

Massachusetts Division of Energy Resources
Energy Conservation Audit
for the

Town of Lee

Water Treatment Plant

Massachusetts

May 2008

Prepared by

THE CENTER FOR ECOLOGICAL TECHNOLOGY

112 Elm Street, Pittsfield, MA 01201
(413) 445-4556, www.cetonline.org

and

PRECISION DECISIONS LLC

PO Box 746, Otis, MA 01253
413-269-4965, vreeland67@msn.com

TABLE OF CONTENTS

<u>SECTION</u>		<u>PAGE</u>
1.0	INTRODUCTION	2
2.0	BACKGROUND	3
3.0	FACILITY DESCRIPTION	4
	<i>Lighting, Process & Electrical Usage</i>	4
	<i>Building Envelope</i>	4
	<i>Heating System</i>	4
	<i>Hot Water System</i>	5
	<i>Energy Profile</i>	5
4.0	ENERGY CONSERVATION MEASURES	6
	<i>ECM CSI – Install Programmable Thermostats</i>	6
	<i>ECM BE1 – Insulate Walls/Roof</i>	7
	<i>ECM MC1 – Fan Motor Controls</i>	7
5.0	SUMMARY OF MEASURES	10

APPENDICES

END OF REPORT

1.0 INTRODUCTION

An energy audit was performed on the Water Treatment Plant (WTP) located at 310 Reservoir Road in the Town of Lee as part of the Energy Audit Program sponsored by the Massachusetts Division of Energy Resources (DOER). The WTP energy audit is part of a multi-site audit for the town; this audit was performed in advance of the other building audits so that it would coincide with the publication of a Department of Environmental Protection (DEP) energy audit. This report details the energy audit, the measures considered and the recommendations for upgrade.

The audit for the WTP focused only on the energy used for heating at the site. A separate audit focused on electrical usage was performed by other parties as part of the DEP audit of several treatment plants across the Commonwealth. In future, an executive summary under separate cover will compile recommendations for all of the Town of Lee buildings and sites included in the DOER audit project.

The recommendations are based on submitted usage data, a site review and preliminary evaluation. The preliminary cost of recommended upgrades and energy savings are opinions intended to be used for feasibility purposes only. Recommended measures should proceed to detailed design and evaluation followed by competitive bidding per the Massachusetts Procurement Guidelines. The resulting responses to the bid should be used for budget approval purposes. For more information see:

Office of the Inspector General, *Municipal, County, District, and Local Authority Procurement of Supplies, Services, and Real Property*, Publication No. CR-1520-170-200-09/06-IGO.

2.0 BACKGROUND

The Massachusetts Division of Energy Resources offers energy audits subject to available funding. The Energy Audit Program (EAP) provides technical assistance to cities, towns, regional school districts and waste water districts to identify capital improvements that help cut energy costs.

Schools in cities, towns and regional school districts, as well as waste water treatment plants and other municipal structures are eligible for assistance if they meet the following criteria: 1) the facility must be owned and occupied by a city, town, regional school district, or waste water district; 2) there must be no plans to close or dispose of the building within the next ten years. Additionally, some buildings may be deemed ineligible because planned remodeling or renovation projects will impact potential conservation projects.

The audit provides each project participant with a list of energy conservation recommendations, and an outline of estimated costs and energy savings. This information may be used to support a future application to DOER's Energy Audit Program; support performance contracting; or justify a municipal bond-funded improvement program. **Only projects identified or confirmed on a DOER approved energy audit are eligible for funding through the Energy Audit Program.** EAP is a state funded grant program that potentially provides funds, when available, for energy conserving capital improvements.

The DOER contracts with energy consultants across the state to perform some of the audits. One of these energy consultants is the Center for Ecological Technology Inc. (CET). For more than 30 years, CET has provided residents, businesses and communities with the tools to make it easy and affordable to carry out daily life in a more environmentally sustainable manner. Its work focuses on energy efficiency, renewable energy, waste management and environmental education. To augment CET's energy audit capabilities, CET has partnered with Precision Decisions LLC in performing the DOER energy audits. Precision Decisions LLC is an engineering consultant with experience in energy conservation and renewable energy. CET and Precision Decisions LLC have collaborated on energy matters in Western Massachusetts since 2004.

Precision Decisions' licensed professional engineer Chris Vreeland performed the onsite audit, developed the recommendations and wrote the audit report. Personnel from the municipality provided site-specific information for the audit as well as observations during the site walkthrough.

3.0 FACILITY DESCRIPTION

The Water Treatment Plant is a 6,768 square foot, 1 story building located at 310 Reservoir Road. The building was constructed in 1997. The plant is operated year-round and serves 2055 customers. The plant is staffed from 7-4:40 Monday through Friday, 8-noon Saturday and Sunday, with occasional other periods during equipment breakdowns.

Lighting, Process & Electrical Usage

Since this audit does not include electrical assessment a description of the lighting, process and electrical usage is not included. There is no thermal energy used in the process other than for electric heat to keep the caustic storage tank above crystallization temperature.

Building Envelope

The foundation is concrete. There is no basement. The walls are precast concrete with 2 inches of rigid foam insulation. The concrete roof is flat and has 2 inches of polyisocyanurate insulation with concrete decking. There are no windows in the building.

Heating System

Heat is produced with an oil-fired boiler with a nameplate rating of 783,000 BTUs. The boiler was manufactured by Smith in 1997. This serves the entire building area through a hot water distribution system that feeds 12 separate industrial fan coil units. Each of these units is controlled by a manual thermostat (for a total of 12 zones). There are nine exhaust fans and 6 air intakes with automatic dampers. Seven of the fans and louvers are controlled by automatic fan controls. Two are controlled by toggle switches. In two cases the heating zone and fan are tied into the same thermostat with a single set point. There are no provisions for setback. There is no central AC system.



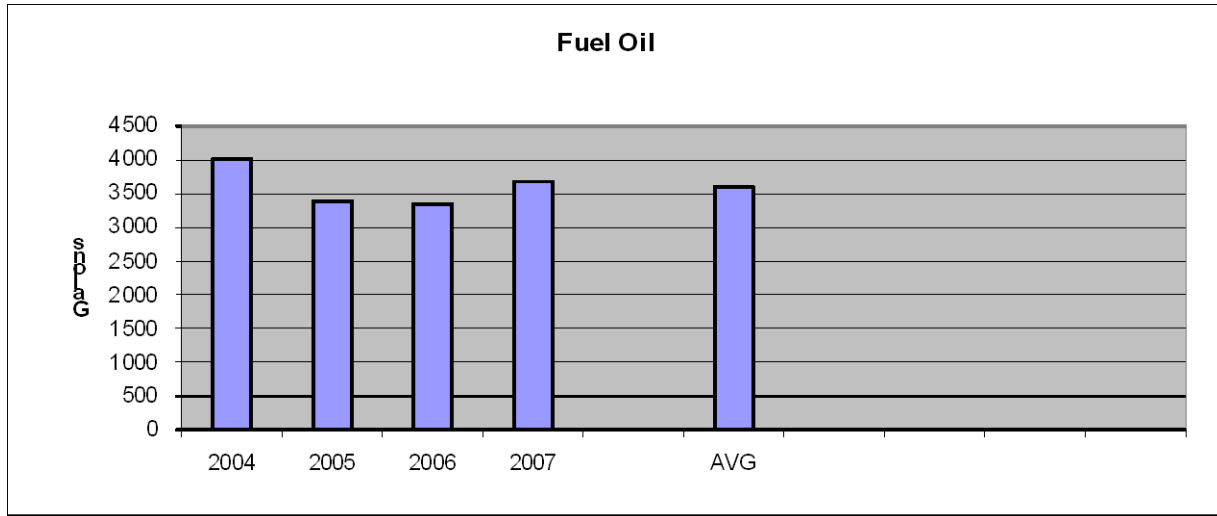
Hot Water System

Hot water was originally provided by a small hot water heater. A larger commercial heater was recently installed to provide tempered water to eyewash stations per new OSHA requirements. Other alternatives exist that could more cost-effectively meet this need; since this unit is new, however, removal would not be viable.

Energy Profile

The Water Treatment Plant uses an average of 3600 gallons of #2 fuel based on four years of stick reading taken by WTP personnel. A monthly profile was not possible due to the sporadic time periods between measurements.

Year	2004	2005	2006	2007	AVG
#2 Oil	3990	3367	3328	3669	3589



The records submitted had an amount of \$2.50 per gallon. However, oil prices have spiked during the winter of 2008 to over \$3.70 a gallon. Given the large tank size at the site a rate of \$3.00 per gallon was used for savings estimates in this report.

4.0 ENERGY CONSERVATION MEASURES

For the Water Treatment Plant the following energy conservation measures were evaluated:

- Control system upgrades
- Motor control(s) for fans

For each ECM detailed below, there is a corresponding appendix that further details the quantitative assumptions, projections and opinions of cost for the measure. The name of each appendix corresponds with each ECM section (i.e. ECM CS1 would be found in appendix CS).

ECM CS1 – Install Programmable Thermostats

Programmable thermostats should be installed for 9 out of 12 of the heating system fan coil units. The lab/office area should be left at a constant temperature due to the process and lab equipment in this room. The ammonia and chlorine rooms should also be left at constant temperatures. All the other areas** should be programmed to heat areas to a comfortable work temperature (68 F) in correspondence with building occupancy (M-F 7-4:40, S-S 8-12). During all non-working hours it should be dropped to 55 F. The caustic storage tank has its own heat tracing which should keep the caustic from crystallizing. The system should be tested to ensure that it is working and capable of maintaining tank and piping temperature with an ambient temperature of 55 F.

One alternative to caustic storage is to plan tank draw-downs so that the tank is only filled full during summer months and at 2/3 or less from October to April. In October the caustic storage can be diluted to 35%, which will lower the crystallization temperature. The later stage process dilution that goes from 50% to 25% would need to be adjusted accordingly.

** The areas to receive programmable thermostats would be: bathroom, boiler room, chemical storage area, storage room, the entryway, the 'Ross valve' area, and 3 units in the main process room.

One of the existing thermostats is installed directly behind the 25% caustic 'make-down' tank and shows signs of accelerated corrosion. This should be relocated around the corner from the tank so that it is not exposed to the fumes generated during caustic dilution.

The savings would be 651 gallons, or \$1952/year. The cost of this measure would be \$2050 resulting in a payback of 1.1 years.



(corrosive thermostat, as noted above)

ECM BE1 – Insulate Walls/Roof

The walls and roof each have 2” of rigid foam insulation. Adding additional insulation would not be cost effective, as it is not easily added to this type of construction. However, when the roof is replaced (10-20+ years) additional insulation should be added (4 or even 6 inches depending on the cost of fuel and insulation at that time).

ECM MCI – Fan Motor Controls

Bathroom

The bathroom fan is tied to the same controller that runs the zone valve for the fan coil unit. This runs off a single control point from the Honeywell T6052B thermostat (with a 2 degree dead band). As with the other fans this is set up to ventilate during periods of overheating. This is the wrong application for a bathroom fan. The fan should be removed from this controller and set up to run off an occupancy sensor (the light can be set up to run off this as well). Once activated, this would be set to run for an 8-10 minute interval before switching off.

Other Fan Controllers

The remaining controlled fans are set up with the same single control point off of other Honeywell thermostats. For a water treatment plant the role of these fans should be to remove humidity during the winter and excess heat in the summer. The current controllers only allow for the removal of heat. When left on automatic control, during the winter heating season they inappropriately react to temperature variations as minor as 2 degrees throughout the facility. The excess runtime results in heat being exhausted from the building. Additionally, one of the storage room thermostats is taped up preventing proper temperature sensing and resulting in the fan running continuously. This should be replaced

or repaired, or set for only manual operation (off during winter). The operation of several of these fans (including the malfunctioning fan that is always on) opens up the automatic louvers over the main entry bringing in fresh air which then must be heated. This operation does little for humidity removal or air turnover since the points of entry and exhaust are adjacent to each other.



(louvers over main entrance)

It is recommended that most of the fans be turned off for the winter heating season. A few of the fans over the open tanks can be outfitted with a dual controller that operates on either high temperature or humidity. This would be set for either summer operation (high temperature) or winter operation (low temperature). Alternatively, these could convert to 'humidity only' and run off this setting all year; the remaining fans would control the excess heat in the summer.



(local vent in process area)

A few issues could arise with limiting the operation of the fans:

- Excess humidity could develop. This should be mitigated by the humidistat. However, depending on the location of humidity generation, the newly installed sensors may not be adequate. Additional humidity controls on other fans (in areas of condensation) should alleviate this issue.
- Adequate 'purge air' may be limited. The amount of fresh air in the facility should be adequate for the current occupancy. However, there are several chemicals that get used at the plant, some of which do evaporate into the building air. Most of these chemicals are stored in enclosed tanks and are added in very small quantities to treat the water; auxiliary fresh air for 'purging' is not normally necessary*. It is possible that reductions in operation of the exhaust fans will increase the concentration of airborne chemicals to unacceptable levels. As stated above, the current fan operation does little to address this issue. If elevated levels arise, then cross ventilation should be set up; this is accomplished by the operation of the exhaust fan closest to the point of fume generation (likely close to one of the open process tanks) and with an inlet louver open on the opposite site of the plant. This would only be done if required.

*Note: during some operations, such as caustic dilution, chemical fumes are generated so manual operation of some exhaust fans may be required.

By installing an occupancy sensor on the bathroom fan, a replacement to the storage room fan controller, and installation of dual humidistat-thermostat controls to the process area fans, a total of 514 gallons of oil and 511 kWh per year would be saved (\$1623 per year). The estimated cost of this measure would be \$2983 resulting in a simple payback of 1.8 years.

This savings estimate is based on a reduction of one 413 cfm fan from running 24 hours per day through the winter to running 10 hours per day. The actual savings will vary in accordance with how often the fan runs to reduce humidity and for process air purges; the savings will increase the less the fan is needed.

5.0 SUMMARY OF MEASURES

Several of the energy conservation measures considered have a simple payback of less than 10 years. These ECMs are summarized in the first appendix table (and will also be included in the executive summary report of all buildings covered in this audit). For the Water Treatment Plant, the options have a combined savings of 32% on fuel and less than 1% on electricity. The total cost of upgrades is estimated at just under \$3600, with an average payback of 1.4 years.

SUMMARY OF MEASURES

Water Treatment Plant					Annual Usage of Each System (Base Case)						Annual Energy Savings						Annual Cost Savings						Simple Payback ECM Cost/ Savings (years)
					Electrical		Fuels			Energy	Electrical		Fuels			Energy	Electrical		Fuels			Energy	
ECM#	Description	ECM Cost	Utility Funding	Net Cost	kWh	kW	Oil Gal.	Nat. Gas CCF	LPG Gal	Total MMBTU	kWh	kW	Oil Gal.	Nat. Gas CCF	LPG Gal	Total MMBTU	kWh	kW	Oil	Nat. Gas	LPG	Total	
CSs	Control System	\$2,050	\$0	\$2,050	0	0.0	3600	0	0	500.4	0	0.0	651	0	0	90.4	\$ -	\$ -	\$ 1,952	\$ -	\$ -	\$ 1,952	1.1
MCs	Motor Controls	\$2,983	\$0	\$2,983	1,226	0.0	986.13	0	0	137.1	511	0.0	514	0	0	73.1	\$ 82	\$ -	\$ 1,541	\$ -	\$ -	\$ 1,623	1.8
TOTAL		\$5,033	\$0	\$5,033							511	0.0	1164	0	0	163.6	\$ 82	\$ -	\$ 3,492	\$ -	\$ -	\$ 3,574	1.4

Annual Usage Total (for Building)	205,000	0	3,600	0	0	1200.3	#####	\$ -	\$ 10,800	\$ -	\$ -	\$ 43,600
Savings Reduction (%)	0%	#DIV/0!	32%	#DIV/0!	#####	14%	0%	#DIV/0!	32%	#DIV/0!	###	8%

Appendix CS

Control System Upgrade

Town of Lee

Water Treatment Plant

May-08

Area	ECM#	Description	Base Case				Proposed				Annual Savings			Total Est. Cost	Simple Payback	Code	Utility Funding	
			Annual Usage Gallons	Efficiency X zone %	Net Energy MBTU	Annual Cost	Efficiency X zone	Net Energy MBTU	MBTU	Gallons	\$	Cost	Payback				\$/Unit	Total
	CS1	zone 1 - P stat	3600	77.3%	386.559	\$10,800	77.3%	296	90	651	\$1,952	\$2,050	1.1					
			0	7.8%	0	\$0	7.8%	0	0	0	\$0	\$0	#DIV/0!					
			0	8.0%	0	\$0	8.0%	0	0	0	\$0	\$0	#DIV/0!					
										0	\$0							
										0	\$0							
Total	CSs	Control System	3600						90	651	\$1,952	\$2,050	1.1					\$0
Fuel Type: Oil																		
Cost: \$3.00																		

Opinion of Cost

Measure	Item	Detail	UOM	Qty	Equip (ea)	Matl (lot)	Labor (hr)	Labor rate	Subtotal	Engineering	Conting	Total	Source
										12%	10%		
CS1	T Stat	zone 1 - P stat	ea	9	\$75	\$15	2	\$55	\$1,680	\$202	\$168	\$2,050	Est
									\$0	\$0	\$0	\$0	Est
									\$0	\$0	\$0	\$0	Est
									\$0	\$0	\$0	\$0	Est
									\$0	\$0	\$0	\$0	Est

Appendix MC

Motor Controls

Town of Lee

Water Treatment Plant

May-08

Area	ECM#	Description	Base Case				Proposed				Annual Savings			Total Est.	Simple	Utility Funding		
			Elec Use	Heat Loss	System	Annual Cost	Elec Use	Heat Loss	System	Annual Cost	Gallons	kWh	\$	Cost	Payback	Code	\$/Unit	Total
			kWh	MMBTU	Efficiency		kWh	MMBTU	Efficiency									
	MC1	Fan Controls	1226.4	137.1	80%	\$3,894	715	80.0	80.0%	\$2,272	514	511	\$1,623	\$2,983	1.8			
			0	0.0	80%	\$0	0	0.0	80.0%	\$0	0	0	\$0		#DIV/0!			
			0	0.0	80%	\$0	0	0.0	80.0%	\$0	0	0	\$0		#DIV/0!			
			0	0.0	80%	\$0	0	0.0	80.0%	\$0	0	0	\$0		#DIV/0!			
Total	MCs	Motor Controls	1,226	137		\$3,894	715	80		\$2,272	514	511	\$1,623	\$2,983	1.8			\$0
Fuel Type:		Oil																
Cost:		\$3.00																
		Electric																
		\$0.16																

Opinion of Cost

Measure	Item	Detail	UOM	Qty	Equip (ea)	Matl (lot)	Labor (hr)	Labor rate	Subtotal	Engineering	Conting	Total	Source
										12%	10%		
MC1	Process	Install Humidity Sensors	ea	3	\$220	\$120	4	\$70	\$1,620	\$194	\$162	\$1,976	Est
	Bathroom	Occupancy Sensor	ea	1	\$75	\$80	6	\$70	\$575	\$69	\$58	\$702	Est
	Storage	Replace controls	ea	1	\$110	\$0	2	\$70	\$250	\$30	\$25	\$305	Est
									\$0	\$0	\$0	\$0	Est
									\$0	\$0	\$0	\$0	Est