	$ 250		$ 400	$ 500	$ -	$ 900	
10 Gallon Drip Tank	2	ea	$ 100	$ 78		$ 200	$ 156	$ -	$ 356	
						$ -	$ -	$ -	$ -	

$ 16,916	Subtotal
$ 2,537	15% Contingency
$ 2,537	15% Contractor O&P
$ 3,383	20% Engineering
$ 25,374	**Total**

APPENDIX O

Wind


bing
Quarry Ln
Quarry Ln
Quarry Ln
Apple Orchard Rd
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Wind Resource of New Jersey

Mean Annual Wind Speed at 30 Meters

Features

- City
- Interstate Highway
- County Boundary
- Water Body

Generalized Transmission Line

Category	
Under 100 kV	500 kV
100 kV-161 kV	736 kV +
230 kV-287 kV	Step-Up
345 kV	DC Line

Mean Speed at 30 m

mph	m/s
< 10.1	< 4.5
10.1 - 11.2	4.5 - 5.0
11.2 - 12.3	5.0 - 5.5
12.3 - 13.4	5.5 - 6.0
13.4 - 14.5	6.0 - 6.5
14.5 - 15.7	6.5 - 7.0
15.7 - 16.8	7.0 - 7.5
16.8 - 17.9	7.5 - 8.0
17.9 - 19.0	8.0 - 8.5
> 19.0	> 8.5

AWS Truewind

Projection: Tranverse Mercator,
UTM Zone 17 WGS84
Spatial Resolution of Wind Resource Data: 200m
This map was created by AWS Truewind using the MesoMap system and historical weather data. Although it is believed to represent an accurate overall picture of the wind energy resource, estimates at any location should be confirmed by measurement.

The transmission line information was obtained by AWS Truewind from the Global Energy Decisions Velocity Suite. AWS does not warrant the accuracy of the transmission line information.

AWS Truewind, LCC

APPENDIX P

EPA Portfolio Manager

OMB No. 2060-0347

STATEMENT OF ENERGY PERFORMANCE
North Brunswick DPW Building

Building ID: 1855646
For 12-month Period Ending: December 31, 2008[1]
Date SEP becomes ineligible: N/A

Date SEP Generated: September 28, 2009

Facility
North Brunswick DPW Building
45 Quarry Lane
North Brunswick, NJ 08902

Facility Owner
Township of North Brunswick
710 Herman Road
North Brunswick, NJ 08902

Primary Contact for this Facility
Glen Sandor
45 Quarry Lane
North Brunswick, NJ 08902

Year Built: 1988
Gross Floor Area (ft²): 18,400

Energy Performance Rating[2] (1-100) N/A

Site Energy Use Summary[3]

Electricity - Grid Purchase(kBtu)	409,031
Natural Gas (kBtu)[4]	2,106,000
Total Energy (kBtu)	2,515,031

Energy Intensity[5]

Site (kBtu/ft²/yr)	137
Source (kBtu/ft²/yr)	194

Emissions (based on site energy use)

Greenhouse Gas Emissions ($MtCO_2e$/year)	174

Electric Distribution Utility
PSE&G - Public Service Elec & Gas Co

National Average Comparison

National Average Site EUI	104
National Average Source EUI	213
% Difference from National Average Source EUI	-9%
Building Type	Other

Stamp of Certifying Professional

Based on the conditions observed at the time of my visit to this building, I certify that the information contained within this statement is accurate.

Certifying Professional
N/A

Meets Industry Standards[6] **for Indoor Environmental Conditions:**

Ventilation for Acceptable Indoor Air Quality	**N/A**
Acceptable Thermal Environmental Conditions	**N/A**
Adequate Illumination	**N/A**

Notes:
1. Application for the ENERGY STAR must be submitted to EPA within 4 months of the Period Ending date. Award of the ENERGY STAR is not final until approval is received from EPA.
2. The EPA Energy Performance Rating is based on total source energy. A rating of 75 is the minimum to be eligible for the ENERGY STAR.
3. Values represent energy consumption, annualized to a 12-month period.
4. Natural Gas values in units of volume (e.g. cubic feet) are converted to kBtu with adjustments made for elevation based on Facility zip code.
5. Values represent energy intensity, annualized to a 12-month period.
6. Based on Meeting ASHRAE Standard 62 for ventilation for acceptable indoor air quality, ASHRAE Standard 55 for thermal comfort, and IESNA Lighting Handbook for lighting quality.

The government estimates the average time needed to fill out this form is 6 hours (includes the time for entering energy data, PE facility inspection, and notarizing the SEP) and welcomes suggestions for reducing this level of effort. Send comments (referencing OMB control number) to the Director, Collection Strategies Division, U.S., EPA (2822T), 1200 Pennsylvania Ave., NW, Washington, D.C. 20460.

ENERGY STAR® Data Checklist for Commercial Buildings

In order for a building to qualify for the ENERGY STAR, a Professional Engineer (PE) must validate the accuracy of the data underlying the building's energy performance rating. This checklist is designed to provide an at-a-glance summary of a property's physical and operating characteristics, as well as its total energy consumption, to assist the PE in double-checking the information that the building owner or operator has entered into Portfolio Manager.

Please complete and sign this checklist and include it with the stamped, signed Statement of Energy Performance.
NOTE: You must check each box to indicate that each value is correct, OR include a note.

CRITERION	VALUE AS ENTERED IN PORTFOLIO MANAGER	VERIFICATION QUESTIONS	NOTES	☑
Building Name	North Brunswick DPW Building	Is this the official building name to be displayed in the ENERGY STAR Registry of Labeled Buildings?		☐
Type	Other	Is this an accurate description of the space in question?		☐
Location	45 Quarry Lane, North Brunswick, NJ 08902	Is this address accurate and complete? Correct weather normalization requires an accurate zip code.		☐
Single Structure	Single Facility	Does this SEP represent a single structure? SEPs cannot be submitted for multiple-building campuses (with the exception of acute care or children's hospitals) nor can they be submitted as representing only a portion of a building		☐

North Brunswick DPW Building (Other)

CRITERION	VALUE AS ENTERED IN PORTFOLIO MANAGER	VERIFICATION QUESTIONS	NOTES	☑
Gross Floor Area	18,400 Sq. Ft.	Does this square footage include all supporting functions such as kitchens and break rooms used by staff, storage areas, administrative areas, elevators, stairwells, atria, vent shafts, etc. Also note that existing atriums should only include the base floor area that it occupies. Interstitial (plenum) space between floors should not be included in the total. Finally gross floor area is not the same as leasable space. Leasable space is a subset of gross floor area.		☐
Number of PCs	12 (Optional)	Is this the number of personal computers in the space?		☐
Weekly operating hours	55 Hours(Optional)	Is this the total number of hours per week that the space is 75% occupied? This number should exclude hours when the facility is occupied only by maintenance, security, or other support personnel. For facilities with a schedule that varies during the year, "operating hours/week" refers to the total weekly hours for the schedule most often followed.		☐
Workers on Main Shift	29 (Optional)	Is this the number of employees present during the main shift? Note this is not the total number of employees or visitors who are in a building during an entire 24 hour period. For example, if there are two daily 8 hour shifts of 100 workers each, the Workers on Main Shift value is 100.		☐

ENERGY STAR® Data Checklist for Commercial Buildings

Energy Consumption

Power Generation Plant or Distribution Utility: PSE&G - Public Service Elec & Gas Co

Fuel Type: Electricity

Meter: Electric (kWh (thousand Watt-hours))
Space(s): Entire Facility
Generation Method: Grid Purchase

Start Date	End Date	Energy Use (kWh (thousand Watt-hours))
12/01/2008	12/31/2008	8,910.00
11/01/2008	11/30/2008	9,540.00
10/01/2008	10/31/2008	8,280.00
09/01/2008	09/30/2008	10,110.00
08/01/2008	08/31/2008	11,010.00
07/01/2008	07/31/2008	12,630.00
06/01/2008	06/30/2008	13,050.00
05/01/2008	05/31/2008	8,550.00
04/01/2008	04/30/2008	8,610.00
03/01/2008	03/31/2008	10,080.00
02/01/2008	02/29/2008	9,390.00
01/01/2008	01/31/2008	9,720.00
Electric Consumption (kWh (thousand Watt-hours))		**119,880.00**
Electric Consumption (kBtu (thousand Btu))		**409,030.56**
Total Electricity (Grid Purchase) Consumption (kBtu (thousand Btu))		**409,030.56**
Is this the total Electricity (Grid Purchase) consumption at this building including all Electricity meters?		☐

Fuel Type: Natural Gas

Meter: Natural Gas (therms)
Space(s): Entire Facility

Start Date	End Date	Energy Use (therms)
12/01/2008	12/31/2008	2,971.00
11/01/2008	11/30/2008	2,989.00
10/01/2008	10/31/2008	1,228.00
09/01/2008	09/30/2008	161.00
08/01/2008	08/31/2008	120.00
07/01/2008	07/31/2008	117.00
06/01/2008	06/30/2008	147.00
05/01/2008	05/31/2008	872.00
04/01/2008	04/30/2008	1,609.00
03/01/2008	03/31/2008	3,253.00

02/01/2008	02/29/2008	3,806.00
01/01/2008	01/31/2008	3,787.00
Natural Gas Consumption (therms)		**21,060.00**
Natural Gas Consumption (kBtu (thousand Btu))		**2,106,000.00**
Total Natural Gas Consumption (kBtu (thousand Btu))		**2,106,000.00**
Is this the total Natural Gas consumption at this building including all Natural Gas meters?		☐

Additional Fuels	
Do the fuel consumption totals shown above represent the total energy use of this building? Please confirm there are no additional fuels (district energy, generator fuel oil) used in this facility.	☐

On-Site Solar and Wind Energy	
Do the fuel consumption totals shown above include all on-site solar and/or wind power located at your facility? Please confirm that no on-site solar or wind installations have been omitted from this list. All on-site systems must be reported.	☐

Certifying Professional

(When applying for the ENERGY STAR, the Certifying Professional must be the same as the PE that signed and stamped the SEP.)

Name: _____ Date: _____

Signature: _____

Signature is required when applying for the ENERGY STAR.

FOR YOUR RECORDS ONLY. DO NOT SUBMIT TO EPA.

Please keep this Facility Summary for your own records; do not submit it to EPA. Only the Statement of Energy Performance (SEP), Data Checklist and Letter of Agreement need to be submitted to EPA when applying for the ENERGY STAR.

Facility
North Brunswick DPW Building
45 Quarry Lane
North Brunswick, NJ 08902

Facility Owner
Township of North Brunswick
710 Herman Road
North Brunswick, NJ 08902

Primary Contact for this Facility
Glen Sandor
45 Quarry Lane
North Brunswick, NJ 08902

General Information

North Brunswick DPW Building	
Gross Floor Area Excluding Parking: (ft^2)	18,400
Year Built	1988
For 12-month Evaluation Period Ending Date:	December 31, 2008

Facility Space Use Summary

North Brunswick DPW Building	
Space Type	Other - Other
Gross Floor Area(ft^2)	18,400
Number of PCs[o]	12
Weekly operating hours[o]	55
Workers on Main Shift[o]	29

Energy Performance Comparison

	Evaluation Periods		Comparisons		
Performance Metrics	**Current** (Ending Date 12/31/2008)	**Baseline** (Ending Date 12/31/2008)	**Rating of 75**	**Target**	**National Average**
Energy Performance Rating	N/A	N/A	75	N/A	N/A
Energy Intensity					
Site (kBtu/ft2)	137	137	0	N/A	104
Source (kBtu/ft2)	194	194	0	N/A	213
Energy Cost					
$/year	$ 48,996.00	$ 48,996.00	N/A	N/A	$ 37,278.40
$/ft2/year	$ 2.66	$ 2.66	N/A	N/A	$ 2.02
Greenhouse Gas Emissions					
$MtCO_2e$/year	174	174	0	N/A	132
$kgCO_2e/ft^2$/year	9	9	0	N/A	7

More than 50% of your building is defined as Other. This building is currently ineligible for a rating. Please note the National Average column represents the CBECS national average data for Other. This building uses X% less energy per square foot than the CBECS national average for Other.

Notes:
o - This attribute is optional.
d - A default value has been supplied by Portfolio Manager.

APPENDIX Q

Equipment Inventory

New Jersey BPU Energy Audit Program
CHA #20418
Township of North Brunswick
Equipment Inventory - Department of Public Works

Description	Manufacturer Name	Model No.	Equipment Type	Capacity/Size	Estimated Efficiency	Location	Areas Served	Date Installed	Useable Life Expectancy	Other Info.
Air Compressor	Curtis	10TH-T2-A3	Air Compressor	10 HP motor		Garage	Garage			No air leaks detected
Garage Unit Heaters (10)	Reznor	XLB300-5 (S/N ANF31H1N2543)	Unit Heater	300 MBH input 231 MBH output 3/4 HP motor	Burner - 77%	Garage	Garage	1988	20 years	Natural Gas, 110 Volt, Individual Thermostat Control
Domestic Hot Water Circulating Pump	TACO	007-BF5	Domestic Hot Water Circulating Pump	1/25 HP, 110 volt/0.76 amp	Motor - 85%	Offices	Offices	2004	15 Years	110 volt
Window Air Conditioners (2)	Varies	Varies	Window AC	10,000 Btu/hr (each)	7.0 EER	Offices	Offices	Varies	15 Years	110 Volt
Outside air intake fans 1-4	COOLAIR	PT30L Powertube Fan	Forced air ventilation	1 HP 11,850 CFM	Motor - 85%	Garage	Garage	1988	20 years	Controlled by circuit breakers
Exhaust Fans 1-4	COOLAIR	MBH30L Fan	Exhaust Fan	1 HP 10,600 CFM	Motor - 85%	Garage	Garage	1988	20 years	110 Volt
Exhaust Fan 5	BAYLEY	B1222B	Exhaust Fan	1.5 HP 1,204 CFM	Motor - 85%	Garage	Garage	1988	20 years	110 Volt
Exhaust Fan 6	JENN-AIR	121 NCBR	Exhaust Fan	1/6 HP 910 CFM	Motor - 85%	Garage	Garage	1988	20 years	110 Volt
Wall Heater #1	NUTONE	#9383	Electric Wall Heater	1500 watts, 208 volts, 5120 BTUH	100%	Offices	Offices	1988	15 Years	
Wall Heater #2	NUTONE	#9381	Electric Wall Heater	1000 watts, 208 volts, 3114 BTUH	100%	Offices	Offices	1988	15 Years	
Wall Heater #3	NUTONE	#9381	Electric Wall Heater	1000 watts, 208 volts, 3114 BTUH	100%	Offices	Offices	1988	15 Years	
Wall Heater #4	NUTONE	#9381	Electric Wall Heater	1000 watts, 208 volts, 3114 BTUH	100%	Offices	Offices	1988	15 Years	
HVAC-1	CARRIER	48TME0145	Roof top Package HVAC w/ economizer	12.5 Ton nominal cooling 154 MBH input 128 MBH output	11.0 EER Burner - 80%	Office Roof	Offices	2006	20 years	Singe Thermostat Control
Hot Water Heater	AO Smith	BT 65 110 (S/N J04A000594)	HW Heater/Tank	65 gallons 65,000 BTUH	Burner - 80%	Storage Room	Entire Building	9/1/2004	20 Years	Natural Gas fired, 120 degree F. Set Point
Hot Water Storage Tanks (2)	AO Smith	T-75	Storage Tank	75 Gallon		Storage Room	Entire Building	1988	20 Years	Connected to BT 65 110 water heater
Emergency Generator	Caterpillar	Olympian D75P3	Emergency Generator	75 kW Standby		Outside	DPW Building			Diesel Fuel, Test fired once per month