Office of the New York State Comptroller

Division of Local Government
& School Accountability

Light-Emitting Diodes in Municipal Traffic Signals Reduce Costs and Emissions

2009-MR-2

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State of New York
Office of the State Comptroller

Division of Local Government
and School Accountability

June 2009

Dear Local Officials:

A top priority of the Office of the State Comptroller is to help local government officials manage government resources efficiently and effectively and, by so doing, provide accountability for tax dollars spent to support government operations. The Comptroller is mandated to oversee the fiscal affairs of local governments statewide, as well as compliance with relevant statutes and observance of good business practices. This fiscal oversight is accomplished through our audits, which identify opportunities for improving operations and municipalities' governance. Audits can also identify strategies to reduce costs and to strengthen controls intended to safeguard local government assets.

Following is a report of our audit entitled Light-Emitting Diodes in Municipal Traffic Signals Reduce Costs and Emissions. This audit was conducted pursuant Article V, Section 1 of the State Constitution, and the State Comptroller's authority as set forth in Article 3 of the General Municipal Law.

This audit's results and recommendations are resources for local government officials to use in effectively managing operations and in meeting the expectations of their constituents. If you have questions about this report, please feel free to contact the local regional office for your county, as listed at the end of this report.

Respectfully submitted,

Office of the State Comptroller
Division of Local Government
and School Accountability

EXECUTIVE SUMMARY

Traffic signals act as an integral part of smooth day-to-day operations within all municipalities. Signals operate 24 hours a day, seven days a week for a total annual operating cycle of 8,760 hours. Opportunity exists for substantial cost savings if these devices could operate more efficiently. Although incandescent bulbs have long been used to illuminate traffic signals, municipalities have recently started to move from incandescent bulbs to light-emitting diode (LED) bulbs. LED technology has gained popularity for lighting traffic signals because of its energy efficiency, leading to reduced electricity use and cost savings.

The pollutants released into the atmosphere by fossil fuels accounted for 85 percent of the nation's greenhouse emissions in 2006.[1] Municipalities that use LED technology can significantly reduce their production of harmful green house gas emissions by reducing their demand for electricity.

In 2008, the U.S. Department of Energy, commissioned a study[2] to determine the effects of using energy-saving LEDs in traffic signal applications. This study found that municipalities that switched to LEDs realized significant cost savings and that approximately 52 percent of the traffic signal market has already moved to LEDs. Another study conducted by the New York State Energy and Research Development Authority (NYSERDA) concluded that replacing incandescent bulbs with LEDs could result in an estimated average energy savings of 90 percent for traffic signals.[3]

Scope and Objective

Our audit examined traffic signal expenditures for the period January 1, 2006 to June 1, 2008 in the Cities of Binghamton[4] and Cortland, and in the Villages of Endicott and Johnson City. Our audit addressed the following related question:

- Can municipalities reduce electricity costs and emissions by replacing the incandescent bulbs in their traffic signals with LED bulbs?

[1] Environmental Protection Agency, Inventory of US Greenhouse Gas Emissions and Sinks: 1990-2006 (Washington, D.C.: April 2008).

[2] U. S. Department of Energy, Energy Savings Estimates of Light-Emitting Diodes in Niche Lighting Applications, prepared by Navigant Consulting, Inc. (Washington, D. C.: September 2008)

[3] NYSERDA, LED Traffic Signals: Saving Money and Energy in New York State (Albany, April 2001) http://www.lrc.rpi.edu/programs/transportation/LED/pdf/NYSLEDBrochure.pdf

[4] For the City of Binghamton, we also reviewed traffic signal expenditure data for a 10-year period (1997-2007).

Audit Results

Our audit showed that replacing incandescent bulbs with LED bulbs is a leaner - and greener-way for municipalities to operate their traffic signals. Binghamton officials replaced all the incandescent bulbs in their traffic signals with LEDs in 2002. This replacement has produced average annual savings of about $49,800 since 2002; that means Binghamton is now paying approximately 59 percent less for operating its traffic signals than it did before it switched to LED bulbs. Cortland, Endicott and Johnson City still use incandescent bulbs for the majority of their traffic signals. If these three municipalities replaced their remaining incandescent traffic signals with LED bulbs, they could save more than $426,000 in electricity costs and avoid $78,800 in maintenance costs over a 10-year period.

Statewide, if other municipalities excluding New York City, converted their remaining traffic signals still using incandescent bulbs to LED bulbs, the municipalities and their taxpayers could collectively realize potential savings of approximately $40.1 million in electricity and maintenance costs over 10 years. If New York City's potential savings in electricity and maintenance costs were included, municipalities' potential cost savings statewide would rise to $76.5 million over 10 years. (See our methodology for these cost savings calculations in Appendix C of this report.) The potential for obtaining American Recovery and Reinvestment Act monies to pay for the initial replacement costs could increase municipalities' savings even further by reducing or eliminating these costs.

These municipalities could also save approximately 244,134 kilowatt-hours of electricity each year by using LED bulbs in all their traffic signals. This reduction in electricity use could avoid producing over 100 tons of greenhouse gas emissions annually. If local governments statewide switched to LED bulbs to light their traffic signals, they could lower their municipalities' costs of operation, energy consumption, and harmful emissions.

Comments of Local Officials

The results of our audit and recommendations have been discussed with local officials and their comments, which appear in Appendix A, have been considered in preparing this report. Local officials generally agreed with our recommendations and indicated they planned to initiate corrective action.

Introduction

Background

Traffic signals act as an integral part of smooth day-to-day operations within all municipalities. Signals operate 24 hours a day, seven days a week, for a total annual operating cycle of 8,760 hours. Opportunity exists for substantial cost savings if these devices could operate more efficiently. Although incandescent bulbs have long been used to illuminate traffic signals, municipalities have recently started to move to light-emitting diode (LED) bulbs.

LED technology gained popularity for lighting traffic signals because of its energy efficiency, reduced electricity use and cost savings. Approximately 52 percent of the traffic signal market has already moved to LEDs: LED bulbs are now used in 65 and 59 percent of red and green signals, respectively.[5] Yellow LED bulbs are not widely used in traffic signals because they are illuminated for only a fraction of the time compared to red or green LED bulbs, and are therefore not cost-effective to replace.

In 2008, the U.S. Department of Energy commissioned a study[6] to determine the effects of using energy-saving LEDs in traffic signals. This study found that municipalities that switched to LED bulbs realized significant cost savings. Another study conducted by the New York State Energy and Research Development Authority (NYSERDA) concluded that replacing incandescent bulbs with LEDs could result in an estimated average energy savings of 90 percent for traffic signals.[7] In addition, the Lighting Research Institute[8] (LRI) at Rensselaer Polytechnic Institute has determined that the cost savings derived from using LEDs can be obtained with very little reduction in overall effectiveness of the traffic signal.

Objective

Our audit examined traffic signal expenditures in the Cities of Binghamton and Cortland and in the Villages of Endicott

[5] U.S. Department of Energy, Energy Savings Estimates of Light-Emitting Diodes in Niche Lighting Applications, prepared by Navigant Consulting, Inc. (Washington, D. C.: September 2008)

[6] Ibid

[7] NYSERDA, LED Traffic Signals: Saving Money and Energy in New York State (Albany: April 2001) http://www.lrc.rpi.edu/programs/transportation/LED/pdf/NYSLEDBrochure.pdf

[8] Lighting Research Center, Transportation Lighting, (Troy, NY: April 2004) http://www.lrc.rpi.edu/programs/transportation/led/issuesOptions.asp

and Johnson City. Our audit addressed the following related question:

- Can municipalities reduce electricity costs and emissions by replacing their incandescent bulbs in their traffic signals with LED bulbs?

Scope and Methodology

Our audit examined traffic signal expenditures in the Cities of Cortland and Binghamton[9] and the Villages of Endicott and Johnson City for the period January 1, 2006 to June 1, 2008. We examined traffic signal data for the these four municipalities to determine the amount and cost of electricity and maintenance required to run the municipalities' traffic signals and to identify any potential savings that could be achieved by replacing existing incandescent bulbs in traffic signals with LEDs.

We conducted our audit in accordance with generally accepted government auditing standards (GAGAS). More information on such standards and the methodology used in performing this audit are included in Appendix B of this report.

Comments of Local Officials

The results of our audit and recommendations have been discussed with local officials and their comments, which appear in Appendix A, have been considered in preparing this report. Local officials generally agreed with our recommendations and indicated they planned to initiate corrective action.

[9] For the City of Binghamton, we also reviewed traffic signal expenditure data for a 10-year period (1997-2007).

Potential Cost Savings

Many municipalities[10] in New York State have realized cost savings by switching to LED bulbs in traffic signals. LED bulbs use about 85 percent less energy than incandescent bulbs to produce the number of lumens required by New York State Department of Transportation (NYS DOT) for traffic signals.[11]

According to NYSERDA, LED signals, on average, use 90 percent less energy than comparable incandescent alternatives.[12] Yellow LED signals use more energy than red or green, and are not as cost effective because they remain illuminated only briefly. Many municipalities have replaced the incandescent red and green bulbs in their traffic signals with LEDs, which accounted for 97 percent of traffic signal electric usage, and have continued to use incandescent yellow bulbs in their traffic signals.

Our audit found that, by switching to LED traffic signals, Binghamton saved almost $318,000 in electricity and maintenance costs between 2002 and 2007. If the other municipalities we audited replaced the remaining incandescent bulbs in their traffic signals with LEDs, we conservatively estimate that they could collectively save more than $500,000 in electricity and maintenance costs. Although we estimate that other municipalities across the State[13] could experience similar savings, we recommend that local officials carefully calculate the costs savings and overall lifecycle costs of LED use in their own municipalities.[14]

LED Replacement Progress

Binghamton officials replaced all their incandescent traffic signal bulbs with LEDs in 2002. With this replacement, Binghamton has realized average annual savings of $49,800 since 2002, a

[10] Onondaga and Westchester Counties have both switched to LED technologies for their traffic signals.

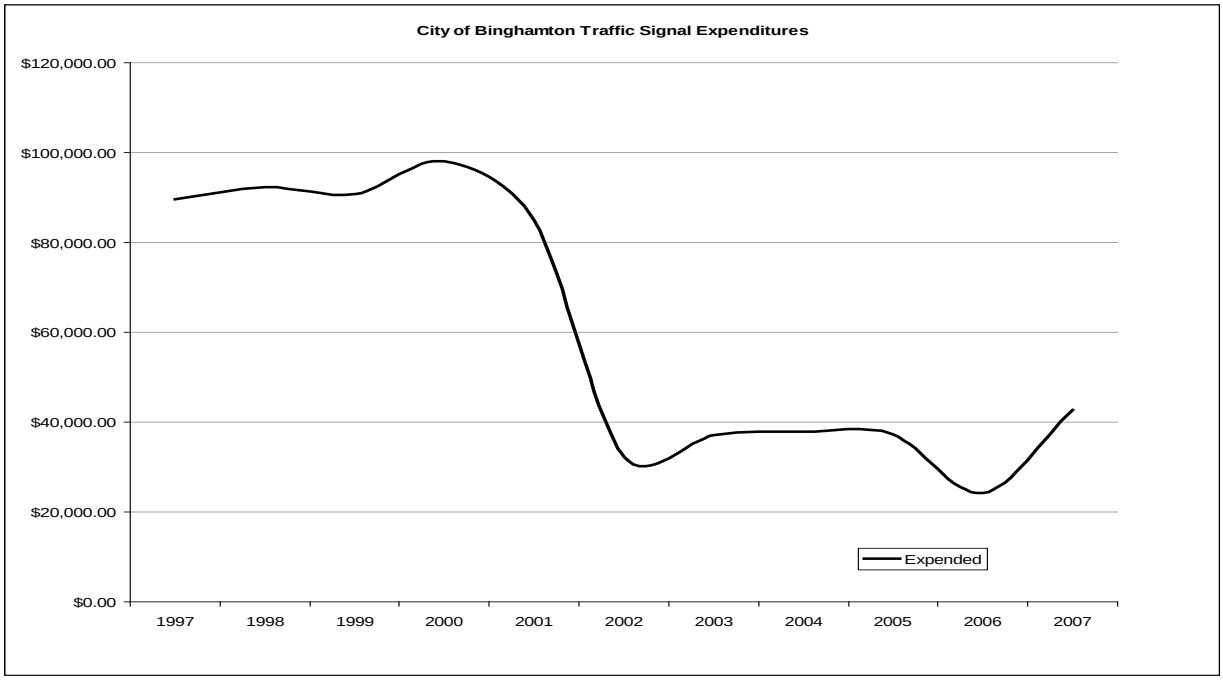
[11] NYS DOT requires a minimum of 595 lumens for 8" signals and 1750 lumens for 12" lights.

[12] NYSERDA, LED Traffic Signals: Saving Money and Energy in New York State (Albany: April 2001) http://www.lrc.rpi.edu/programs/transportation/LED/pdf/NYSLEDBrochure.pdf

[13] NYSERA, LED Traffic Signal Analyzer Basic Tool available at: http://www.lrc.rpi.edu/programs/transportation/LED/xls/led-lcc.xls

[14] We based our savings estimates on studies that were completed several years ago. Since then, changes may have occurred in municipal traffic signal inventories that may impact a municipality's actual savings. See Appendix C, Statewide Cost and Emission Savings Estimates.

savings of 59 percent since the 2002 replacement. The following chart, which shows Binghamton's electricity expenditures for traffic light operations for the last 10 years, illustrates the dramatic reduction in these costs with the conversion to LED bulbs.



In addition to cost savings from reduced electric consumption, Binghamton is also saving money on the labor costs involved in maintaining the traffic signals. Typically, an incandescent light bulb lasts for less than one year,[15] so each bulb needs replacing annually. In contrast, an LED bulb's useful life is more than five times longer than that of an incandescent bulb. That means that Binghamton saved approximately four years of labor costs by replacing the incandescent bulbs with LED bulbs. Binghamton's average maintenance cost savings totaled over $3,000 annually.

Cortland, Endicott and Johnson City had not replaced a majority of their traffic signals with LEDs. Replacement programs begun in each of these municipalities did not have sufficient budgetary funding to permit replacing the incandescent bulbs used in all their traffic control signals. Therefore, these three municipalities replaced incandescent bulbs with LED bulbs in just a small number of traffic signals: Cortland replaced bulbs at four of its 33 intersections, Endicott replaced bulbs at four of its 20 intersections, and Johnson City replaced bulbs at seven of 16 intersections.

[15] Typically, an incandescent bulb can last for 8,000 hours while an LED bulb lasts for 50,000 hours.

A total of 54 intersections in these three municipalities still use incandescent bulbs that could be replaced with LEDs to achieve greater cost savings. Table 1 shows these 54 intersections, their location, and the number and type of bulbs needing replacement at each one.

Table 1: Replacements Needed			
Municipality	**Number of Intersections Needing Replacements**	**Number of Incandescents by Bulb Type**	
		12-inch	8-inch
City of Cortland	29	199	175
Village of Endicott	16	47	124
Village of Johnson City	9	20	114

Replacement Costs

Generally, incandescent traffic signals do not require any type of upgrade or retrofitting to accommodate LED replacements. The LED bulbs install just like the incandescent types currently used. Although replacing LED bulbs does not require any specific upgrades to existing equipment, Johnson City officials told us that installing LED bulbs would require replacing three outdated signal lamp housings at one intersection. The replacement costs we calculated include the LED bulbs, the labor-hours to install the new bulbs, the cost of using municipal equipment, and in Johnson City's case, the new housings. The LED replacement cost for each municipality is shown in Table 2 below.

Table 2: Replacement Costs per Municipality			
Municipality	**Replacement Costs**		
	Materials	Labor	Total
City of Cortland	$ 16,259	$ 5,174	$ 21,433
Village of Endicott	$ 6,975	$ 2,369	$ 9,344
Village of Johnson City	$ 5,492	$ 3,004	$ 8,496

Payback Period

Payback period[16] is the length of time required for a municipality to recover the cost of the original investment required to replace incandescent bulbs with LEDs. The expected payback periods would vary by municipality, but our analysis shows that all three municipalities could recover their original investment in LED signal lighting in less than one year. This means that each municipality's original investment in LED lighting could be

[16] The payback period is the length of time required for the return on an investment to "repay" the sum of the original investment. For example, a $1,000 investment that returned $500 per year would have a two-year payback period. It intuitively measures how long something takes to "pay for itself."

recovered at least six times before the end of the useful life of the LED bulbs, which is about 5.7 years. The expected payback periods, based on projected savings and original investment costs for each municipality, are presented in Table 3 below:

Table 3: Payback Period for Investment in LED Signal Lighting

Municipality	Projected Labor and Electricity Saved Annually	Projected LED Replacement Cost	Payback Period in Years
City of Cortland	$ 30,580	$ 21,433	0.70
Village of Endicott	$ 13,685	$ 9,344	0.68
Village of Johnson City	$ 10,181	$ 8,496	0.83

Potential Federal Funding

There is funding available in the American Recovery and Reinvestment Act (ARRA) to pay for energy-efficient replacement of street lights and traffic signals. We contacted NYSERDA to find out if the traffic signal retrofits we recommend in this report (that is, the replacement of incandescent bulbs with LED bulbs) would be eligible for funding under ARRA. NYSERDA officials indicated that they have Federal grant funds available that can be used for this purpose, and that NYSERDA awards the grant funds on a competitive basis. If Cortland, Endicott and Johnson City could obtain funding to pay for the initial replacement of traditional bulbs with LED bulbs, they could realize even greater costs savings than the amounts we calculated in this report by reducing or eliminating replacement costs.

Energy and Maintenance Cost Savings

These three municipalities could realize significant cost savings if they converted from their current incandescent signal lighting to signal lighting using energy-efficient LED bulbs. Over a 10-year period,[17] the municipalities could save over $426,000 in electricity costs, and avoid $78,800 in maintenance costs. The expected energy and maintenance cost savings for each municipality are presented in Table 4.

[17] We used a 10-year period to illustrate the cost savings produced by replacing all the incandescent bulbs with LED bulbs in year one, followed by systematically replacing all the LED bulbs in traffic signals during years six through 10 (20 percent of the inventory each year).

Table 4: Expected Savings Over 10 Years					
Municipality	**Cumulative Energy Savings**	**Cumulative Maintenance Savings**	**Total Gross Savings**	**Less: Initial Upgrade Costs**	**Total Net Savings[18]**
City of Cortland	$ 247,118	$ 37,251	$284,369	$21,433	$262,936
Village of Endicott	$ 109,853	$ 17,648	$127,501	$9,344	$118,158
Village of Johnson City	$ 69,388	$ 23,921	$93,309	$8,496	$84,813
Totals	$ 426,359	$ 78,820	$505,179	$39,273	$465,907

Our analysis also showed that if other municipalities across the State converted their remaining traffic signals still using incandescent bulbs to LEDs, local taxpayers could benefit from significant savings. Municipalities statewide, excluding New York City, could realize potential savings of approximately $40.1 million in electricity and maintenance costs over 10 years; if New York City's potential savings in electricity and maintenance costs were included, municipalities' potential cost savings statewide would rise to $76.5 million over 10 years. (See our methodology for these cost savings calculations in Appendix C of this report.) The potential for obtaining ARRA monies to pay for the initial replacement costs could increase municipalities' savings even further by reducing or eliminating these costs.

Recommendations

1. Local officials should replace the incandescent bulbs in their traffic signals with LED bulbs to achieve energy and maintenance cost savings.

2. Local officials should apply for ARRA funding through NYSERDA to pay for the initial costs of replacing incandescent bulbs with LED bulbs in traffic signal units.

[18] We reduced the total net cost savings for Cortland, Endicott and Johnson City to account for the costs these municipalities would incur for LED bulb replacement and other normal maintenance activities over the 10-year period.

Environmental Impact

Between 1994 and 2005, electricity usage in the United States increased by 24 percent and emissions from the production of electricity increased by 22 percent.[19] Fossil fuels, that is, oil, natural gas, and coal, generate a large percentage of electricity, while nuclear, hydroelectric and refuse produce the remainder. All of these sources, except for nuclear and hydroelectric (which some consider clean alternatives to fossil fuels) produce certain pollutants that a have negative impact on the environment. The pollutants released into the atmosphere by fossil fuels accounted for 85 percent of the nation's greenhouse emissions in 2006.[20]

A study released by the National Academy of Sciences[21] confirmed that greenhouse gases are accumulating in the earth's atmosphere as a result of human activities, and that these gases contribute to global warming. Key pollutants that contribute to smog and acid rain include carbon dioxide (CO_2), nitrous oxide (N_2O), and sulfur dioxide (SO_2). Information about these gases follows:

- Carbon dioxide is a colorless, odorless gas that allows light from the sun's rays to transmit to the earth's surface but blocks heat radiating from the earth's surface from escaping into the atmosphere, thus contributing to global climate change or warming due to the "greenhouse" effect.

- Nitrogen oxide is a compound of nitrogen and oxygen that, when released into the air, may undergo a chemical transformation into nitrates and nitric acid, contributing to acid rain and ground-level ozone (photochemical smog).

- Sulfur dioxide is a heavy, colorless gas that, when released into the air, may undergo a chemical transformation into sulfates and sulfuric acid, contributing to acid rain.

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[19] U.S. Department of Energy, Energy Information Administration, Annual Energy Review, 2007 (Washington, D.C.: June 2008).

[20] Environmental Protection Agency, Inventory of US Greenhouse Gas Emissions and Sinks: 1990-2006 (Washington, D.C.: April 2008).

[21] National Research Council, Climate Change Science: An Analysis of Some Key Questions, (Washington, D.C.: National Academy Press, 2001).

Electric generation facilities are the largest source of SO_2 emissions. Federal and State environmental regulatory programs control and monitor SO_2 emissions.[22]

Municipalities that use LED technology can significantly reduce their production of harmful green house gas emissions by reducing their demand for electricity. Cortland, Endicott and Johnson City could reduce their demand for electricity, and therefore produce fewer harmful emissions, by converting to all-LED traffic signals. The municipalities could save approximately 244,134 kilowatt-hours (kWh) of electricity each year if they replaced the remainder of their existing incandescent traffic signal bulbs with LED bulbs. Since each kWh of traditionally-generated electricity that is consumed produces harmful emissions or byproducts, these three municipalities could also avoid producing over 100 tons[23] of greenhouse gas emissions annually. The following table illustrates the thousands of pounds of emissions these municipalities could avoid by replacing their incandescent bulbs with LED bulbs.

Table 5: Annual Avoided Emissions of Greenhouse Gases

Potential kWh Savings	Pollution Emissions (pounds)		
	CO_2	N_2O	SO_2
244,134	200,190	243	1,024

Our analysis also showed that if municipalities across the State[24] switched from incandescent bulbs to LED bulbs in their traffic signals, they could potentially save 22.3 million kilowatt-hours of electricity annually - enough to power over 3,000 homes for an entire year.[25] Further, reduced demand for electricity can prevent the emission of potentially harmful greenhouse gases. By switching to LED bulbs, municipalities across the State[26] could avoid producing over 9,215 tons of greenhouse gas emissions annually.

By modeling environmentally-friendly operations municipalities can reduce both their energy consumption and the emission of greenhouse gases.

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[22] New York State Public Service Commission, Consumer Guide - Environmental Disclosure, July 2007

[23] 200,000 lbs/2,000 lbs equals 100 tons (1 ton = 2,000 lbs).

[24] New York City was not included in these estimates. See Appendix C, Statewide Cost and Emission Savings Estimates.

[25] The average New York household uses about 7,248 kilowatt-hours a year: http://www.eia.doe.gov/cneaf/electricity/esr/table5.xls

[26] See Appendix C, Statewide Cost and Emission Savings Estimates

Recommendation

3. Local officials should pursue alternatives, such as using LED bulbs to light traffic signals, that can reduce both the cost and the environmental impact of municipal operations.

APPENDIX A

RESPONSES FROM LOCAL OFFICIALS

We provided a draft copy of this global report to each of the four local governments audited and requested responses. While the four local governments were provided an opportunity to respond, they chose not to. Instead, the officials at all four local governments requested that we consider the response each provided to their individual report letter as their response to the global report. All four local governments agreed with our findings and recommendations and indicated a willingness to consider replacing the incandescent bulbs in traffic signals with LED bulbs.

The following comments were excerpted from the four responses to the individual report letters we received.

City of Binghamton: "the City… is pleased to note, the cost savings and other positive effects the LED replacement has had on our environment."

City of Cortland: "The City… will continue to convert from incandescent traffic bulbs to LED traffic bulbs at City owned traffic signals that are not in need of a complete rebuild. We are always receptive to innovative ways in which we can reduce the financial burden carried by our real property taxpayers."

Village of Endicott: "As you have shown a potential savings to the Village, I will be sharing the information with all responsible departments for suggestions on implementing the changes you have outlined. With the numbers in hand, I anticipate that all parties will wish to pursue your recommendations."

Village of Johnson City: "The Village realized a 37% cost savings …for one traffic signal replaced in January 2005 when comparing energy costs. …The Village will continue to seek funding to replace the incandescent traffic signals with LEDs."

APPENDIX B

AUDIT METHODOLOGY AND STANDARDS

As part of our audit procedures, we examined the municipality's traffic signal vouchers and interviewed appropriate local officials to determine whether they had the equipment and technical skills necessary to replace and maintain LED traffic signals. We also contacted appropriate third parties including staff of other New York State agencies, and officials from municipalities that had recently replaced their traffic signals to LED within their municipal jurisdictions. We estimated the replacement price for the municipality's traffic signals, as well as their maintenance and repair costs, based on data obtained from State contracts and estimates. We then compared those cost estimates to current traffic signal expenditures to identify any savings.

- We interviewed appropriate local officials to gain an understanding of their traffic signal systems, as well as routine and emergency maintenance.

- We estimated the replacement price for the municipality's red and green traffic signals, as well as their maintenance and repair costs, based on data obtained from New York State's Office of General Services (OGS) contracts and the municipalities' estimates. We then compared those cost estimates to current traffic signal expenditures to identify any potential savings.

- We examined six months of electricity usage and kilowatt-hour costs at the City of Cortland, and the Villages of Endicott and Johnson City to calculate an average electric cost and determine the amount and cost of electricity required to run the municipalities' traffic signals.

- We reviewed 10 years of electricity usage costs for the City of Binghamton to determine if City officials realized significant savings from replacing their incandescent traffic signal bulbs with LEDs.

- We performed an inventory of each municipality's traffic signals to gain an accurate estimate of LED replacement bulb needs.

- We calculated the labor, vehicle, and LED bulb costs that each municipality would incur if they replaced their existing incandescent traffic signal bulbs with LEDs.

- We calculated the amount of greenhouse gases each municipality produces annually to determine the number of pounds of key pollutants that each municipality could avoid emitting and the kilowatt-hours that could be saved if they replaced existing incandescent bulbs with LEDs.

We conducted our audit in accordance with generally accepted government auditing standards (GAGAS). Such standards require that we plan and conduct our audit to adequately assess those municipal operations within our audit scope. Further, those standards require that we understand the municipality's management controls and those laws, rules and regulations that are relevant to

the municipality's operations included in our scope. An audit includes examining, on a test basis, evidence supporting transactions recorded in the accounting and operating records and applying such other auditing procedures, as we consider necessary in the circumstances. We believe that our audit provides a reasonable basis for our findings, conclusions and recommendations contained in this report.

APPENDIX C

STATEWIDE COST AND EMISSIONS SAVINGS ESTIMATES

Our statewide cost and emission savings estimates were compiled using methodology from our regional audits, as well as information gathered from other sources with knowledge of total traffic signal numbers for the State. We based our estimates on studies that were completed several years ago. Since then, changes may have occurred in municipal traffic signal inventories that may impact a municipality's actual savings.

In order to project these cost savings we performed the following:

- We contacted representatives from New York State Department of Transportation for an estimate of the number of traffic signals located in municipalities across the State.

- We estimated the number of signals already converted to LEDs using research completed by the U.S. Department of Energy.[27] That research stated that approximately 52 percent of traffic signals in the U.S. were converted to LED bulbs. We determined the replacement cost, labor, energy savings, and total savings on the remaining 48 percent of traffic signals still utilizing incandescent bulbs.

- We calculated the number of bulbs per signal based on data collected during the Lighting Research Institute[28] (LRI) at Rensselaer Polytechnic Institute study of LED bulb use in traffic signals. A member of the research team provided us with an estimate of the number of bulbs across the State. We calculated our savings estimates based on using eight lights per traffic intersection.[29]

- We projected the savings in electricity consumption statewide based on the replacement of incandescent bulbs with LED bulbs. The savings were determined using average commercial kWh and meter charges of the four largest energy providers in the State.[30]

- Our calculation of labor cost associated with the conversion to LED bulbs was based on the data collected from the three municipalities included in this regional audit.

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[27] U. S. Department of Energy, Energy Savings Estimates of Light Emitting Diodes in Niche Lighting Applications, prepared by Navigant Consulting, Inc. (Washington, D. C.: September 2008)

[28] Lighting Research Center, Transportation Lighting, (Troy, NY: April 2004) http://www.lrc.rpi.edu/programs/transportation/LED/issuesOptions02.asp

[29] Eight lights are equivalent to one four-way intersection with red and green bulbs.

[30] These four are New York State Electric & Gas, National Grid, Rochester Gas & Electric, and Central Hudson Gas & Electric.

Table 6 shows the potential cost savings statewide over five, 10, and 20 years based on the assumptions and methodology detailed above.

Table 6: Estimates of Cost Savings Statewide						
	Municipalities Statewide (Excluding New York City)			Municipalities Statewide (Including New York City)		
	5-Years	10-Years	20-Years	5-Years	10-Years	20-Years
Cumulative Energy Savings	$17,246,552	$34,493,105	$68,986,209	$32,804,299	$65,608,598	$131,217,196
Cumulative Maintenance Savings	$5,407,178	$8,866,004	$16,433,106	$10,483,902	$17,190,226	$31,862,068
Total Gross Savings	$22,653,730	$43,359,108	$85,419,315	$43,288,201	$82,798,824	$163,079,264
Less: Initial Upgrade Costs	$(3,247,253)	$(3,247,253)	$(3,247,253)	$(6,295,962)	$(6,295,962)	$(6,295,962)
Total Net Savings	$19,406,477	$40,111,855	$82,172,062	$36,992,239	$76,502,863	$156,783,302

Table 7 shows the potential savings in greenhouse gas emissions statewide based on the information detailed above.

Table 7: Estimates of Annual Emissions Avoided Statewide						
	Municipalities Statewide (Excluding New York City)			Municipalities Statewide (Including New York City)		
Potential kWh Savings	22,333,665 kWh			43,301,675 kWh		
Emission Type	CO_2	N_2O	SO_2	CO_2	N_2O	SO_2
Pollution Emissions (pounds)	18,313,605	22,222	93,712	35,507,374	43,085	181,694

APPENDIX D

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