4 Building Systems Narratives

4.1 Sustainable Design Elements

The design of the Lincoln School incorporates numerous sustainable design elements intended to: increase occupant comfort and productivity, use renewable and recyclable materials, consume less energy, use fewer natural resources, and minimize the building's impact on the environment. The project will meet the criteria for a high-performance school as defined by the Massachusetts Collaborative for High Performance Schools (MA CHPS), and is attempting to become a MA CHPS Verified Leader. Please refer to the MA CHPS scorecard in Section 5 for the current points summary.

The sustainable design begins with a superior building envelope, consisting of new exterior walls having a combination of 3" of continuous rigid insulation and batt insulation with a total R-value of 36, and a roof assembly with an R-value of 32. The windows in the new building, as well as the 1963 and 1971 buildings, will have 1" low-e insulated glass with argon-filled air space. The existing windows in the 1994 link building are to remain. Please refer to the following Sustainable Design Options document prepared by Garcia, Galuska, DeSousa, which analyzes the energy savings that will result from utilizing these building assemblies in the design.

In addition to the high performance building envelope, other sustainable features include a light colored PVC roof, which will reduce heat island effect. Sunshades are provided on south and west facing classrooms to control daylight, and interior light shelves are provided to distribute natural light deeper into the classrooms. Clerestories will bring natural light into interior corridors and deeper into the Cafeteria.

At the interior, products using recycled content are being utilized, such as linoleum, ceramic and porcelain tile, carpet, gypsum wall board, plastic lockers, plastic toilet partitions, and wood casework and doors. Materials such as adhesives, sealants, paints, furnishings, and other materials will have low VOC content. A construction waste management plan will be in place to reduce the amount of waste going into landfills by recycling, re-using, or salvaging building materials. It is the intent to provide views to the outside from all classrooms, and as many other spaces as possible. Acoustics are an important aspect of the learning environment, and measures are being taken to improve the acoustics in existing spaces, in addition to providing a high level of acoustic performance in new spaces.

The building systems are designed to provide maximum efficiency while being cost effective. The mechanical system consists of displacement ventilation with perimeter fin-tube radiation in all of the classrooms, and induction units in the Media Center. High efficiency mechanical equipment is being utilized. High-efficiency LED lighting fixtures will be installed throughout the building, with classrooms and other daylit spaces having photo and motion sensors to conserve energy. New, low-level site lighting will be provided with cutoff fixtures to avoid light pollution. Water-conserving fixtures will be installed throughout the building, including waterless urinals, and fixtures with sensors to reduce water usage. Hot water will be provided via a high-efficiency gas-fired condensing water heater.

Rooms such as copy rooms, custodial spaces, and science rooms will be exhausted directly to the outdoors for chemical source control. A walk-off entry mat system will control pollutants for improved indoor air quality.

In addition to these measures, the project will incorporate permanent displays identifying high-performance features throughout the building, so that the building becomes a teaching tool for both students and the public using the building. Environmental gardens and outdoor classroom areas will be used for educational development of both students and the community.

Date: 5/29/2012

Project: Lincoln Public Schools

GARCIA • GALUSKA • DESOUSA
Consulting Engineers Inc.
370 Faunce Corner Road, Dartmouth, MA 02747-1217

Assumptions: An SD level building design is used as the basis for a thermal model. The thermal model uses base case assumptions that meet the MA CHPS/ASHRAE Standard 90.1-2007 minimums. Numerous simulations are run to quantify the energy consumption and cost differences for design options that increase performance as compared to the base case building. This spread sheet shows relevant costs and operating cost differences.

SUSTAINABLE DESIGN OPTIONS - Analysis Results & Comparisons

Total Building Area (ft²) = 139,550

No.	DESIGN OPTION	DESCRIPTION	ASSUMPTIONS			CONSTRUCTION COST IMPACT $	ANNUAL ELEC. CONS. (KWH)	ANNUAL GAS CONS. (MBTU)	ANNUAL UTITLY CONS. (KBTU)	ANNUAL UTILITY CONS. (KBTU/S.F.)	ANNUAL ELECTRIC COST $/YEAR	ANNUAL GAS COST $/YEAR	OPERATING COST $/YEAR	OPERATING COST SAVINGS $/YEAR	SIMPLE PAYBACK YEARS	REMARKS
CODE/ASHRAE BASE CASE BUILDING - ALL BUILDINGS																
	Existing Envelope for Existing Buildings, ASHRAE Standard 90.1-2007 Baseline Envelope for New Construction, ASHRAE Standard 90.1-2007 Baseline Lighting and Mechanical Systems					$5,542,100	888,620	7,020.5	10,052,471	72.0	$141,290	$96,243	$237,533			
BUILDING ENVELOPE OPTIONS - NEW ADDITION (52,534 ft²)			R-Value	Other	Other											
	Baseline Wall	Base Case - Meets ASHRAE	R-13 + R-10 c.i.			$45,000	373,670	2,934.8	4,209,762	80.1	$59,414	$40,234	$99,648	$0	N/A	
	Design Wall		R-21 + R-15 c.i.			$60,000	373,120	2,904.3	4,177,385	79.5	$59,326	$39,815	$99,141	$507	29.6	
	Baseline Roof	Base Case - Meets ASHRAE	R-25 c.i.			$137,000	373,670	2,934.8	4,209,762	80.1	$59,414	$40,234	$99,648	$0	N/A	
	Roof Type-2		R-32 c.i.			$158,600	373,340	2,901.1	4,174,936	79.5	$59,361	$39,771	$99,132	$516	41.9	
	Baseline Glazing	Base Case - Meets ASHRAE		U = 0.45	SHGC=0.40	$620,600	373,670	2,934.8	4,209,762	80.1	$59,414	$40,234	$99,648	$0	N/A	
	Design Glazing	Double pane argon fill w/ heat mirror		U = 0.20	SHGC=0.40	$878,000	374,100	2,598.1	3,874,529	73.8	$59,482	$35,618	$95,100	$4,548	56.6	
BUILDING ENVELOPE OPTIONS - LINK (32,403 ft²)			R-Value	Other	Other											
	Design Wall	Existing	R-19			$0	178,700	719.0	1,328,694	41.0	$28,413	$9,856	$38,269	$0	N/A	
	Baseline Roof	Existing	R-20 c.i.			$0	178,700	719.0	1,328,694	41.0	$28,413	$9,856	$38,269	$0	N/A	
	Roof Type-2		R-32 c.i.			$124,354	178,150	668.3	1,276,148	39.4	$28,325	$9,162	$37,487	$782	159.0	
	Design Glazing	Existing		U = 0.55	SHGC=0.6	$0	178,700	719.0	1,328,694	41.0	$28,413	$9,856	$38,269	$0	N/A	
BUILDING ENVELOPE OPTIONS - BROOKS (40,602 ft²)			R-Value	Other	Other											
	Baseline Wall	Existing	No Insulation			$0	236,230	1,888.2	2,694,217	66.4	$37,560	$25,886	$63,446	$0	N/A	
	Design Wall		R-13 + R-10 c.i.			$115,000	223,820	1,158.2	1,921,874	47.3	$35,587	$15,877	$51,464	$11,982	9.6	
	Baseline Roof	Existing	R-25 c.i.			$111,300	236,230	1,888.2	2,694,217	66.4	$37,560	$25,886	$63,446	$0	N/A	
	Roof Type-2		R-32 c.i.			$128,100	235,990	1,865.7	2,670,898	65.8	$37,522	$25,577	$63,099	$347	48.4	
	Baseline Glazing	Existing		U = 0.55	SHGC=0.6	$0	236,230	1,888.2	2,694,217	66.4	$37,560	$25,886	$63,446	$0	N/A	
	Design Glazing	Double pane argon fill w/ heat mirror		U = 0.20	SHGC=0.40	$351,000	233,920	1,739.6	2,537,735	62.5	$37,193	$23,848	$61,041	$2,405	145.9	
BUILDING ENVELOPE OPTIONS - REED (14,011 ft²)			R-Value	Other	Other											
	Baseline Wall	Existing	No Insulation			$0	110,880	1,767.7	2,146,023	153.2	$17,630	$24,234	$41,864	$0	N/A	
	Design Wall		R-21 + R-10 c.i.			$141,700	108,440	1,512.9	1,882,897	134.4	$17,242	$20,740	$37,982	$3,882	36.5	
	Design Roof	Existing	R-21 c.i.			$0	110,880	1,767.7	2,146,023	153.2	$17,630	$24,234	$41,864	$0	N/A	
OVERALL DESIGN ENVELOPE																
	Design Envelope Options with ASHRAE Standard 90.1-2007 Baseline Lighting and Mechanical Systems					**$7,552,960**	**519,590**	**6,321.2**	**8,094,041**	**58.0**	**$82,615**	**$86,657**	**$169,272**	**$68,261**	**29.5**	
HVAC SYSTEM																
B	Baseline - VAV System	Baseline Envelope & Lighting simulated with Baseline HVAC System				$4,209,550	888,620	7,020.5	10,052,471	72.0	$141,290	$96,243	$237,533	$0	N/A	
1a	Displacement Ventilation System w/ Refurbished Chilled Water Coil VAV AHU in Media Center	Baseline Envelope & Lighting simulated with Design HVAC System				$3,772,340	936,980	4,668.3	7,865,276	56.4	$148,979	$63,997	$212,976	$24,557	**Instant***	***Simple payback is instant as system is more efficient and less expensive than baseline system.**
ELECTRICAL																
	Baseline Lighting Fixtures and Controls	Base Case - Per ASHRAE Standard 90.1-2007			1.2 w/s.f. average	$418,650	888,620	7,020.5	10,052,471	72.0	$141,290	$96,243	$237,533	$0	N/A	
	Design Lighting Fixtures and Controls	LED lighting for common areas and High Efficiency Fluorescent lighting in classrooms with Daylighting Controls			0.3 w/s.f. average	$627,975	558,460	7,658.1	9,563,566	68.5	$88,795	$104,985	$193,780	$43,753	4.8	
Design Building with Design MEP Systems																
											$0.16					
	Design Building - Superior Envelope Options, Superior Electrical Fixtures & Controls, and Option 1a Displacement Ventilation System (R-32 Roof in liue of R-42)					**$6,411,175**	**582,180**	**4,217.3**	**6,203,698**	**44.5**	**$92,567**	**$57,815**	**$150,382**	**$87,151**	**10.0**	**36.69% energy cost savings over baseline building**
RENEWABLES																
	Design Building - Superior Envelope Options, Superior Electrical Fixtures & Controls, and Option 1a Displacement Ventilation System					**$6,411,175**	**580,750**	**4,117.1**	**6,098,619**	**43.7**	**$92,340**	**$56,441**	**$148,781**	**$88,752**	**9.8**	
			Annual Energy Generated (kWh)													
	Solar PV System Option-1	100 kW	115,230			$400,000	534,120	2,802.5	4,624,917	33.1	$84,925	$38,419	$136,682	$12,099	33.1	
	Solar PV System Option-2	200 kW	230,459			$800,000	418,891	2,802.5	4,231,756	30.3	$66,604	$38,420	$124,583	$24,198	33.1	**Capital cost does not include sale of SREC.**
	Solar PV System Option-3	500 kW (Arch. 2015)	576,148			$2,000,000	73,202	2,802.5	3,052,265	21.9	$11,639	$38,421	$88,285	$60,496	33.1	
	Solar PV System Option-4	1,600 kW (Net Zero)	1,843,672			$6,400,000	-1,194,322	2,802.5	-1,272,527	-9.1	-$189,897	$38,422	-$44,805	$148,781	43.0	

*Rebatable items will have to be confirmed by the local utility providers.

4.2 Site

Please refer to attached site narrative and Permitting Schedule from Nitsch Engineering, as well as a Summary Table of Existing Septic Flows.

Nitsch Engineering

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Lincoln Public Schools
Lincoln, Massachusetts
Nitsch Project #8429

Basis of Design Narrative
Lincoln Public Schools Site

May 24, 2012

The Towns of Lincoln is proposing a new school building option to replace the existing Smith and Lincoln Schools. The new school will be located behind the present location of the existing school. This narrative outlines some of the major items to consider about the project including permitting, utility infrastructure and other issues.

Permitting

WETLANDS PROTECTION ACT (310 CMR 10.00)

The Wetlands Protection Act ensures the protection of Massachusetts' inland and coastal wetlands, tidelands, great ponds, rivers, and floodplains. It regulates activities in coastal and wetlands areas, and contributes to the protection of ground and surface water quality, the prevention of flooding, and storm damage and the protection of wildlife and aquatic habitat.

The site is located within or adjacent to several environmental protection areas. The existing building is within the 100-foot wetland buffer zone of what appears to be a Bordering Vegetated Wetland. The site also includes Riverfront Area of at least one stream, 1% Annual Chance Floodplain, and a Floodway.

The proposed option does not affect the wetland directly. Work is proposed within the wetland buffer zones and Riverfront Area. There are no stream crossings or filling of wetlands proposed. The project does not appear to be within a 750 foot radius of the vernal pool.

The proper permits include a Notice of Intent (NOI) filed with the Natural Resource Commission (Conservation Commission) and with the Massachusetts Department of Environmental Protection (DEP) as part of the wetland permitting for the project. A review by the Lincoln Planning Board and the Lincoln Board of Health is required as well. In addition, a design review by the Lincoln Public Works Commission is required for the replacement of the existing water line and the existing sewer line.

LINCOLN WETLANDS PROTECTION BYLAW

The Town of Lincoln’s Wetland Protection Bylaw includes a 50-foot wetland buffer zone “no-disturb area”. Isolated areas of flooding, including vernal pools, are protected as are water bodies themselves. In addition, the Watershed Protection Bylaw protects activities within the Flint's Pond Watershed.

SURFACE WATER SUPPLY PROTECTION (310 CMR 22.20)

The Massachusetts DEP ensures the protection of surface waters used as sources of drinking water supply from contamination by regulating land use and activities within critical areas of surface water sources and tributaries and associated surface water bodies to these surface water sources.

A review of the Massachusetts DEP resource layers available on the MassGIS indicates the entire site is within Zone II Water Supply Protection Zone. Zone II is a Groundwater Supply Protection Area that includes the area of an aquifer which contributes water to a well. Zone II protection includes governing use of the site related to hazardous materials, fertilizers, and other site disturbance that may affect the groundwater. As part of the calculations performed by GZA to demonstrate compliance of the site septic system with DEP regulations, GZA demonstrated that the hypothetical nitrogen load to the groundwater is 2.16 mg/l, which is below the Zone II goal of 5 mg/l.

A portion of the site is also within a Zone A Water Supply Protection Zone. Zone A is a Surface Water Protection area. Protection of Zone A relative to this site includes specific regulation regarding storage of hazardous materials, siting of sewage disposal and conveyance systems, and the use of herbicides.

NATURAL HERITAGE & ENDANGERED SPECIES PROGRAM

According to MassGIS, the site is NOT a Priority Habitat or Estimated Habitat for the Natural Heritage and Endangered Species Program (NHESP). NHESP also does NOT indicate any certified or potential Vernal Pools within 750 feet of the site. No such areas appear within close proximity to the site.

The MassGIS Open Space Viewer identifies the site as a Protected Open Space – Limited. Protected Open Space includes recreational land such as town parks, playing fields, and school fields.

FLOOD PLAIN

Based on the Flood Insurance Rate Map (FIRM), Community Panel Number 25017C0387E, dated June 4, 2010 the site is located near a Flood Zone AE (Special Flood Hazard Areas Subject to Inundation by the 1% Annual Chance Flood – Base Flood Elevations Determined). The Flood Zone also contains an area identified as Floodway Areas in Zone AE. The Floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

The Flood Plain is located to the north and east of the proposed site. The base flood elevations have been determined to vary between elevation 208 to the east of the site and elevation 218 to the north of the site, referenced to the North American Vertical Datum of 1988 (NAVD 88). Any work proposed within the Flood Plain will require replication of any lost flood storage volume. No work will be permitted within the Floodway.

ZONING

The Lincoln Schools campus is located within the R-1 Single Family Residence Zoning District. Portions of the site are also governed by the W (Wetland and Watershed Protection) and FP (Flood Plain) Districts.

The following is a list of requirements under the Zoning By-Law:

<u>Building Height:</u> The height of any structure shall not exceed 36 feet or 2 1/2 stories whichever is less.
<u>Area:</u> The minimum area of any lot shall be 80,000 square feet.
<u>Frontage:</u> The minimum street frontage shall be 120 feet.
<u>Width of lot:</u> The minimum width of a lot between any point on any side lot line and any point on the other side lot line measured through any point on the principal building shall be 250 feet.
<u>Yards</u>: The minimum front, side, and rear yard is 75 feet for non-residential principal structures and for structures that are not accessory to residential use.

Parking: One parking space for each classroom therein, plus one space for each two employees or staff members other than teachers; and, in addition to the above, where an auditorium is provided, one space for each three seats therein. Standard parking spaces shall be 8.5' wide by 18' long with a 24' maneuvering aisle.

USEPA NPDES

Construction activities that disturb more than one acre are regulated under the United States Environmental Protection Agency's (EPA) National Pollution Discharge Elimination System (NPDES) Program. In Massachusetts, the USEPA issues NPDES permits to operators of regulated construction sites. Regulated projects are required to develop and implement stormwater pollution prevention plans in order to obtain permit coverage.

SEPTIC SYSTEM (TITLE 5)

The school septic system is currently operating under a variance. The variance was granted to allow the school to use a design flow of 200% its average water meter readings (as per 310 CMR 15.416(3)) instead of 15 gallons per person per day (as per 310 CMR 15.203(5)). The approved variance design flow is 7,790 gpd.

MASSACHUSETTS ENVIRONMENTAL POLICY ACT (MEPA)

The MEPA Office of the Executive Office of Energy and Environmental Affairs (EEA) conducts reviews of the environmental impacts of development projects and other activities that require one or more State Agency Actions and that exceed MEPA review thresholds, as specified in the MEPA regulations. The review thresholds identify categories of Projects or aspects thereof of a nature, size or location that are likely, directly or indirectly, to cause Damage to the Environment. A preliminary review suggests no MEPA thresholds will be exceeded.

Table 1 – Permitting Schedule

Permit	Permitting Authority	Anticipated Filing Date	Anticipated Approval Date
Notice of Intent (Order of Conditions)	Town of Lincoln Conservation Commission	After 100% DD	Approval in 3 to 6 months
Planning Board Site Plan Review	Town of Lincoln Planning Board	From SD to DD	On-going - Up to 6 months+
Board of Health	Town of Lincoln Board of Health	From SD to DD	Up to 6 months
Public Works Commission - Right of Way Permit and Storm Water Regulations	Town of Lincoln Public Works Commission	From SD to CD	Up to 6 months
Public Works Commission – Water and Sewer Approval	Town of Lincoln Public Works Commission	From SD to CD	3 to 6 months
National Pollutant Discharge Elimination System (NPDES) with EPA Notice of Intent (NOI)	Environmental Protection Agency (EPA)	After 100% CD	Once Submitted; Close NOI at end of Construction
Municipal Separate Storm Sewer System (MS4)	Environmental Protection Agency (EPA)	After 100% CD	Once Submitted, ongoing; yearly reports required

Utility Infrastructure:

The project surveyor will obtain existing as-built and record plan information from the Town and Utility owners to aid the utility designer in determining the impact on existing utilities for the three options.

Water:

The existing 8” water main in Ballfield Road will remain. A new 8” ductile iron fire protection/water service will connect the new/renovated building to the existing water main on site. New fire hydrants will be placed near the new school building in locations as requested by the Lincoln Fire Department.

Sanitary Sewer:

The site sewer and septic system will remain. A new sewer service and associated septic tanks, pump chamber, and force main will be installed to connect the new/renovated building to the existing septic system.

The existing septic system is operating under a variance. Calculations performed in 2007 for original septic system design assumed an estimated 13,792 gallons/day design flow (based on 310 CMR 15). Proposed discharges greater than 10,000 gallons per day require a Groundwater Discharge Permit from the Massachusetts Department of Environmental Protection (DEP). The applicant filed for a variance to show actual flows were less than 10,000 gallons per day. The variance was approved in May 2007 based on a design flow of 7,790 gpd (200% of the average daily water meter readings from October 2001 to April 2006).

Nitsch Engineering has performed calculations to demonstrate that based on 310 CMR 15, the proposed flows from the entire site are less than 10,000 gallons per day. Since the proposed flows are less than 10,000 gallons per day, at 7,578 gallons per day, the septic system complies with Title V and the variance is no longer required. The attached calculations will be sent to the Lincoln Board of Health to request the variance be removed from the site.

Storm Drain:

The storm drainage system proposed for this project is a closed system consisting of underground plastic piping, deep sump hooded catch basins, water quality structures and underground detention/infiltration systems (large diameter perforated pipe wrapped in stone and geotextile fabric). The project also includes bio-retention systems and gravel wetlands that will further treat and infiltrate stormwater on site. All storm runoff will be treated to meet the requirements of the Massachusetts Department of Environmental Protection (DEP) Stormwater Handbook.

Gas:

A new gas line will be proposed to the school. The project currently anticipates connecting to the existing gas service on the site.

Electric:

Proposed site lighting will connect to the existing electrical infrastructure on site.

Project: Lincoln Public Schools
Location: Lincoln, MA
Nitsch Project #: 8429

Date: May 1, 2012
Prepared by: CRC
Checked by: SAB

SUMMARY TABLE OF EXISTING SEPTIC FLOWS

Building	Description	Units	#	Unit Flow gallons/person/day (gpd)	Total Flow	Septic Tank	Pump Chamber	Leach Field
Smith	Elementary School with cafeteria but no gymnasium with showers	Students	238.2	8	1,906	1,906	1,906	1,906
		Teachers/Staff	56		448	448	448	448
Brooks/Link/Reed	Secondary/Middle School with cafeteria, gymnasium and showers	Students	203.1	20	4,062	4,062	4,062	4,062
		Teachers/Staff	50.6		1,012	1,012	1,012	1,012
Hartwell	Elementary School without cafeteria, gymnasium, or showers	Students	79.5	5	398	398	398	398
		Teachers/Staff	26.2		131	131	131	131
Hartwell	Office Building	per 1,000 sf	6	75	450	450	450	450
	Total					**8,406**	**8,406**	**8,406**

Building	Description	Units	#	Unit Flow gallons/person/day (gpd)	Total Flow	Septic Tank	Pump Chamber	Leach Field
Pods	Elementary School without cafeteria, gymnasium or showers	Students	24	5	120	120	120	120
		Teachers/Staff	4		20	20	20	20
Pods	Office Building	per 1,000 sf	4	75	300	300	300	300
	Total					**440**	**440**	**440**

Total Site Existing	Maximum Approved Capacity					9,999	9,999	9,999
	Combined Existing Flows					**8,846**	**8,846**	**8,846**
	Reserve Capacity					**1,153**	**1,153**	**1,153**

SUMMARY TABLE OF PROPOSED SEPTIC FLOWS

Building	Description	Units	#	Unit Flow gallons/person/day (gpd)	Total Flow	Septic Tank	Pump Chamber	Leach Field
New Building	Elementary School with cafeteria but no gymnasium with showers *	Students	238.2	8	1,906	1,906	1,906	1,906
		Teachers/Staff	56		448	448	448	448
New Building	Secondary/Middle School with cafeteria but no gymnasium and showers *	Students	203.1	15	3,047	3,047	3,047	3,047
		Teachers/Staff	50.6		759	759	759	759
Hartwell	Elementary School without cafeteria, gymnasium, or showers	Students	79.5	5	398	398	398	398
		Teachers/Staff	26.2		131	131	131	131
Hartwell	Office Building	per 1,000 sf	6	75	450	450	450	450
	Total					**7,138**	**7,138**	**7,138**

* Gymnasium with four showers will be installed for occasional use only

Building	Description	Units	#	Unit Flow gallons/person/day (gpd)	Total Flow	Septic Tank	Pump Chamber	Leach Field
Pods	Elementary School without cafeteria, gymnasium or showers	Students	24	5	120	120	120	120
		Teachers/Staff	4		20	20	20	20
Pods	Office Building	per 1,000 sf	4	75	300	300	300	300
	Total					**440**	**440**	**440**

Total Site Proposed	Maximum Approved Capacity					9,999	9,999	9,999
	Combined Proposed Flows					**7,578**	**7,578**	**7,578**
	Reserve Capacity					**2,421**	**2,421**	**2,421**

4.3 Foodservice

Please refer to attached foodservice narrative from Crabtree McGrath Associates, Inc.

Foodservice Narrative

Crabtree McGrath Associates, Inc., a consulting group specializing in foodservice facilities planning and design, has been retained by OMR Architects of West Acton, Massachusetts to provide foodservice design for the new consolidated kitchen to serve students in grades K thru 8.

In meeting with the Foodservice staff, the design team reviewed the current conditions and identified program items that would be part of the foodservice operation. For example, the program today operates with disposable ware. The goal is to move to a compartmented reusable tray. Many other requests made by the kitchen staff were baseline equipment items needed to efficiently operate a modern foodservice operation.

Kitchen and Food Preparation Area

The kitchen facility shall include all the necessary components of a functional kitchen to include: a receiving area to be used as a staging point for the breakdown and distribution of delivered goods; refrigerated rooms for storage of refrigerated and frozen products are to be offered and sized to accommodate the needs of the facility; and dry goods storage for the keeping of canned, boxed, and other non-refrigerated food items. Food grade storage shelving and dunnage platforms shall be provided for dry goods storage and for storage of disposable items like plastic utensils, serving trays, and other paper related items.

Food preparation shall take place on stainless steel tables of various sizes and configurations. Tables may be fashioned with sinks, drawers, shelves, and overhead pot storage hook racks. Motorized food preparation equipment such as a food slicer, food cutter, and mixer shall be provided. Sizing of this equipment will be based on the scope of food preparation and tailored to fit the designed operation.

Cooking shall take place in a common location adjacent to both food storage and preparation. Equipment shall consist of standard pieces such as convection ovens, cooking kettles, braising pans, steamers, and open burner range tops. Adjustments shall be made to cooking equipment to suite the specific desired menu. The facility will include the necessary ware washing equipment to process ware, pots, trays, and pans.

Other support facilities located in or adjacent to the kitchen will include a staff toilet for men and women, a dedicated kitchen slop sink with enough space for the storage of mops, buckets and detergents. A clothes washer and dryer will be provided for the washing of mop heads, aprons, and kitchen hand towels. Typically grouped with this equipment are employee locker accommodations for the storage of personal items such as coats, handbags, or shoes.

161 West Main Street, Georgetown, Massachusetts 01833 phone: 978.352.8500 fax: 978.352.8588
mail@crabtree-mcgrath.com

Serving Area

Serving will take place in three separate lines on various counters, organized into linear configurations, allowing for orderly and secure serving of food products. Counters are grouped into multiple hot food serving lines that will serve the typical school lunch. These lines shall include the necessary equipment needed to provide cold side offerings such as fruit, salads, and beverages.

Other serving lines sometimes consist of an alternate hot food line with the ability to serve hot sandwiches, burgers, pizza, and any other alternate hot food items.

Each of the lines will funnel into a common area large enough to accommodate the flow of traffic where the transaction is to take place. Mobile counters with tray slides will be provided to accept "Point of Sale" terminals, where students can pay with cash, or type in a code that is linked to a declining balance pre-paid system.

Serving line configurations will include a separation of cold and hot items as well as a separation of grade levels. Due to varying tray slide heights and menu needs, the K-4 students shall be served in a dedicated line. The 5th-8th grade level shall be served on the remaining two lines, allowing for more choices and higher level of service. The middle grades menu is typically more complex and offers greater variety. In each instance, an adequate amount of mechanical cold pans and appropriate hot holding equipment is needed.

4.4 Structural

Please refer to attached structural narrative from Foley, Buhl and Roberts Engineering.

SCHEMATIC OUTLINE SPECIFICATIONS

STRUCTURAL – GENERAL (Refer to Schematic Design Structural Drawings)

The proposed, one-story addition will be constructed on a relatively flat site and divided into two distinct areas. One area will be located between the existing 1963 Auditorium and 1970 Reed Field House, and the other will be situated to the south of the existing 1963, 1970, and 1994 Buildings to remain. Program elements of the new addition to the north include the Gymnasium, the Cafeteria, the Kitchen, Faculty Dining, and Receiving/Storage (all in Part B). Program elements of the new addition to the south include elementary classroom and administrative areas (all in Part C). The new additions will be connected to each other and to the existing construction with new one-story corridors. The total area of new construction is approximately 53,000 square feet.

The 1963, 1970, and 1994 Buildings (Brooks School), which comprise a total of 86,000 square feet in area, will be renovated and remain in service. A small storage area to the north of the Reed Field House, constructed in 2007, and approximately 900 square feet in area, will also remain in service. Program elements in the renovated wings will include middle school classrooms, the Media Center, the Auditorium, music rooms, gymnasiums, and locker rooms.

The original 1948 elementary school building and the 1951, 1954 and 1994 Kindergarten classroom additions (Smith School) will be demolished and removed from the site.

The new addition will be steel framed, for reasons of economy, performance, flexibility and speed of construction. The roof will be steel framed, with steel roof deck supported by open web steel joists, wide flange steel beams and columns (no concrete slab). Long span steel joists will be used at the Gymnasium to economically achieve the long span, column free spaces, while closely matching the existing framing in the Reed Field House. Typical columns will be rectangular hollow steel tube sections. Lateral stability for wind and seismic loads will be provided by steel bracing in each direction. Roof steel framing will be surface prepped and be shop primed.

Foundations are expected to be conventional shallow spread footing construction (per the *Preliminary Geotechnical Recommendations of* August 3, 2011 prepared by Nobis Engineering, Inc.), with concrete slabs on grade at the First Floor. It is assumed that existing utilities within the footprint of the addition will be removed and relocated to accommodate the new construction. It is not expected that rock will be encountered in the general building excavation.

Exterior wall construction will be a mixture of glazing and steel stud cavity wall construction with a brick/stone veneer. Continuous, steel channels will be provided at the heads of continuous glass transoms, and a steel girt/sill/wind column system will be provided to frame out large window openings.

STRUCTURAL - BASIS OF DESIGN

Codes and Design Standards:

Building Code:	Massachusetts State Building Code (780 CMR) - Eighth Edition.
Structural Steel:	AISC “Specification for Structural Steel Buildings” and AISC “Code of Standard Practice”; latest editions.
Concrete:	ACI 318 and ACI 301; latest editions.

Design Loads/Parameters:

Live Loads

Classrooms (with partition allowance):	80 PSF
Corridors and Open Plan Areas:	100 PSF
Stairs:	100 PSF
Mechanical Areas:	150 PSF

Snow Loads

Basic Ground Snow Load (Lincoln):	55 PSF

Wind Loads

Wind Speed (Lincoln):	100 MPH

Seismic Parameters

Short Period Spectral Response Acceleration(S_s):	0.280
1.0 Sec. Spectral Response Acceleration (S_1):	0.069
Seismic Use Group:	II
Seismic Design Category:	B
Site Class:	D (Preliminary)
Structural System:	Building Frame System
Lateral Load Resisting System:	Concentrically Braced Frames (*Not Specifically Detailed for Seismic Resistance)*
Response Modification Factor (R):	3.0
System Overstrength Factor (Ω_0):	3.0
Deflection Amplification Factor (Cd):	3.0

Foundations:

The preliminary foundation design is based on an allowable bearing capacity of 4.0 kips per square foot (2.0 TSF) on natural soils or on compacted structural fill, per the *Preliminary Geotechnical Recommendations of* August 3, 2011 prepared by Nobis Engineering, Inc.

Construction Classification:

The new addition is expected to be classified as Type 2B Construction (Noncombustible, Unprotected). All new steel framed construction is considered to be *restrained.*

Sustainable Design Considerations:

Sustainable design considerations will be incorporated into the building design; it is intended that the project will comply with the provisions of the 2009 Collaborative for High Performance Schools, *Massachusetts High Performance Green School Guidelines.* No green roof areas are proposed.

GROUP A – SUBSTRUCTURE (Refer to Schematic Design Structural Drawings)

A10 Foundations:

Preliminary borings indicate that subsurface soils vary throughout the site. The eastern portion of the site is underlain by soft to stiff silt/clay/sand deposits with organics, approximately 5 to 7.5 feet thick, and excavation of this material is required, followed by backfill of suitable compacted structural fill. The western portion of the site does not include such organics, and it is recommend that the building be supported by shallow spread footings bearing on the native inorganic sand, sand and gravel, or on Gravel Fill placed above these materials. The northern portion of the site, between the existing auditorium and gymnasium, is underlain by medium dense sand and gravel fill, approximately 9 feet thick. There is also an underground storage tank at this area.

It is assumed that the underground utilities and storage tank will be removed prior to construction. It is recommended that any fill at the northern portion of the site that is not removed during excavation of existing utilities be densified by intensive Surface Compaction. Also, the existing Boiler Room addition (and foundations) at the1963 Auditorium will be demolished, and this area will be backfilled with compacted structural fill.

All foundation walls and footings will be cast-in-place, reinforced concrete. The preliminary foundation design is based on an allowable bearing capacity of 4.0 kips per square foot (2.0 TSF) on natural soils or on compacted structural fill, per the *Preliminary Geotechnical Recommendations of* August 3, 2011 prepared by Nobis Engineering, Inc.

Groundwater was encountered at 5 to 9 feet below the ground surface. Foundation and/or underslab drainage systems will not generally be required, as there are no basement areas. However, dewatering during construction may be needed, as recommended in the *Preliminary Geotechnical Recommendations.*

Refer to the *Preliminary Geotechnical Recommendations* for additional information regarding site conditions, site preparation, foundation construction and drainage issues.

A1010 Standard Foundations:

- Typical perimeter frost wall: *14” thick, with an 8” wide masonry shelf with horizontal and vertical reinforcing each face (4.0+/- psf). The outside surface of perimeter foundation walls should receive a trowelled-on bituminous mastic.*

- Typical perimeter frost wall continuous footing: *2’-0” wide, by 12” deep, with continuous reinforcing bars, plus dowels to the foundation wall (10.0+/- plf). The bottom of the footing will be placed 4’- 0” minimum below the exterior finish grade for frost protection.*

- Typical, average interior column footings: *5’-0” x 5’-0” x 1’-6” deep, with 165 pounds of reinforcing. The bottom of the footing will be approximately 2’-6” below the First Floor slab on grade.*

- Typical, average perimeter column footings: *4’-0” x 4’-0” x 1’-6” deep, with 100 pounds of reinforcing. The bottom of the footing will be approximately 4’-6” below the exterior finish grade.*

- Piers/pilasters at interior/perimeter columns: *22 inches square, reinforced concrete with 35 plf reinforcing.*

- Anchor Rods: Anchor rods at column base plates shall conform to ASTM F1554 – Grade 36 and shall be headed type. Provide a minimum of four (4), ¾" diameter anchor bolts at all columns; additional rods and/or larger diameter will be required at bracing locations.

A1020 Special Foundations:

- Additional special foundation work will be required at the 1994 Link Building (e.g. underpinning of existing slabs/foundations along the western edge to frost depth, etc.), as described later in this Specification.

A1030 Slabs on Grade:

First Floor Construction will typically be a 5" thick concrete slab on grade, reinforced with welded wire fabric. The slab will be underlain by a vapor barrier, rigid insulation and 6" of compacted gravel fill. Buried duct work will be placed below the new slab on grade; refer to the Schematic Design Mechanical Drawings for additional information. Saw cut control joints (1.25" deep) will be provided in each direction on each column line. Full depth isolation joints will be constructed around columns

- Welded wire fabric for slabs on grade: *6x6-W2.9xW2.9.*

- Slab on Grade Thermal Insulation: *R=5 extruded polystyrene foamed plastic board.*

- Slab On Grade Vapor Retarder: *ASTM E1745 Standard for Specification for Water Vapor Retarders Used In Contact With Soil or Granular Fill Under Concrete Slabs; Class A.*

GROUP B – SHELL (Refer to Schematic Design Structural Drawings)

B10 Superstructure:

Structural Bays/Spans: At the Classroom Wing (Part C), a 6'-0" x 4'-0" module has been established. The typical structural bay size is 30'-0" x 28'-0", with intermediate columns at the 12 foot and 18 foot (east-west) locations, as required for lateral bracing. Classrooms are generally 28'-0" x 30'-0". Interior columns will be located on both sides of the east-west corridor and along the breakout/resource rooms (at braced frames). In Part B, the Gymnasium roof has a clear span of approximately 75 feet, and bay sizes vary in the Cafeteria, Storage, and Faculty Dining areas. Refer to the Schematic Design Structural Drawings for additional information.

Story Heights: The preliminary story height for roof level of the Classroom Wing (Part C) has been established at 10'-6", with a clerestory roof height of 17'-2" along the corridor. At Part B, roof elevations vary at the Gymnasium, the Cafeteria/Kitchen/Storage/Faculty. Refer to the Schematic Design Architectural Drawings for additional information.

Steel Framing Connections: Type 2 simple framing connections (shear only); double clip angles typically.

Columns: Typical columns will be rectangular steel tube (HSS) sections.

Lateral Force Resisting System: Lateral (wind and seismic) forces will be resisted by steel bracing, for reasons of economy, stiffness, reduced structural depth and smaller column sizes. Bracing members will be square or rectangular HSS sections. Brace configurations may include chevrons, inverted chevrons ("V"), or single diagonals in short bays, as required by architectural considerations. At the new corridors, lateral load resistance will be resisted by steel moment frames.

Expansion (Seismic) Joints: North-south expansion joints will be provided within Part C and between the areas of new and existing construction.

Fire Protection: Fire walls will be provided between all new and existing construction so that the existing buildings can retain their current Construction Type classifications. All new construction will be fully sprinklered and classified as Type 2B Construction (Noncombustible, Unprotected). All new steel framed construction is considered to be *restrained.* Refer to the Schematic Design Architectural Drawings for additional information.

<u>B1020 Roof Construction</u>:

At the Classroom Wing (Part C), steel roof deck will be the cellular acoustic type (3” deep, 20/20 gauge). Above classrooms, the deck will span to exposed, open web steel roof joists at 5’-0” o.c., and above administrative areas, the deck will span to steel beams at 5’-0” +/- o.c. The clerestory roof framing (over the corridor) will be of the same construction as the roof framing over the classrooms. At both areas, steel beams are typically supported by wide flange steel girders and steel tube columns (HSS).

At the Gymnasium (Part B), steel roof deck will be the cellular acoustic type (3” deep, 20/20 gauge) spanning to, deep longspan, open web steel joists (3’-4” deep), with pitched top chords, spaced at 10’-0” +/- o.c. and clear spanning the space (75 feet +/-). At the remainder of Part B, flat roof construction will consist of a 1½” deep, Type WR, 18 gauge galvanized steel roof deck spanning 6 feet (maximum) to open web steel joists and wide flange steel beams. Steel beams are typically supported by wide flange steel girders and steel tube columns (HSS).

Structural steel for the corridor and cafeteria columns will be Architecturally Exposed Structural Steel (A.E.S.S.).

Roof drainage will typically be achieved with tapered insulation. Continuous, bent steel plates will be installed around the entire roof perimeter to support the roof edge and blocking.

Rooftop mechanical units (with manufacturer’s standard curbs) will be supported directly on the roof structure. Steel framed equipment screens will be provided around selected units. Roofing will be a lightweight, adhered membrane system. Refer to the Schematic Design Architectural and Mechanical Drawings for more information.

<u>Estimated weight of steel:</u>

- The estimated total weight of structural steel for the various roof areas of the new building (based on 53,000 +/- gross square feet of total new framed roof area), including beams, columns, bracing, plates, angles, sills, girts, wind posts/headers, miscellaneous frames, connections, etc., but excluding entry canopies is ***310 +/- Tons.***
- The estimated weight of steel joists and accessories is ***50 +/- Tons.***

<u>B20 Exterior Enclosure</u>:

<u>B2010 Exterior Walls</u>:

Exterior walls for new addition will be a mixture of glazing and steel stud/brick veneer cavity wall construction. Continuous steel channels will be provided at the heads of continuous and/or long windows below the roof.

Vertical steel tubes (approximately 2’-4” high), spaced at 6’-0” o.c. and integrated with the steel stud backup wall, will be bolted to the perimeter frost wall at the First Floor to laterally support the stone veneer below the continuous windows.

The steel stud backup will be 16 gauge minimum, designed for an H/600 deflection limitation. Vertical slip joints will be provided in the metal stud backup system at each level. A sunscreen element, integrated with the window system, will be provided at the south-facing exterior walls of the new building.

STRUCTURAL - SCOPE OF WORK AT EXISTING BUILDINGS

The 1963, 1970 and 1994 Buildings, which comprise approximately 86,000 square feet in area, will be renovated and remain in service. Program elements in the renovated buildings will include middle school classrooms, the Media Center, the Auditorium, music rooms, gymnasiums, and locker rooms.

Renovations, alterations, repairs and additions to existing buildings in Massachusetts are governed by the provisions of the Massachusetts State Building Code (MSBC – 8th Edition) and the Massachusetts Existing Building Code (MEBC). These documents are based on amended versions of the 2009 *International Building Code (IBC)* and the 2009 *International Existing Building Code (IEBC)*, respectively.

The MEBC defines three (3) compliance methods for the repair, alteration, change of occupancy, addition or relocation of an existing building. The three methods are *Prescriptive Compliance Method, Work Area Compliance Method,* and *Performance Compliance Method*. The method of compliance is chosen by the Design Team (based on the project scope and cost considerations) and cannot be combined with other methods.

A review of the proposed renovation scope suggests that the *Prescriptive Compliance Method* can be selected by the Design Team. This assumption will continue to be evaluated as the project proceeds through future design phases.

The *Prescriptive Compliance Method* (IEBC Chapter 3) duplicates Sections 3403 through 3411 of Chapter 34 in the IBC and prescribes specific minimum requirements for construction related to additions, alterations, repairs, fire escapes, glass replacement, change of occupancy, historic buildings, moved buildings and accessibility. A complete structural evaluation of the building is not required, if the impact of the proposed alterations and additions to structural elements carrying gravity loads and lateral loads is minimal (less than 5% and 10% respectively). Seismic upgrades to the existing building are generally not required. An exception is buildings with unreinforced masonry (URM) bearing walls (as in this project). Buildings with unreinforced masonry bearing walls are required to be evaluated with respect to the provisions of Appendix A1 of the IEBC (applies to all compliance methods).

Under this compliance method, a comprehensive structural review of the primary structural systems (gravity and lateral loads) is not required, except as necessary to ascertain the effect of the proposed work on the existing building structure. Full compliance with the seismic provisions of the code for new construction will not be necessary. However, as the renovations to the building will exceed 50% of the area, the existing unreinforced masonry (URM) walls in the building will need to be evaluated for compliance with the provisions of Appendix A1 of the 2009 IEBC (Section 101.10 of the Massachusetts Amendments to the 2009 IEBC). Essentially, this means the following:

- A lateral load analysis of the building will be required to demonstrate that capacity exists to withstand 50% of the seismic forces required by the code for new construction.

- Interior, non-structural masonry partitions, scheduled to remain will need to be braced at the top.

- Floor and roof diaphragm capacity and anchorage to the masonry walls will need to be evaluated.

The new addition will be structurally separated from the existing buildings by expansion (seismic) joints to avoid an increase in gravity load or lateral loads to existing structural elements (Sections 302.3 and 302.4 of the 2009 IEBC, respectively). Where proposed alterations to existing structural elements carrying gravity loads result in an increase of over 5%, the affected element will be reinforced or replaced to comply with the code for new construction (Section 303.3). Proposed alterations to existing structural elements carrying lateral load which result in an increase in the demand - capacity ratio of over 10% will generally be avoided (Section 303.4).

The anticipated scope of structural alterations to the existing buildings is noted below:

- At the 1970 Reed Field House, new supports for HVAC equipment will be required, as well as minor modifications to existing structural elements to accommodate MEP/FP distribution systems. *The preliminary cost estimate should include a line item to cover this work.* See Schematic Design Mechanical and Architectural Drawings for additional information.

- A portion of the western edge of the 1994 Building adjoins the original (1948) building. As this area is presently an interior condition, the edge of the slab on grade terminates with a downturned, concrete haunch or a grade beam (bottom at 2'-0" +/- below the top of slab). Upon demolition of the adjacent, 1948 construction, this section will become exterior and will be exposed to cold temperatures (frost concerns). Accordingly, underpinning of the existing slab/foundations to frost depth or the construction of a new foundation wall with 4'-0" minimum soil cover to the bottom of the footing will be required (approximately 80 linear feet total). New exterior wall construction in these areas (brick veneer with a steel stud backup) will be supported on the modified existing foundations and/or the new foundation walls. Since the 1994 Building is not perpendicular to the 1948 Building, a new, triangular shaped area of slab will be required to create a straight edge on the remaining 1994 Building. *The preliminary cost estimate should include a line item for this work.*

- The roof decks of the 1963 and 1970 buildings (except for the high field house roof) are constructed of 2" tongue and groove roof decking. This type of decking does meet the diaphragm requirements of Appendix A1 of the 2009 IEBC, and it will need to reinforced with a new, plywood diaphragm. *The preliminary cost estimate should include a line item for a layer of ¾" plywood, screwed and glued to existing decking at these locations*.

- The new addition between the auditorium and the Reed Field House will create a snow drift condition at the eastern edge of the adjacent low roof (of 106 psf, in addition to the flat snow load of 42 psf). In addition, the presence of the high (auditorium roof) creates a snow drift condition (of 80 psf max, in addition to the flat snow load 42 psf) on the other three sides of the low roof (the original design snow load was 40 psf total). As a result of this loading, the existing low roof framing on the east and west sides does not have sufficient capacity for this loading and will need to be reinforced or rebuilt to sustain the higher loading. *The preliminary cost estimate should include a line item for 5,000 square feet of existing wood joist and steel beam roof reinforcement or reconstruction.* Also, at the north and south sides of the Auditorium, the existing wood decking at the low roof, adjacent to the Auditorium walls, needs to be reinforced with a layer of steel roof decking. *The preliminary cost estimate should include a line item for 1,500 square feet of new 3" deep, 20 gage steel roof decking screwed through the plywood to the existing decking.*

- All unreinforced masonry perimeter bearing walls and all unreinforced masonry interior non-bearing walls will be connected to the existing roof deck. *The preliminary cost estimate should include a line item for an L8x6x½ x 12" long, at 4'-0" o.c. max, with 2-5/8" diameter x 5" embedment screen tube anchors into the existing masonry walls and 2-½" dia. x 2" long lag screws into the existing decking.*

- With reference to the May 13, 2011 *Existing Conditions Structural Report*, prepared by FBRA, the existing precast concrete veneer panels at the top portion the Reed Field House are damaged and will be replaced with new, metal panels and steel stud backup walls. Also, the existing steel channel girts at the top of the masonry will be reinforced for the current Code wind loading. *The preliminary cost estimate should include a line item for this work.* See Schematic Design Architectural Drawings for additional information.

- At the Auditorium, there is equipment above the stage which may be improperly hung and in need of resupport. Refer to the *Existing Conditions Structural Report* for additional information. *The preliminary cost estimate should include a line item to cover Metal Fabrications for resupport of this equipment.*

- At the existing tunnels below the slab on grade, new penetrations will be made in the tunnel walls to connect new duct work. At these locations, the existing slab on grade will be demolished, and the side wall of the existing concrete tunnel will be cut. After mechanical work is complete, the side wall of tunnel will be patched, the tunnel will be backfilled, and the adjacent slab on grade will be patched. *The preliminary cost estimate should include a line item for this work.* Refer to the Schematic Design Mechanical Drawings for additional information.

STRUCTURAL - OUTLINE SPECIFICATIONS

Cast in Place Concrete:

- All concrete shall be normal weight, 4,000 psi at 28 days, except foundation walls and footings, which shall be normal weight, 3,000 psi and exterior (exposed) concrete (paving) which shall be normal weight, 4,500 psi.

- Portland Cement: ASTM C150, Type I or II.

- Fly Ash: ASTM C618, Class F. Replacement of cement content with fly ash is limited to 20% (by weight). Fly ash is not permitted in exterior, exposed concrete, or in any slabs.

- Ground Granulated Blast-Furnace Slag – ASTM C 989 – Grade 100 or 120. Slag is not permitted in exterior, exposed concrete or during winter concreting conditions.

- All concrete shall be proportioned with 3/4” maximum aggregate, ASTM C 33, except 3/8” maximum aggregate shall be used at toppings less than 2” thick (e.g. metal pan stairs).

- All reinforcing shall be ASTM A 615 deformed bars, Grade 60.

- All welded wire fabric shall conform to ASTM A 185.

- Reinforcing bars, steel wire, welded wire fabric, and miscellaneous steel accessories shall contain a minimum of 25% (combined) post-industrial/post-consumer recycled content (the percentage of recycled content is based on the weight of the component materials). Certification of recycled content shall be in accordance with Submittal Requirements.

- Concrete products manufactured within 500 miles (by air) of the project site shall be documented in accordance with Submittal Requirements.

- Cure all concrete by moisture retention methods, approved by Architect; curing compounds shall not be used.

Structural Steel Framing:

- Structural steel shapes shall conform to ASTM A 992, Fy = 50 ksi.
- Rectangular steel tubes (HSS) shall conform to ASTM A 500, Grade B, Fy = 46 ksi.
- Round steel tubes (Pipe) shall conform to ASTM A 53, Grade B Fy = 35 ksi.
- Structural steel plates and bars shall conform to ASTM A 36, Fy = 36 ksi.
- Steel members shall contain a minimum of 25% (combined) post-industrial/post-consumer recycled content (the percentage of recycled content is based on the weight of the component materials). Certification of recycled content shall be in accordance with the Submittal Requirements.
- Steel manufactured within 500 miles (by air) of the project site shall be documented in accordance with the Submittal Requirements.
- Anchor Rods: Anchor rods at column base plates shall conform to ASTM F1554 – Grade 36 and shall be headed type. Provide a minimum of four (4), ¾" diameter anchor bolts at all columns; additional bolts and/or larger diameter will be required at bracing locations.
- Bolted connections shall be ASTM A 325, Type N (bearing) bolts, except slip-critical bolts shall be used at lateral brace beam connections.
- Shop and field welding shall be AWS D1.1 E70XX electrodes.
- Surface treatment for typical structural steel: SSPC Surface Preparation No. 3 (Power Tool Cleaning). Structural steel shall receive one (1) shop coat of rust inhibitive primer, except those areas to be fireproofed and surfaces to receive field welded shear connectors.
- Structural steel for corridor and (round HSS) cafeteria columns shall be Architecturally Exposed Structural Steel (A.E.S.S.) and shall meet the requirements of Section 10 of the AISC manual.
- Surface treatment for Architecturally Exposed Structural Steel: SSPC Surface Preparation No. 6 (Commercial Blast Cleaning). Exposed structural steel shall be primed with a premium architectural primer.
- All exterior, exposed structural steel shall be hot-dip galvanized.

Steel Joist Framing:

- All steel joists, joist accessories and workmanship shall be in accordance with Steel Joist Institute (SJI) standards.
- Steel joists shall be shop primed with a primer that is compatible with the finish paint.

Steel Decking:

- Typical steel roof deck shall be 1½" deep, 18 gauge, Type WR, conforming to ASTM A 653, Grade 33 (minimum), galvanized in accordance with ASTM A 653, coating class G-60. Exposed steel roof deck above the Gymnasium and classrooms shall be 3" deep, 20/20 gauge cellular acoustic deck and shall have a factory applied primer on the exposed bottom surface.

- All roof deck accessories (finish strips, closures, etc.) shall be the same finish as the deck; 18 gauge minimum.

- Steel deck shall contain a minimum of 25% (combined) post-industrial/post-consumer recycled content (the percentage of recycled content is based on the weight of the component materials). Certification of recycled content shall be in accordance with the Submittal Requirements.

- Steel deck manufactured within 500 miles (by air) of the project site shall be documented in accordance with the Submittal Requirements.

- Provide 14 gauge sump pans at roof drains.

4.5 Plumbing

Please refer to attached plumbing narrative from Garcia, Galuska, and DeSousa Consulting Engineers.

GARCIA • GALUSKA • DESOUSA
Consulting Engineers Inc.

Lincoln K-8 School
Lincoln, MA
J#320 005 00.00
L#35506/Page 1/June 7, 2012

PLUMBING SYSTEMS

NARRATIVE REPORT

The following is the Plumbing system narrative, which defines the scope of work and capacities of the Plumbing system as well as the Basis of Design. The Plumbing systems shall be designed and constructed for ***MA-CHPS*** where indicated on this narrative.

1. CODES

   A. All work installed under Section 220000 shall comply with the MA Building Code, MA Plumbing Code and all state, county, and federal codes, laws, statutes, and authorities having jurisdiction.

2. DESIGN INTENT

   A. All work is new, unless noted otherwise, and consists of furnishing all materials, equipment, labor, transportation, facilities, and all operations and adjustments required for the complete and operating installation of the Plumbing work and all items incidental thereto, including commissioning and testing.

3. GENERAL

   A. The Plumbing Systems that will serve the project are cold water, sanitary waste and vent system, grease waste system, special waste system, storm drain system, and natural gas.

   B. The Building will be serviced by Municipal water and on-site sewage disposal system.

   C. All Plumbing in the building will conform to Accessibility Codes and to Water Conserving sections of the Plumbing Code.

4. DRAINAGE SYSTEM

   A. Soil, Waste, and Vent piping system is provided to connect to all fixtures and equipment. System runs from 10 feet outside building and terminates with stack vents through the roof.

   B. A separate Grease Waste System starting with connection to an exterior concrete grease interceptor running thru the kitchen and servery area fixtures and terminating with a vent terminal through the roof. The grease interceptor is provided under the Site Utilities scope.

   C. Storm Drainage system is provided to drain all flat roofs with roof drains piped through the building to a point 10 feet outside the building.

   D. Drainage system piping will be service weight cast iron piping; hub and spigot with gaskets for below grade; no hub with gaskets, bands and damps for above grade 2” and larger. Waste and vent piping 1-1/2” and smaller will be type ‘L’ copper.

E. In existing buildings, existing drainage piping may be reused if adequately sized for intended use. Integrity of existing piping will be confirmed via video inspection.

F. A separate Special Waste System shall be provided starting with a connection to an exterior double wall fiberglass holding tank with interstitial monitoring system, running thru the science classroom fixtures and terminating with a vent terminal through the roof. Special Waste and Vent piping will be Schedule 40 electric heat fused polypropylene piping, fittings & traps, flame retardant above grade and non-flame retardant below ground.

5. WATER SYSTEM

A. New 4" domestic water service from the yard water system will be provided for the building. A meter will be provided meeting local water department standards.

B. Cold water distribution main is provided. Non-freeze wall hydrants with integral back flow preventers are provided along the exterior of the building.

C. Domestic hot water heating will be provided by gas fired, high efficiency, condensing water heater equipped with thermostatically controlled mixing devices to control water temperature to the fixtures.

D. A pump will re-circulate hot water from the piping system loop. Water temperature will be 140° to serve the kitchen and 120° to serve general use fixtures.

E. Water piping will be type 'L' copper with wrot copper sweat fittings, silver solder. All piping will be insulated with 1" thick high density fiberglass.

6. GAS SYSTEM

A. Natural gas service will be provided for the building and will serve the boilers, domestic water heaters, kitchen cooking equipment, and roof top equipment.

B. Gas piping will be Schedule 40 black steel pipe with threaded gas pattern malleable fittings for 2" and under and butt welded fittings for 2-1/2" and larger.

7. FIXTURES ***CHPS Credit WC1.1/P&OC5***

A. Furnish and install all fixtures, including supports, connections, fittings, and any incidentals to make a complete installation.

B. Fixtures shall be the manufacturer's guaranteed label trademark indicating first quality. All acid resisting enameled ware shall bear the manufacturer's symbol signifying acid resisting material.

C. Vitreous china and acid resisting enameled fixtures, including stops, supplies and traps shall be of one manufacturer by Kohler, American Standard, or Eljer. Supports shall be Zurn, Smith or Josam. All fixtures shall be white. Faucets shall be Speakman or Chicago.

D. Fixtures shall be as scheduled on drawings.

1. Water Closet: Sloan high efficiency toilet, 1.28 gallon per flush, wall hung, vitreous china, siphon jet. Sloan sensor operated 1.28 gallon per flush-flush valve.

2. Urinal: Sloan Model #WES-1000, waterless urinal, wall hung, wall outlet, vitreous china.

3. Lavatory: Sloan wall hung/countertop ADA lavatory. Sloan infra-red, sensor mixing faucet, 0.5 GPM aerator. Faucet shall be programmed for a 10 second cycle.

4. Sink: Just SL-ADA-1921-A-GR single bowl, 19" x 21" x 5-1/2” deep self rimming countertop mounted, 18 GA type 304 stainless steel sink with offset rear outlet; three (3) hole punched faucet ledge & quick clip mounting system, sound deadening underside. Chicago #201A-GN8A-E2805-5CP-317 concealed deck faucet with 8" swing gooseneck spout, 4" wrist blade handles, E-2805 0.5 GPM aerator.

5. Drinking Fountain: Halsey Taylor hi-low wall mounted electric water cooler, stainless steel basin.

6. Janitor Sink: Stern-Williams Model MTB-2424, 24” x 24” x 10”, mop service basin with stainless steel rim guard on exposed sides, 3" caulk connection, stainless steel strainer. Include caulking and sealant to seal between unit and finished wall and floor. Chicago 897-CP service sink fitting.

8. DRAINS

A. Drains are cast iron, caulked outlets, nickaloy strainers, and in waterproofed areas and roofs shall have galvanized iron clamping rings with 6 lb. lead flashings to bond 9” in all directions. Drains shall be Smith, Zurn or Josam.

9. VALVES

A. Locate all valves so as to isolate all parts of the system. Shutoff valves 3” and smaller shall be ball valves, solder end or screwed, Apollo, or equal.

10. INSULATION

A. All water piping shall be insulated with snap-on fiberglass insulation Type ASJ-SSL, equal to Johns Manville Micro-Lok HP.

11. CLEANOUTS

A. Cleanouts shall be full size up to 4” threaded bronze plugs located as indicated on the drawings and/or where required in soil and waste pipes.

B. Cleanouts for Special Waste System shall be Zurn #Z9A-C04 polypropylene cleanout plug with Zurn #ZANB-1463-VP nickel bronze scoriated floor access cover.

12. ACCESS DOORS

A. Furnish access doors for access to all concealed parts of the plumbing system that require accessibility. Co-ordinate types and locations with the Architect.

13. WATER HEATER

A. Natural-gas fired, high efficiency, condensing, sealed combustion unit water heater with thermostatically controlled mixing device to control water temperature to fixtures.

4.6 HVAC

Please refer to attached HVAC narrative from Garcia, Galuska, and DeSousa Consulting Engineers.

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Lincoln K-8 School
Lincoln, MA
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HVAC SYSTEMS

NARRATIVE REPORT

The following is the HVAC system narrative, which defines the scope of work and capacities of the HVAC system as well as the Basis of Design. The HVAC systems shall be designed and constructed for ***MA-CHPS*** or ***LEED for Schools***.

1. CODES

All work installed under Division 230000 shall comply with the Town of Lincoln Building Code and all state, county, and federal codes, laws, statutes, and authorities having jurisdiction.

2. DESIGN INTENT

The work of Division 230000 is described within the narrative report. The HVAC project scope of work shall consist of providing new HVAC equipment and systems as described here within. All new work shall consist of furnishing all materials, equipment, labor, transportation, facilities, and all operations and adjustments required for the complete and operating installation of the Heating, Ventilating and Air Conditioning work and all items incidental thereto, including commissioning and testing.

In addition, the existing building boiler plant, hot water zone circulators, air handling equipment, terminal heating equipment, and automatic temperature controls shall be demolished. Portions of the existing hot water piping and air distribution ductwork system shall remain and be re-used as indicated on the drawings.

3. BASIS OF DESIGN: (MASS CODE)

Massachusetts Code values are listed herein based on Middlesex County values as determined from table 1305.1 Chapter 13.

Outside: Winter 7°F, Summer 87°F DB 74°F WB

Inside: 70°F +/- 2°F for heating and 75°F +/- 2°F (50% RH) for cooling (air conditioned spaces). Unoccupied temperature setback will be provided.

Generally outside air is provided at the rate of 15 cfm/person in all classrooms and large group spaces, and 15 cfm/person for the combination auditorium, gymnasium and cafeteria. In all cases ASHRAE guide 62.1-2007 and the International Mechanical Code will be met as a minimum. All occupied areas will be designed to maintain 1,000 PPM carbon dioxide maximum.

4. SYSTEM DESCRIPTION

A. Central Heating Plants: ***MA-CHPS Credit EC1 & 5***

Heating for the entire building will be through the use of a high efficiency gas-fired condensing boiler plant. A new boiler plant with (4) 3000 MBH output boilers and (2) end suction base mounted pumps with a capacity of 800 gpm each. Each boiler plant will supply heating hot water to all heating apparatus located throughout the adjacent building areas through a two-pipe fiberglass insulated schedule 40 black steel piping system. New hot water piping shall be installed to serve new HVAC systems.

The boiler plants shall supply a maximum hot water temperature of 160 deg F on a design heating day and the hot water supply water temperature will be adjusted downward based on an outside temperature reset schedule to improve the overall operating efficiency of the power plants. Primary and standby end suction base mounted pumps will be provided with variable frequency drives for variable volume flow through the water distribution system for improved energy efficiency.

Combustion air for each boiler will be directly ducted to each boiler through a galvanized ductwork distribution system. Venting from each boiler shall be through separate double wall aluminized stainless steel (AL29-4C) vent system and shall discharge between 6 feet to 12 feet above the roof level depending on the located of building intake air locations.

Note: As an alternate, all hot water coil air handling units will be gas-fired with the listed capacities and the boiler plant will consist of (3) 2500 MBH output boilers and (2) end suction base mounted pumps with a capacity of 500 gpm each.

B. Central Cooling Plant: ***MA-CHPS Credit EC1 & 5***

A high efficiency central chilled water cooling plant consisting of an 80 ton outdoor air cooled chilled, primary and standby chilled water pumps with VFDs, accessories, controls and steel and copper piping distribution system shall be provided to serve chilled water cooling HVAC equipment located throughout the building.

C. Classroom Heating and Ventilation:
MA-CHPS Credit EC1, 2 & 5, IEQP1, 2, 6 & 9, IEQC 4.7 & 8

It is proposed that a new displacement ventilation system shall be provided to serve the New and Renovated Classroom areas.

In the Brooks and Link Building new rooftop air handling units with supply and return fan with VFDs, energy recovery wheels, hot water heating coils with modulating hot water valve, DX cooling system and MERV 13 filtration will be provided to serve a new displacement ventilation system. Supply air will be provided to the space through new galvanized steel supply duct distribution system and shall be connected to wall mounted displacement ventilation diffusers located within the classrooms. Return air will be drawn back to the units by ceiling return air registers located within the classroom and will be routed back to the rooftop unit by a galvanized sheet metal return air ductwork distribution system. Supplemental hot water fin tube radiation heating will be provided along exterior walls.

It is estimated that the following Rooftop air handling equipment will be required to serve the Classroom areas:

(1) One air handling unit with a capacity of 10000 CFM (40 Tons Cooling, 600 MBH Heating) to serve the lower and upper central renovated classrooms.

(1) One air handling unit with a capacity of 4000 CFM (15 Tons Cooling, 200 MBH Heating) to serve the renovated classrooms adjacent to the Media Center.

(2) Two air handling units with a capacity of 6000 CFM (25 Tons Cooling, 360 MBH Heating) to serve the single story classroom addition.

(1) One air handling unit with a capacity of 2500 CFM (10 Tons Cooling, 200 MBH Heating) to serve the band/music classrooms.

Displacement Ventilation:

The displacement ventilation system for the classroom wings are intended to provide a maximum cooling temperature during peak cooling periods of approximately 78°F, however, the ventilation air provided will be extremely dry which will be the result of utilizing refrigeration equipment and hot gas reheat to reduce vapor pressure to an extremely low condition of approximately 40 grains of moisture per pound of air and reheating the air to a supply temperature of approximately 68°F which will be distributed to each space. The extremely dry condition of the supply air provides the perception of a condition which is cooler than is actually occurring due to the evaporation of moisture to the adjacent air from the occupants of the space.

Considering maximum cooling requirements occur primarily during the months of July and August when the majority of the academic areas are not in use, it would suggest maintaining slightly higher temperatures may not present a discomfit, however, will relate to a substantial operating cost savings and a reduced installation cost.

An additional major benefit of utilizing dry air within the building will be the overall reduction of vapor pressure typically present in outside ventilation air during summer months. This reduction in vapor pressure will dramatically reduce the amount of moisture entering the building and the potential of condensation resulting in moisture, and a direct relationship with the formation of mold.

New exhaust air ductwork and exhaust air fans systems shall be provided under this Option to serve adjacent restrooms and utility closets.

D. Field House - Gymnasium:
MA-CHPS Credit EC1, 2 & 5, IEQP1, 2, 6 & 9, IEQC 4, 7 & 8

The gymnasium will be provided with two (2) new indoor air handling units of the recirculation design. The units will be approximately 8,500 CFM and will include supply and return fans with VFDs, 400 MBH duct mounted hot water coil with modulating hot water valve, MERV 13 filtration, and carbon dioxide controls which will reduce outside air as allowed maintaining a maximum of 1000 PPM. Supply air ventilation will be provided to the space through the existing galvanized steel supply duct which will connect to a fabric duct distribution system. As levels of carbon dioxide drop generally relating to a reduction in population a variable frequency drive located in each rooftop unit will modulate to reduce air flow and ventilation while always maintaining a maximum of 1000 ppm. Return air will be drawn back to each air handling unit by an existing low wall return air register. As a potential alternate, air conditioning will be provided for the space with the addition of a DX cooling section to the unit.

E. Gymnasium (Addition)
MA-CHPS Credit EC1, 2 & 5, IEQP1, 2, 6 & 9, IEQC 4, 7 & 8

The gymnasium will be provided with a new indoor air handling unit of the recirculation design. The unit will be approximately 8,500 CFM and will include supply and return fans with VFDs, 400 MBH duct mounted hot water coil with modulating hot water valve, MERV 13 filtration, and carbon dioxide controls which will reduce outside air as allowed maintaining a maximum of 1000 PPM. Supply air ventilation will be provided to the space through a galvanized steel supply duct which will connect to a fabric duct distribution system. As levels of carbon dioxide drop generally relating to a reduction in population a variable frequency drive located in each rooftop unit will modulate to reduce air flow and ventilation while always maintaining a maximum of 1000 ppm. Return air will be drawn back to the air handling unit by an a low wall return air register. As a potential alternate, air conditioning will be provided for the space with the addition of a DX cooling section to the unit.

F. Field House - Locker Rooms:
MA-CHPS Credit EC1, 2 & 5, IEQP1, 2, 6 & 9, IEQC 4, 7 & 8

The Boys and Girls locker rooms will be provided with a new roof-mounted air handling unit of the 100% outside air design with energy recovery. The unit will be approximately 3000 CFM and will include a supply and exhaust fan with VFDs, 400 MBH hot water coil with modulating hot water valve, and MERV 13 filtration. Supply air ventilation will be provided to each space through new galvanized supply duct which will travel throughout each locker room area to a series of ceiling mounted supply registers. New exhaust air ductwork and air distribution devices shall be installed and shall be routed from the locker rooms to the new air handling unit.

G. Auditorium and Stage:
MA-CHPS Credit EC1, 2 & 5, IEQP1, 2, 6 & 9, IEQC 4, 7 & 8

The auditorium will be provided with a new roof-mounted air handling unit of the recirculation design. The units will be approximately 12,000 CFM and will include supply and return fans with VFDs, hot water coil with modulating hot water valve, DX cooling system and MERV 13 filtration. Supply air ventilation to the auditorium will be provided to the space through the existing galvanized steel supply duct which will connect to a fabric duct distribution system. In addition, carbon dioxide controls will be installed which will monitor the overall level of carbon dioxide at a threshold level of 1000 ppm. As levels drop generally relating to a reduction in population the air handling unit outside air damper will modulate to reduce air flow and ventilation while always maintaining a maximum of 1000 ppm. Return air will be drawn back to the units by low wall return air registers. New supply and return air ductwork modifications shall be provided to connect the new units to the existing ductwork distribution system.

The stage will be provided with a new roof-mounted air handling unit of the recirculation design. The units will be approximately 4,000 CFM and will include supply and return fans with VFDs, hot water coil with modulating hot water valve, DX cooling system and MERV 13 filtration. Supply air ventilation to the stage will be provided to the space through the existing galvanized steel supply duct distribution system. In addition, carbon dioxide controls will be installed which will monitor the overall level of carbon dioxide at a threshold level of 1000 ppm. As levels drop generally relating to a reduction in population the air handling unit outside air damper will modulate to reduce air flow and ventilation while always maintaining a maximum of 1000 ppm.

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Return air will be drawn back to the units by low wall return air registers. New supply and return air ductwork modifications shall be provided to connect the new units to the existing ductwork distribution system.

H. Lecture Hall:
MA-CHPS Credit EC1, 2 & 5, IEQP1, 2, 6 & 9, IEQC 4, 7 & 8

The lecture hall will be provided with a new roof-mounted air handling unit of the recirculation design. The units will be approximately 3,200 CFM and will include supply and return fans with VFDs, hot water coil with modulating hot water valve, DX cooling system and MERV 13 filtration. Supply air ventilation to the stage will be provided to the space through the existing galvanized steel supply duct distribution system. In addition, carbon dioxide controls will be installed which will monitor the overall level of carbon dioxide at a threshold level of 1000 ppm. As levels drop generally relating to a reduction in population the air handling unit outside air damper will modulate to reduce air flow and ventilation while always maintaining a maximum of 1000 ppm. Return air will be drawn back to the units by low wall return air registers. New supply and return air ductwork modifications shall be provided to connect the new units to the existing ductwork distribution system.

I. Administration Areas:
MA-CHPS Credit EC1, 2 & 5, IEQP1, 2, 6 & 9, IEQC 4, 7 & 8

Spatial heating and air-conditioning for the Administration area offices within the classroom areas will be served by horizontal ceiling concealed type ducted 4-pipe heating and cooling active chilled beam induction units. Ventilation air to these areas will be provided by the associated classroom rooftop ventilation unit, with hot water and chilled water for the induction unit system provided by the individual hot water and chilled water central recirculation piping system communicating with the boiler and chilled water power plants.

J. Library/Media Center
MA-CHPS Credit EC1, 2 & 4.1, IEQP1, 2, 3, 9, 10, 11, 13 & 14, IEQC2.2, 2.3 & 4.2

The Library/Media Center and adjacent office and classroom spaces will be provided with a roof mounted air handling unit capable of providing 100% outside air and variable air volume operation. The unit will be approximately 4,000 CFM and will include supply and return fan with VFDs, 200 MBH hot water coil with modulating hot water valve, MERV 13 filtration, 15 ton capacity DX cooling section, and exhaust air energy recovery wheel. Supply air ventilation will be provided to each space which will satisfy building code requirements based on population. It is proposed that spatial heating and air-conditioning for zones will be provided by horizontal ceiling concealed type ducted 4-pipe heating and cooling active chilled beam induction units. Ventilation air to these perimeter areas will be provided by the associated rooftop ventilation unit, with hot water and chilled water for the induction unit system provided by the individual hot water and chilled water central recirculation piping system communicating with the boiler and chilled water power plants.

Note: As an alternate, the Library/Media Center and adjacent office and classroom spaces will be served by the existing variable air volume indoor air handling unit located in the penthouse mechanical room. The existing air unit shall be refurbished, including cleaning interior of the unit, providing new supply fan motors and VFD drives, and providing new chilled water cooling coil to replace the existing DX cooling coil.

The majority of the existing supply, return distribution systems and variable air volume terminal boxes will also be reused under this option. New DDC controls will be provided for the air handling unit, VAV terminal boxes and associated hot water reheat coil controls.

The IT data server room will be provided with a new dedicated computer room type air conditioning unit consisting of an indoor air handling unit with split system DX cooling coil and associated roof mounted air cooled condensing unit and controls.

K. Cafeteria
MA-CHPS Credit EC1, 2 & 5, IEQP1, 2, 6 & 9, IEQC 4, 7 & 8

The Cafeteria areas will be provided with a roof mounted air handling unit capable of providing 100% outside air and variable air volume operation. The unit will be approximately 6,000 CFM and will include supply and return fan with VFDs, 300 MBH hot water coil with modulating hot water valve, MERV 13 filtration, 15 ton capacity DX cooling section, and exhaust air energy recovery wheel. Supply air ventilation will be provided to each space which will satisfy building code requirements based on population. It is proposed that spatial heating and air-conditioning for zones will be provided by horizontal ceiling concealed type ducted 4-pipe heating and cooling active chilled beam induction units. Ventilation air to these perimeter areas will be provided by the associated rooftop ventilation unit, with hot water and chilled water for the induction unit system provided by the individual hot water and chilled water central recirculation piping system communicating with the boiler and chilled water power plants.

L. Kitchen:

The kitchen areas shall be provided with new kitchen exhaust air fan and make-up air systems.

A variable volume kitchen exhaust hood control system consisting of kitchen exhaust stack temperature and smoke density sensors, supply and exhaust fan variable speed drives and associated controller will be provided by the kitchen equipment vendor. This system installation shall be field installed and coordinated with the ATC and Electrical contractors.

M. Lobby, Corridor, and Entry Way Heating

Under this Option, lobby, corridor and entry ways shall be heated by a combination of new hot water convectors, cabinet unit heaters and fin tube radiation heating equipment with new DDC temperature controls.

N. Testing, Adjusting, Balancing & Commissioning:

All new HVAC systems shall be tested, adjusted, balanced and commissioned as part of the project scope.

O. Automatic Temperature Controls – Building Energy Management System

A new DDC (direct digital control) automatic temperature control (ATC) and energy management system (EMS) shall be installed to control all new HVAC systems and equipment.

4.7 Life Cycle Cost Analysis

Please refer to attached life cycle cost analysis from Garcia, Galuska, and DeSousa Consulting Engineers.

ENGINEERING ECONOMIC ANALYSIS
FOR
Lincoln Public Schools

Lincoln, MA

June 7, 2012

Prepared for: **Lincoln Public Schools**

Prepared by: Garcia, Galuska & DeSousa
Consulting Engineer, Inc.

Section 1.0: Executive Summary

The goal of the mechanical lifecycle engineering economic analysis is to asses the performance of various mechanical systems in comparison to a baseline mechanical system.

Each option is compared to the baseline system to determine the lowest combined savings over a 30 year cycle to determine the most advantageous system considering electrical costs, gas costs, maintenance costs, and initial construction costs.

By comparison of each option to the baseline system, the option with the greatest total life-cycle savings is generally recommended. To further enhance controllability and overall system performance, additional options should be considered that will enhance year round temperature control and comfort at a possible marginal increase in capital cost.

Each mechanical system option is simulated with the superior design envelope options and the enhanced high-efficiency lighting systems with daylight dimming controls.

Section 1.1: Mechanical System Analysis

1.1.A: Baseline Mechanical System – ASHRAE Baseline VAV Rooftop Units

- Hot water coil heating/direct expansion cooling roof mounted air handling units with variable air volume boxes with hot water reheat coils with serving the academic and support areas, administration areas, auditorium, cafeteria, and media center areas.
- Hot water coil heating/direct expansion cooling roof mounted air handling units with demand ventilation controls serving the auditorium and support areas
- Hot water coil heating and ventilating units serving the gymnasiums and locker rooms
- 100% outside air hot water coil heating and ventilating units with energy recovery wheels serving the locker rooms
- Limited use of fintube radiation and unit heaters serving non-academic areas
- Two-pipe hot water distribution system serving fintube radiation and VAV reheat coils
- (2) 7,200 MBH standard-efficiency gas-fired condensing boilers power plant
- Hot water primary pumping with variable frequency drives
- Direct digital controls throughout

1.1.B: Mechanical System Option One – Displacement Ventilation System with Four-Pipe Induction Unit System (Administration/Cafeteria Areas Only) and Refurbished VAV Air Handling Unit System (Media Center and Support Areas)

- Multiple low wall-mounted displacement diffusers at approximately 200-250 CFM (2 per classroom, 1 per support area) each for each academic and support area
- Dedicated overhead galvanized ventilation distribution system feeding each displacement diffuser

- 100% outside air hot water coil heating/direct expansion cooling rooftop units with energy recovery wheel providing displacement ventilation to the academic and support areas.
- Wall-mounted fintube radiation located along exterior wall between displacement diffusers
- Two-pipe hot water distribution system serving fintube radiation
- Multiple four-pipe two coil heating and cooling induction units served four-pipe heating/cooling piping system serving the administration areas and cafeteria
- 100% outside air hot water coil heating/chilled water coil cooling rooftop units with energy recovery wheel providing ventilation to induction units serving the administration areas and cafeteria
- Refurbished hot water coil heating/direct expansion cooling roof mounted air handling unit and associated condensing unit with variable air volume boxes with hot water reheat coils with demand ventilation controls serving the media center areas
- Hot water coil heating/direct expansion cooling roof mounted air handling units with demand ventilation controls serving the auditorium and support areas
- Hot water coil heating and ventilating units with demand ventilation controls serving the gymnasiums
- 100% outside air hot water coil heating and ventilating units with energy recovery wheels serving the locker rooms
- Primary air ducted directly to induction units
- Limited use of fintube radiation and unit heaters serving non-academic areas
- (4) 3,600 MBH high-efficiency gas-fired condensing boilers power plant
- 80 ton high-efficiency air-cooled chiller power plant
- Chilled and hot water primary pumping with variable frequency drives
- Direct digital controls throughout

1.1.C: Mechanical System Option One (A) – Displacement Ventilation System with Four-Pipe Induction Unit System (Administration/Cafeteria Areas Only) and Refurbished Chilled Water Coil VAV Air Handling Unit System (Media Center and Support Areas)

- Multiple low wall-mounted displacement diffusers at approximately 200-250 CFM (2 per classroom, 1 per support area) each for each academic and support area
- Dedicated overhead galvanized ventilation distribution system feeding each displacement diffuser
- 100% outside air hot water coil heating/direct expansion cooling rooftop units with energy recovery wheel providing displacement ventilation to the academic and support areas.
- Wall-mounted fintube radiation located along exterior wall between displacement diffusers

- Two-pipe hot water distribution system serving fintube radiation
- Multiple four-pipe two coil heating and cooling induction units served four-pipe heating/cooling piping system serving the administration areas and cafeteria
- 100% outside air hot water coil heating/chilled water coil cooling rooftop units with energy recovery wheel providing ventilation to induction units serving the administration areas and cafeteria
- Refurbished hot water coil heating/chilled water coil cooling roof mounted air handling unit and associated condensing unit with variable air volume boxes with hot water reheat coils with demand ventilation controls serving the media center areas
- Hot water coil heating/direct expansion cooling roof mounted air handling units with demand ventilation controls serving the auditorium and support areas
- Hot water coil heating and ventilating units with demand ventilation controls serving the gymnasiums
- 100% outside air hot water coil heating and ventilating units with energy recovery wheels serving the locker rooms
- Primary air ducted directly to induction units
- Limited use of fintube radiation and unit heaters serving non-academic areas
- (4) 3,600 MBH high-efficiency gas-fired condensing boilers power plant
- 120 ton high-efficiency air-cooled chiller power plant
- Chilled and hot water primary pumping with variable frequency drives
- Direct digital controls throughout

1.1.D: Mechanical System Option Two – Displacement Ventilation System with Four-Pipe Induction Unit Systems (Administration/Cafeteria and Media Center Areas)

- Multiple low wall-mounted displacement diffusers at approximately 200-250 CFM (2 per classroom, 1 per support area) each for each academic and support area
- Dedicated overhead galvanized ventilation distribution system feeding each displacement diffuser
- 100% outside air hot water coil heating/direct expansion cooling rooftop units with energy recovery wheel providing displacement ventilation to the academic and support areas.
- Wall-mounted fintube radiation located along exterior wall between displacement diffusers
- Two-pipe hot water distribution system serving fintube radiation
- Multiple four-pipe two coil heating and cooling induction units served four-pipe heating/cooling piping system serving the administration areas and cafeteria

- 100% outside air hot water coil heating/chilled water coil cooling rooftop units with energy recovery wheel providing ventilation to induction units serving the administration areas, cafeteria, and media center areas
- Hot water coil heating/direct expansion cooling roof mounted air handling units with demand ventilation controls serving the auditorium and support areas
- Hot water coil heating and ventilating units with demand ventilation controls serving the gymnasiums
- 100% outside air hot water coil heating and ventilating units with energy recovery wheels serving the locker rooms
- Primary air ducted directly to induction units
- Limited use of fintube radiation and unit heaters serving non-academic areas
- (4) 3,600 MBH high-efficiency gas-fired condensing boilers power plant
- 120 ton high-efficiency air-cooled chiller power plant
- Chilled and hot water primary pumping with variable frequency drives
- Direct digital controls throughout

1.1.E: Mechanical System Option Three – Displacement Ventilation System with Geothermal Plant Four-Pipe Induction Unit Systems (Administration/Cafeteria and Media Center Areas)

- Multiple low wall-mounted displacement diffusers at approximately 200-250 CFM (2 per classroom, 1 per support area) each for each academic and support area
- Dedicated overhead galvanized ventilation distribution system feeding each displacement diffuser
- 100% outside air hot water coil heating/direct expansion cooling rooftop units with energy recovery wheel providing displacement ventilation to the academic and support areas.
- Wall-mounted fintube radiation located along exterior wall between displacement diffusers
- Two-pipe hot water distribution system serving fintube radiation
- Multiple four-pipe two coil heating and cooling induction units served four-pipe heating/cooling piping system serving the administration areas and cafeteria
- 100% outside air hot water coil heating/chilled water coil cooling rooftop units with energy recovery wheel providing ventilation to induction units serving the administration areas, cafeteria, and media center areas
- Hot water coil heating/direct expansion cooling roof mounted air handling units with demand ventilation controls serving the auditorium and support areas
- Hot water coil heating and ventilating units with demand ventilation controls serving the gymnasiums

- 100% outside air hot water coil heating and ventilating units with energy recovery wheels serving the locker rooms
- Primary air ducted directly to induction units
- Limited use of fintube radiation and unit heaters serving non-academic areas
- (4) 3,600 MBH high-efficiency gas-fired condensing boilers power plant
- (2) 60 ton modular high-efficiency water to water source heat pump chillers power plant
- (4) 1500' deep standing column type ground source geothermal wells
- Four-pipe heating/cooling piping system serving induction units and associated air handling units
- Two-pipe hot water distribution system serving fintube radiation
- Chilled, condensing, hot water, and geothermal primary pumping with variable frequency drives
- Direct digital controls throughout

1.1.F: Mechanical System Option Four – Full Geothermal Displacement Ventilation System with Four-Pipe Induction Unit Systems (Administration/Cafeteria and Media Center Areas)

- Multiple low wall-mounted displacement diffusers at approximately 200-250 CFM (2 per classroom, 1 per support area) each for each academic and support area
- Dedicated overhead galvanized ventilation distribution system feeding each displacement diffuser
- 100% outside air hot water coil heating/chilled water coil cooling rooftop units with energy recovery wheel providing displacement ventilation to the academic and support areas.
- Wall-mounted fintube radiation located along exterior wall between displacement diffusers
- Two-pipe hot water distribution system serving fintube radiation
- Multiple four-pipe two coil heating and cooling induction units served four-pipe heating/cooling piping system serving the administration areas and cafeteria
- 100% outside air hot water coil heating/chilled water coil cooling rooftop units with energy recovery wheel providing ventilation to induction units serving the administration areas, cafeteria, and media center areas
- Hot water coil heating/chilled water coil cooling roof mounted air handling units with demand ventilation controls serving the auditorium and support areas
- Hot water coil heating and ventilating units with demand ventilation controls serving the gymnasiums
- 100% outside air hot water coil heating and ventilating units with energy recovery wheels serving the locker rooms

- Primary air ducted directly to induction units
- Limited use of fintube radiation and unit heaters serving non-academic areas
- (4) 3,600 MBH high-efficiency gas-fired condensing boilers power plant
- (2) 60 ton modular high-efficiency water to water source heat pump chillers power plant
- (4) 1500' deep standing column type ground source geothermal wells
- Four-pipe heating/cooling piping system serving induction units and associated air handling units
- Two-pipe hot water distribution system serving fintube radiation
- Chilled, condensing, hot water, and geothermal primary pumping with variable frequency drives
- Direct digital controls throughout

Section 1.2: Mechanical System Analysis Conclusion

The packaged variable air volume rooftop units with terminal VAV boxes with hot water coil reheats system is selected as the baseline system since it is the required baseline system for a building of this square footage per ASHRAE Standard 90.1-2007 Appendix G. This system results in overall ownership costs that in some cases are higher as compared to the alterative systems primarily relating to the increased annual operating costs while also possibly compromising the thermal comfort of the building. The option comparison of each alternative system to the baseline assesses the benefits of improved systems with potentially reduced combined operating costs and improved thermal comfort with the goal of selecting the system with the highest ownership savings over the 30 year study period.

Annual electrical and gas consumption is calculated thru the results of a thermal dynamic heat transfer analysis utilizing Department of Energy (DOE-2)/eQuest software with all architectural data provided by The Office of Michael Rosenfeld Architects.

Building operation schedules are that of a typical school including breaks and holidays. During the school year the building is simulated open Monday through Friday from 7 am through 6 pm. During reduced summer hours building is simulated at low use Monday through Friday from 9 am through 2 pm.

The building infiltration rates carried for all options are 0.038 CFM/s.f. for perimeter zones and 0.001 CFM/s.f. for core zones.

Utility cost data for electricity and gas were obtained from directly from the owner.

The “Building Life-Cycle” analysis included future worth of each system option considered using standard industry discount, inflation, and interest rates.

Our observations of the Mechanical System Payback Summary suggest that option one, a displacement ventilation system with a refurbished air handling unit serving the media center, represents the most cost effective solution by yielding an approximate $974,436 savings over the 30 year study period with an instant payback by having the lowest installed cost.

It should be noted that the associated condensing unit of the existing air handling unit serving the media center has been problematic and has had several failures over recent years. As a result it is the owner's desire to replace this unit. In Option One (A), the direct expansion coil of the existing air handling unit is replaced with a chilled water coil that is served by the central plant chiller. This option would be the second most cost effective solution by yielding an approximate $929,945 savings over the 30 year study period with an instant payback by having the second lowest installed cost.

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DESIGN BUILDING MECHANICAL SYSTEM PAYBACK SUMMARY

Baseline	System	GROSS CAPITAL INVESTMENT*	ANNUAL ELEC. CONS. (KWH)	ANNUAL GAS CONS. (MBTU)	ANNUAL ELECTRIC COST	ANNUAL GAS COST	COMBINED UTILITY COST	ANNUAL UTILITY $/S.F.	ANNUAL KBTU/S.F.	ANNUAL MAINT. COST	COMBINED ANNUAL EXPENSE	COMBINED EXPENSE SAVINGS**	TOTAL LIFE-CYCLE SAVINGS***	SIMPLE PAYBACK (YEARS)****
-	ASHRAE Standard 90.1-2007 System 5 - Packaged Rooftop VAV with Hot Water Coil Reheat	$4,209,550	519,590	6,321.2	$82,615	$86,657	$169,272	$1.21	58.00	$35,900	$205,172	-	-	-

Option	System	GROSS CAPITAL INVESTMENT*	ANNUAL ELEC. CONS. (KWH)	ANNUAL GAS CONS. (MBTU)	ANNUAL ELECTRIC COST	ANNUAL GAS COST	COMBINED UTILITY COST	ANNUAL UTILITY $/S.F.	ANNUAL KBTU/S.F.	ANNUAL MAINT. COST	COMBINED ANNUAL EXPENSE	COMBINED EXPENSE SAVINGS**	TOTAL LIFE-CYCLE SAVINGS***	SIMPLE PAYBACK (YEARS)****
1	Displacement Ventilation System with Induction Unit System serving the Admin./Cafeteria and Refurbished VAV AHU Media Center	$3,730,340	580,070	4,117.1	$92,231	$56,441	$148,672	$1.07	43.69	$34,200	$182,872	$22,300	$974,436	N/A******
1A	Displacement Ventilation System with Induction Unit System serving the Admin./Cafeteria and Refurbished Chilled Water Coil VAV AHU Media Center	$3,772,340	580,750	4,117.1	$92,340	$56,441	$148,781	$1.07	43.70	$34,200	$182,981	$22,191	$929,945	N/A******
2	Displacement Ventilation System with Induction Unit Sytem serving the Admin./Cafeteria and Media Center	$3,822,740	580,400	4,104.8	$92,284	$56,273	$148,557	$1.06	43.61	$33,020	$181,577	$23,595	$908,837	N/A******
3	Displacement Ventilation System with Geothermal Induction Unit Sytem serving the Admin./Cafeteria and Media Center	$4,155,740	599,131	3,618.1	$95,290	$49,600	$144,890	$1.04	40.58	$34,520	$179,410	$25,762	$627,031	N/A******
4	Full Geothermal Plant serving the Displacement Ventilation System with Induction Unit Sytem serving the Admin./Cafeteria and Media Center	$4,711,820	646,040	2,757.0	$102,721	$37,796	$140,517	$1.01	35.55	$36,020	$176,537	$28,635	$134,763	16

* Gross capital investment based upon in-house cost estimate utilizing cost data from similar past projects and industry standard estimating references. Costs have been estimated for system comparison purposes only and do not incorporate all supplemental/independent HVAC system costs which would be required for all systems studied (i.e. kitchen exhaust, sallyport HVAC systems, overhead and profit).
**Combined expense savings is the difference between the combined annual expense of the baseline and system in comparison.
***Total life-cycle savings is based on a 30 year study period.
****Simple payback years is based upon BLCC5 Life Cycle Analysis.
*****Simple payback never reached within 30 year study period.
******Simple payback never reached because system is more efficient and/or less expensive than baseline system.

NIST BLCC 5.3-10: Comparative Analysis

Consistent with Federal Life Cycle Cost Methodology in OMB Circular A-94

Base Case: Baseline - VAV

Alternative: Option 1 - Displacement

General Information

File Name:	C:\Program Files (x86)\BLCC5\projects\Lincoln.xml
Date of Study:	Mon Mar 05 14:30:49 EST 2012
Project Name:	Lincoln Public Schools
Project Location:	Massachusetts
Analysis Type:	OMB Analysis, Non-Energy Project
Analysis Purpose:	Public Investment or Regulatory Analysis
Analyst:	Keith Lane
Base Date:	January 1, 2012
Service Date:	January 1, 2012
Study Period:	30 years 0 months(January 1, 2012 through December 31, 2041)
Discount Rate:	4.5%
Discounting Convention:	End-of-Year

Comparison of Present-Value Costs

PV Life-Cycle Cost

	Base Case	Alternative	Savings from Alternative
Initial Investment Costs:			
Capital Requirements as of Base Date	$4,209,550	$3,730,340	$479,210
Future Costs:			
Energy Consumption Costs	$3,858,697	$3,398,342	$460,355
Energy Demand Charges	$0	$0	$0
Energy Utility Rebates	$0	$0	$0
Water Costs	$0	$0	$0
Recurring and Non-Recurring OM&R Costs	$736,400	$701,529	$34,871
Capital Replacements	$0	$0	$0
Residual Value at End of Study Period	$0	$0	$0
	------------	------------	------------
Subtotal (for Future Cost Items)	$4,595,097	$4,099,871	$495,226
	------------	------------	------------
Total PV Life-Cycle Cost	$8,804,647	$7,830,211	$974,436

Net Savings from Alternative Compared with Base Case

PV of Non-Investment Savings $495,226

- Increased Total Investment	-$479,210

Net Savings	$974,436

NOTE: Meaningful SIR, AIRR and Payback can not be computed unless incremental savings and total savings are both positive.

Energy Savings Summary

Energy Savings Summary (in stated units)

Energy	**-----Average**	**Annual**	**Consumption-----**	**Life-Cycle**
Type	**Base Case**	**Alternative**	**Savings**	**Savings**
Electricity	519,590.0 kWh	580,070.0 kWh	-60,480.0 kWh	-1,814,317.2 kWh
Natural Gas	63,212.0 Therm	41,171.0 Therm	22,041.0 Therm	661,199.8 Therm

Energy Savings Summary (in MBtu)

Energy	**-----Average**	**Annual**	**Consumption-----**	**Life-Cycle**
Type	**Base Case**	**Alternative**	**Savings**	**Savings**
Electricity	1,772.9 MBtu	1,979.3 MBtu	-206.4 MBtu	-6,190.7 MBtu
Natural Gas	6,321.2 MBtu	4,117.1 MBtu	2,204.1 MBtu	66,120.2 MBtu

Emissions Reduction Summary

Energy	**-----Average**	**Annual**	**Emissions-----**	**Life-Cycle**
Type	**Base Case**	**Alternative**	**Reduction**	**Reduction**
Electricity				
CO2	319,930.32 kg	357,170.04 kg	-37,239.72 kg	-1,117,140.60 kg
SO2	888.54 kg	991.96 kg	-103.43 kg	-3,102.62 kg
NOx	278.72 kg	311.16 kg	-32.44 kg	-973.24 kg
Natural Gas				
CO2	333,877.67 kg	217,459.94 kg	116,417.73 kg	3,492,372.67 kg
SO2	2,694.50 kg	1,754.97 kg	939.53 kg	28,184.55 kg
NOx	46.69 kg	65.16 kg	-18.47 kg	-554.16 kg
Total:				
CO2	653,807.99 kg	574,629.98 kg	79,178.02 kg	2,375,232.07 kg
SO2	3,583.04 kg	2,746.94 kg	836.10 kg	25,081.93 kg
NOx	325.41 kg	376.32 kg	-50.92 kg	-1,527.41 kg

NIST BLCC 5.3-10: Comparative Analysis

Consistent with Federal Life Cycle Cost Methodology in OMB Circular A-94

Base Case: Baseline - VAV

Alternative: Option 1a - Displacement with CHW Media AHU

General Information

File Name:	C:\Program Files (x86)\BLCC5\projects\Lincoln.xml
Date of Study:	Mon Mar 05 14:32:33 EST 2012
Project Name:	Lincoln Public Schools
Project Location:	Massachusetts
Analysis Type:	OMB Analysis, Non-Energy Project
Analysis Purpose:	Public Investment or Regulatory Analysis
Analyst:	Keith Lane
Base Date:	January 1, 2012
Service Date:	January 1, 2012
Study Period:	30 years 0 months(January 1, 2012 through December 31, 2041)
Discount Rate:	4.5%
Discounting Convention:	End-of-Year

Comparison of Present-Value Costs

PV Life-Cycle Cost

	Base Case	Alternative	Savings from Alternative
Initial Investment Costs:			
Capital Requirements as of Base Date	$4,209,550	$3,772,340	$437,210
Future Costs:			
Energy Consumption Costs	$3,858,697	$3,400,833	$457,864
Energy Demand Charges	$0	$0	$0
Energy Utility Rebates	$0	$0	$0
Water Costs	$0	$0	$0
Recurring and Non-Recurring OM&R Costs	$736,400	$701,529	$34,871
Capital Replacements	$0	$0	$0
Residual Value at End of Study Period	$0	$0	$0
	------------	------------	------------
Subtotal (for Future Cost Items)	$4,595,097	$4,102,362	$492,735
	------------	------------	------------
Total PV Life-Cycle Cost	$8,804,647	$7,874,702	$929,945

Net Savings from Alternative Compared with Base Case

PV of Non-Investment Savings	$492,735

- Increased Total Investment	-$437,210

Net Savings	$929,945

NOTE: Meaningful SIR, AIRR and Payback can not be computed unless incremental savings and total savings are both positive.

Energy Savings Summary

Energy Savings Summary (in stated units)

Energy	-----Average	Annual	Consumption-----	Life-Cycle
Type	**Base Case**	**Alternative**	**Savings**	**Savings**
Electricity	519,590.0 kWh	580,750.0 kWh	-61,160.0 kWh	-1,834,716.3 kWh
Natural Gas	63,212.0 Therm	41,171.0 Therm	22,041.0 Therm	661,199.8 Therm

Energy Savings Summary (in MBtu)

Energy	-----Average	Annual	Consumption-----	Life-Cycle
Type	**Base Case**	**Alternative**	**Savings**	**Savings**
Electricity	1,772.9 MBtu	1,981.6 MBtu	-208.7 MBtu	-6,260.3 MBtu
Natural Gas	6,321.2 MBtu	4,117.1 MBtu	2,204.1 MBtu	66,120.2 MBtu

Emissions Reduction Summary

Energy	-----Average	Annual	Emissions-----	Life-Cycle
Type	**Base Case**	**Alternative**	**Reduction**	**Reduction**
Electricity				
CO2	319,930.32 kg	357,588.74 kg	-37,658.42 kg	-1,129,701.04 kg
SO2	888.54 kg	993.13 kg	-104.59 kg	-3,137.51 kg
NOx	278.72 kg	311.53 kg	-32.81 kg	-984.19 kg
Natural Gas				
CO2	333,877.67 kg	217,459.94 kg	116,417.73 kg	3,492,372.67 kg
SO2	2,694.50 kg	1,754.97 kg	939.53 kg	28,184.55 kg
NOx	46.69 kg	65.16 kg	-18.47 kg	-554.16 kg
Total:				
CO2	653,807.99 kg	575,048.68 kg	78,759.31 kg	2,362,671.63 kg
SO2	3,583.04 kg	2,748.10 kg	834.94 kg	25,047.04 kg
NOx	325.41 kg	376.69 kg	-51.28 kg	-1,538.35 kg

NIST BLCC 5.3-10: Comparative Analysis

Consistent with Federal Life Cycle Cost Methodology in OMB Circular A-94

Base Case: Baseline - VAV

Alternative: Option 2 - Displacement w/ IU

General Information

File Name:	C:\Program Files (x86)\BLCC5\projects\Lincoln.xml
Date of Study:	Mon Mar 05 14:31:56 EST 2012
Project Name:	Lincoln Public Schools
Project Location:	Massachusetts
Analysis Type:	OMB Analysis, Non-Energy Project
Analysis Purpose:	Public Investment or Regulatory Analysis
Analyst:	Keith Lane
Base Date:	January 1, 2012
Service Date:	January 1, 2012
Study Period:	30 years 0 months(January 1, 2012 through December 31, 2041)
Discount Rate:	4.5%
Discounting Convention:	End-of-Year

Comparison of Present-Value Costs

PV Life-Cycle Cost

	Base Case	Alternative	Savings from Alternative
Initial Investment Costs:			
Capital Requirements as of Base Date	$4,209,550	$3,822,740	$386,810
Future Costs:			
Energy Consumption Costs	$3,858,697	$3,395,746	$462,951
Energy Demand Charges	$0	$0	$0
Energy Utility Rebates	$0	$0	$0
Water Costs	$0	$0	$0
Recurring and Non-Recurring OM&R Costs	$736,400	$677,324	$59,076
Capital Replacements	$0	$0	$0
Residual Value at End of Study Period	$0	$0	$0
	------------	------------	------------
Subtotal (for Future Cost Items)	$4,595,097	$4,073,070	$522,027
	------------	------------	------------
Total PV Life-Cycle Cost	$8,804,647	$7,895,810	$908,837

Net Savings from Alternative Compared with Base Case

PV of Non-Investment Savings $522,027

- Increased Total Investment	-$386,810

Net Savings	$908,837

NOTE: Meaningful SIR, AIRR and Payback can not be computed unless incremental savings and total savings are both positive.

Energy Savings Summary

Energy Savings Summary (in stated units)

Energy Type	-----Average Base Case	Annual Alternative	Consumption----- Savings	Life-Cycle Savings
Electricity	519,590.0 kWh	580,400.0 kWh	-60,810.0 kWh	-1,824,216.8 kWh
Natural Gas	63,212.0 Therm	41,048.0 Therm	22,164.0 Therm	664,889.7 Therm

Energy Savings Summary (in MBtu)

Energy Type	-----Average Base Case	Annual Alternative	Consumption----- Savings	Life-Cycle Savings
Electricity	1,772.9 MBtu	1,980.4 MBtu	-207.5 MBtu	-6,224.5 MBtu
Natural Gas	6,321.2 MBtu	4,104.8 MBtu	2,216.4 MBtu	66,489.2 MBtu

Emissions Reduction Summary

Energy Type	-----Average Base Case	Annual Alternative	Emissions----- Reduction	Life-Cycle Reduction
Electricity				
CO2	319,930.32 kg	357,373.23 kg	-37,442.91 kg	-1,123,236.10 kg
SO2	888.54 kg	992.53 kg	-103.99 kg	-3,119.55 kg
NOx	278.72 kg	311.34 kg	-32.62 kg	-978.55 kg
Natural Gas				
CO2	333,877.67 kg	216,810.27 kg	117,067.40 kg	3,511,861.89 kg
SO2	2,694.50 kg	1,749.73 kg	944.77 kg	28,341.83 kg
NOx	46.69 kg	64.97 kg	-18.28 kg	-548.32 kg
Total:				
CO2	653,807.99 kg	574,183.50 kg	79,624.49 kg	2,388,625.78 kg
SO2	3,583.04 kg	2,742.26 kg	840.78 kg	25,222.28 kg
NOx	325.41 kg	376.31 kg	-50.90 kg	-1,526.88 kg

NIST BLCC 5.3-10: Comparative Analysis

Consistent with Federal Life Cycle Cost Methodology in OMB Circular A-94

Base Case: Baseline - VAV

Alternative: Option 3 -Displacement w/ IU Admin Geo

General Information

File Name:	C:\Program Files (x86)\BLCC5\projects\Lincoln.xml
Date of Study:	Mon Mar 05 14:32:59 EST 2012
Project Name:	Lincoln Public Schools
Project Location:	Massachusetts
Analysis Type:	OMB Analysis, Non-Energy Project
Analysis Purpose:	Public Investment or Regulatory Analysis
Analyst:	Keith Lane
Base Date:	January 1, 2012
Service Date:	January 1, 2012
Study Period:	30 years 0 months(January 1, 2012 through December 31, 2041)
Discount Rate:	4.5%
Discounting Convention:	End-of-Year

Comparison of Present-Value Costs

PV Life-Cycle Cost

	Base Case	Alternative	Savings from Alternative
Initial Investment Costs:			
Capital Requirements as of Base Date	$4,209,550	$4,155,740	$53,810
Future Costs:			
Energy Consumption Costs	$3,858,697	$3,313,783	$544,913
Energy Demand Charges	$0	$0	$0
Energy Utility Rebates	$0	$0	$0
Water Costs	$0	$0	$0
Recurring and Non-Recurring OM&R Costs	$736,400	$708,093	$28,307
Capital Replacements	$0	$0	$0
Residual Value at End of Study Period	$0	$0	$0
	------------	------------	------------
Subtotal (for Future Cost Items)	$4,595,097	$4,021,876	$573,221
	------------	------------	------------
Total PV Life-Cycle Cost	$8,804,647	$8,177,616	$627,031

Net Savings from Alternative Compared with Base Case

PV of Non-Investment Savings $573,221

- Increased Total Investment	-$53,810

Net Savings	$627,031

NOTE: Meaningful SIR, AIRR and Payback can not be computed unless incremental savings and total savings are both positive.

Energy Savings Summary

Energy Savings Summary (in stated units)

Energy	-----Average	Annual	Consumption-----	Life-Cycle
Type	**Base Case**	**Alternative**	**Savings**	**Savings**
Electricity	519,590.0 kWh	599,131.0 kWh	-79,541.0 kWh	-2,386,121.1 kWh
Natural Gas	63,212.0 Therm	36,181.0 Therm	27,031.0 Therm	810,893.0 Therm

Energy Savings Summary (in MBtu)

Energy	-----Average	Annual	Consumption-----	Life-Cycle
Type	**Base Case**	**Alternative**	**Savings**	**Savings**
Electricity	1,772.9 MBtu	2,044.3 MBtu	-271.4 MBtu	-8,141.8 MBtu
Natural Gas	6,321.2 MBtu	3,618.1 MBtu	2,703.1 MBtu	81,089.6 MBtu

Emissions Reduction Summary

Energy	-----Average	Annual	Emissions-----	Life-Cycle
Type	**Base Case**	**Alternative**	**Reduction**	**Reduction**
Electricity				
CO2	319,930.32 kg	368,906.58 kg	-48,976.26 kg	-1,469,220.90 kg
SO2	888.54 kg	1,024.56 kg	-136.02 kg	-4,080.45 kg
NOx	278.72 kg	321.39 kg	-42.67 kg	-1,279.97 kg
Natural Gas				
CO2	333,877.67 kg	191,103.40 kg	142,774.27 kg	4,283,032.78 kg
SO2	2,694.50 kg	1,542.26 kg	1,152.23 kg	34,565.43 kg
NOx	46.69 kg	57.26 kg	-10.58 kg	-317.25 kg
Total:				
CO2	653,807.99 kg	560,009.98 kg	93,798.01 kg	2,813,811.88 kg
SO2	3,583.04 kg	2,566.83 kg	1,016.21 kg	30,484.97 kg
NOx	325.41 kg	378.65 kg	-53.24 kg	-1,597.22 kg

NIST BLCC 5.3-10: Comparative Analysis

Consistent with Federal Life Cycle Cost Methodology in OMB Circular A-94

Base Case: Baseline - VAV

Alternative: Option 4 - Geo Displacement

General Information

File Name:	C:\Program Files (x86)\BLCC5\projects\Lincoln.xml
Date of Study:	Mon Mar 05 14:33:42 EST 2012
Project Name:	Lincoln Public Schools
Project Location:	Massachusetts
Analysis Type:	OMB Analysis, Non-Energy Project
Analysis Purpose:	Public Investment or Regulatory Analysis
Analyst:	Keith Lane
Base Date:	January 1, 2012
Service Date:	January 1, 2012
Study Period:	30 years 0 months(January 1, 2012 through December 31, 2041)
Discount Rate:	4.5%
Discounting Convention:	End-of-Year

Comparison of Present-Value Costs

PV Life-Cycle Cost

	Base Case	Alternative	Savings from Alternative
Initial Investment Costs:			
Capital Requirements as of Base Date	$4,209,550	$4,711,820	-$502,270
Future Costs:			
Energy Consumption Costs	$3,858,697	$3,219,202	$639,494
Energy Demand Charges	$0	$0	$0
Energy Utility Rebates	$0	$0	$0
Water Costs	$0	$0	$0
Recurring and Non-Recurring OM&R Costs	$736,400	$738,862	-$2,462
Capital Replacements	$0	$0	$0
Residual Value at End of Study Period	$0	$0	$0
	------------	------------	------------
Subtotal (for Future Cost Items)	$4,595,097	$3,958,064	$637,033
	------------	------------	------------
Total PV Life-Cycle Cost	$8,804,647	$8,669,884	$134,763

Net Savings from Alternative Compared with Base Case

PV of Non-Investment Savings $637,033

- Increased Total Investment	$502,270

Net Savings	$134,763

Savings-to-Investment Ratio (SIR)

SIR = 1.27

Adjusted Internal Rate of Return

AIRR = 5.33%

Payback Period

Estimated Years to Payback (from beginning of Service Period)

Simple Payback occurs in year	16
Discounted Payback occurs in year	23

Energy Savings Summary

Energy Savings Summary (in stated units)

Energy	**-----Average**	**Annual**	**Consumption-----**	**Life-Cycle**
Type	**Base Case**	**Alternative**	**Savings**	**Savings**
Electricity	519,590.0 kWh	646,040.0 kWh	-126,450.0 kWh	-3,793,326.9 kWh
Natural Gas	63,212.0 Therm	27,570.0 Therm	35,642.0 Therm	1,069,211.2 Therm

Energy Savings Summary (in MBtu)

Energy	**-----Average**	**Annual**	**Consumption-----**	**Life-Cycle**
Type	**Base Case**	**Alternative**	**Savings**	**Savings**
Electricity	1,772.9 MBtu	2,204.4 MBtu	-431.5 MBtu	-12,943.4 MBtu
Natural Gas	6,321.2 MBtu	2,757.0 MBtu	3,564.2 MBtu	106,921.5 MBtu

Emissions Reduction Summary

Energy	**-----Average**	**Annual**	**Emissions-----**	**Life-Cycle**
Type	**Base Case**	**Alternative**	**Reduction**	**Reduction**
Electricity				
CO_2	319,930.32 kg	397,790.15 kg	-77,859.83 kg	-2,335,688.30 kg
SO_2	888.54 kg	1,104.78 kg	-216.24 kg	-6,486.89 kg
NO_x	278.72 kg	346.55 kg	-67.83 kg	-2,034.83 kg
Natural Gas				
CO_2	333,877.67 kg	145,621.20 kg	188,256.47 kg	5,647,436.44 kg
SO_2	2,694.50 kg	1,175.21 kg	1,519.29 kg	45,576.59 kg
NO_x	46.69 kg	43.63 kg	3.05 kg	91.58 kg
Total:				

CO_2	653,807.99 kg	543,411.35 kg	110,396.64 kg	3,311,748.15 kg
SO_2	3,583.04 kg	2,279.99 kg	1,303.05 kg	39,089.71 kg
NO_x	325.41 kg	390.19 kg	-64.78 kg	-1,943.25 kg

GARCIA • GALUSKA • DESOUSA
Consulting Engineers Inc.
370 Faunce Corner Road, Dartmouth, MA 02747-1217

PROJECT:	Lincoln Public School
JOB NO:	32000500
CLIENT:	The Office of Michael Rosenfeld
DATE:	2/25/2012	BY: KL

Baseline - ASHRAE VAV System

ITEM OF WORK	NO.	UNIT PRICE	AREA	PRICE/S.F.	TOTAL
VAV's w/ hot water reheat coil	110	$1,500			$ 165,000.00
VAV RTU (Classrooms) (1) @ 16,000 CFM	16,000 CFM	$7/CFM			$ 112,000.00
VAV RTU (Classrooms) (4) @ 10,000 CFM	40,000 CFM	$7/CFM			$ 280,000.00
VAV RTU (Classrooms) (2) @ 6,000 CFM	12,000 CFM	$7/CFM			$ 84,000.00
VAV RTU (Cafe) 6,000 CFM	6,000 CFM	$7/CFM			$ 42,000.00
VAV RTU (Aud.) (2) 4,000 CFM	8,000 CFM	$7/CFM			$ 56,000.00
VAV RTU (Aud.) 8,000 CFM	8,000 CFM	$7/CFM			$ 56,000.00
HV (Reno Gym) 8,500 CFM	8,500 CFM	$4/CFM			$ 34,000.00
HV (New Gym) 8,500 CFM	8,500 CFM	$4/CFM			$ 34,000.00
ERV (Lockers) (2) @ 1,500 CFM	3,00 CFM	$6/CFM			$ 18,000.00
HV (Kitchen) 4,000 CFM	4,000 CFM	$4/CFM			$ 16,000.00
VAV RTU (Media Center) 18,000 CFM	18,000 CFM	$7/CFM			$ 126,000.00
(2) 7,200 MBH Standard-Efficiency Gas-Fired Boilers	2	$110,000			$ 220,000.00
Pumps (HHW) including VFD's	2	$5,500			$ 11,000.00
HHW Piping & Insulation			139,550 ft^2	$4/ft^2$	$ 558,200.00
Ductwork including GRD's, Dampers, & General Exhaust Systems			139,550 ft^2	$11.5/ft^2$	$ 1,604,825.00
Controls			139,550 ft^2	$5.5/ft^2$	$ 767,525.00
Exhaust Fans (Misc Areas)					$ 25,000.00
				TOTAL	$ 4,209,550.00
				TOTAL ($/FT²)	$ 30.17

Cost estimates have been derived for system comparison purposes only. Estimates do not necessarily include HVAC systems and equipment that would typically be required for all system options studied; example: supplemental cooling systems for elevator machine rooms, tel/data rooms, etc. and radiation heating for unoccupied areas such as storage rooms, corridors, vestibules etc. Estimates do not include project general system costs; example: testing and balancing, commissioning, coordination, as built drawings etc.

GARCIA • GALUSKA • DESOUSA
Consulting Engineers Inc.
370 Faunce Corner Road, Dartmouth, MA 02747-1217

PROJECT:	Lincoln Public School
JOB NO:	32000500
CLIENT:	The Office of Michael Rosenfeld
DATE:	2/25/2012 BY: KL

Option 1 - Displacement Ventilation System

ITEM OF WORK	NO.	UNIT PRICE	AREA	PRICE/S.F.	TOTAL
Displacement Diffuser Assemblies	128	$600			$ 76,800.00
Induction Units (Q1)	20	$1,400			$ 28,000.00
DOAS w/ ERV (Classrooms) (1) @ 6,000 CFM	6,000 CFM	$9/CFM			$ 54,000.00
DOAS w/ ERV (Classrooms) (4) @ 4,000 CFM	16,000 CFM	$9/CFM			$ 144,000.00
DOAS w/ ERV (Classrooms) (2) @ 2,000 CFM	4,000 CFM	$9/CFM			$ 36,000.00
DOAS w/ ERV (Cafe) 4,000 CFM	4,000 CFM	$9/CFM			$ 36,000.00
AHU (Aud.) (2) 4,000 CFM	8,000 CFM	$5/CFM			$ 40,000.00
AHU (Aud.) 8,000 CFM	8,000 CFM	$5/CFM			$ 40,000.00
HV (Reno Gym) 8,500 CFM	8,500 CFM	$4/CFM			$ 34,000.00
HV (New Gym) 8,500 CFM	8,500 CFM	$4/CFM			$ 34,000.00
ERV (Lockers) (2) @ 1,500 CFM	3,00 CFM	$6/CFM			$ 18,000.00
HV (Kitchen) 4,000 CFM	4,000 CFM	$4/CFM			$ 16,000.00
Refurbish Existing AHU (Media Center) 18,000 CFM	18,000 CFM	$3/CFM			$ 54,000.00
Refurbish Existing AHU Condensing Unit (Media Center) 50 tons	1	$50,000			$ 54,000.00
(4) 3,600 MBH High-Efficiency Gas-Fired Condensing Boilers	4	$61,460			$ 245,840.00
Pumps (CHW & HHW) including VFD's	4	$5,500			$ 22,000.00
HHW Piping & Insulation			139,550 ft²	$4/ft²	$ 558,200.00
80 Ton Air-Cooled Chiller	80 tons	$1,200 ton			$ 96,000.00
CHW Piping & Insulation and Condensate (Induction Unit System)			40,000 ft²	$4/ft²	$ 160,000.00
Ductwork including GRD's, Dampers, & General Exhaust Systems			139,550 ft²	$9.5/ft²	$ 1,325,725.00
Controls			139,550 ft²	$4.5/ft²	$ 627,975.00
Demand Ventilation Controls	8	$600			$ 4,800.00
Exhaust Fans (Misc Areas)					$ 25,000.00
				TOTAL	$ 3,730,340.00
				TOTAL ($/FT²)	$ 26.73

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GARCIA • GALUSKA • DESOUSA
Consulting Engineers Inc.
370 Faunce Corner Road, Dartmouth, MA 02747-1217

PROJECT:	Lincoln Public School
JOB NO:	32000500
CLIENT:	The Office of Michael Rosenfeld
DATE:	3/1/2012 BY: KL

Option 1a - Displacement Ventilation System with Refurbished CHW Coil VAV AHU Media Center

ITEM OF WORK	NO.	UNIT PRICE	AREA	PRICE/S.F.	TOTAL
Displacement Diffuser Assemblies	128	$600			$ 76,800.00
Induction Units (Q1)	20	$1,400			$ 28,000.00
DOAS w/ ERV (Classrooms) (1) @ 6,000 CFM	6,000 CFM	$9/CFM			$ 54,000.00
DOAS w/ ERV (Classrooms) (4) @ 4,000 CFM	16,000 CFM	$9/CFM			$ 144,000.00
DOAS w/ ERV (Classrooms) (2) @ 2,000 CFM	4,000 CFM	$9/CFM			$ 36,000.00
DOAS w/ ERV (Cafe) 4,000 CFM	4,000 CFM	$9/CFM			$ 36,000.00
AHU (Aud.) (2) 4,000 CFM	8,000 CFM	$5/CFM			$ 40,000.00
AHU (Aud.) 8,000 CFM	8,000 CFM	$5/CFM			$ 40,000.00
HV (Reno Gym) 8,500 CFM	8,500 CFM	$4/CFM			$ 34,000.00
HV (New Gym) 8,500 CFM	8,500 CFM	$4/CFM			$ 34,000.00
ERV (Lockers) (2) @ 1,500 CFM	3,00 CFM	$6/CFM			$ 18,000.00
HV (Kitchen) 4,000 CFM	4,000 CFM	$4/CFM			$ 16,000.00
Refurbish Existing AHU (Media Center) 18,000 CFM	18,000 CFM	$3/CFM			$ 54,000.00
(4) 3,600 MBH High-Efficiency Gas-Fired Condensing Boilers	4	$61,460			$ 245,840.00
Pumps (CHW & HHW) including VFD's	4	$5,500			$ 22,000.00
HHW Piping & Insulation			139,550 ft^2	$4/$ft^2$	$ 558,200.00
120 Ton Air-Cooled Chiller	120 tons	$1,200 ton			$ 144,000.00
CHW Piping & Insulation and Condensate (Induction Unit System)			52,000 ft^2	$4/$ft^2$	$ 208,000.00
Ductwork including GRD's, Dampers, & General Exhaust Systems			139,550 ft^2	$9.5/$ft^2$	$ 1,325,725.00
Controls			139,550 ft^2	$4.5/$ft^2$	$ 627,975.00
Demand Ventilation Controls	8	$600			$ 4,800.00
Exhaust Fans (Misc Areas)					$ 25,000.00
				TOTAL	$ 3,772,340.00
				TOTAL ($/FT^2)	$ 27.03

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GARCIA • GALUSKA • DESOUSA
Consulting Engineers Inc.
370 Faunce Corner Road, Dartmouth, MA 02747-1217

PROJECT:	Lincoln Public School
JOB NO:	32000500
CLIENT:	The Office of Michael Rosenfeld
DATE:	2/25/2012
BY:	KL

Option 2 - Displacement Ventilation System (Media Center Induction)

ITEM OF WORK	NO.	UNIT PRICE	AREA	PRICE/S.F.	TOTAL
Displacement Diffuser Assemblies	128	$600			$ 76,800.00
Induction Units (Q1)	56	$1,400			$ 78,400.00
DOAS w/ ERV (Classrooms) (1) @ 6,000 CFM	6,000 CFM	$9/CFM			$ 54,000.00
DOAS w/ ERV (Classrooms) (4) @ 4,000 CFM	16,000 CFM	$9/CFM			$ 144,000.00
DOAS w/ ERV (Classrooms) (2) @ 2,000 CFM	4,000 CFM	$9/CFM			$ 36,000.00
DOAS w/ ERV (Cafe) 4,000 CFM	4,000 CFM	$9/CFM			$ 36,000.00
AHU (Aud.) (2) 4,000 CFM	8,000 CFM	$5/CFM			$ 40,000.00
AHU (Aud.) 8,000 CFM	8,000 CFM	$5/CFM			$ 40,000.00
HV (Reno Gym) 8,500 CFM	8,500 CFM	$4/CFM			$ 34,000.00
HV (New Gym) 8,500 CFM	8,500 CFM	$4/CFM			$ 34,000.00
ERV (Lockers) (2) @ 1,500 CFM	3,00 CFM	$6/CFM			$ 18,000.00
HV (Kitchen) 4,000 CFM	4,000 CFM	$4/CFM			$ 16,000.00
DOAS w/ ERV (Cafe) 6,000 CFM	6,000 CFM	$9/CFM			$ 54,000.00
(4) 3,600 MBH High-Efficiency Gas-Fired Condensing Boilers	4	$61,460			$ 245,840.00
Pumps (CHW & HHW) including VFD's	4	$5,500			$ 22,000.00
HHW Piping & Insulation			139,550 ft²	$4/ft²	$ 558,200.00
120 Ton Air-Cooled Chiller	120 tons	$1,200 ton			$ 144,000.00
CHW Piping & Insulation and Condensate (Induction Unit System)			52,000 ft²	$4/ft²	$ 208,000.00
Ductwork including GRD's, Dampers, & General Exhaust Systems			139,550 ft²	$9.5/ft²	$ 1,325,725.00
Controls			139,550 ft²	$4.5/ft²	$ 627,975.00
Demand Ventilation Controls	8	$600			$ 4,800.00
Exhaust Fans (Misc Areas)					$ 25,000.00
				TOTAL	$ 3,822,740.00
				TOTAL ($/FT²)	$ 27.39

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Consulting Engineers Inc.
370 Faunce Corner Road, Dartmouth, MA 02747-1217

PROJECT:	Lincoln Public School
JOB NO:	32000500
CLIENT:	The Office of Michael Rosenfeld
DATE:	2/25/2012
BY:	KL

Option 3 - Displacement Ventilation System with Geothermal Admin. and Media Center Induction

ITEM OF WORK	NO.	UNIT PRICE	AREA	PRICE/S.F.	TOTAL
Displacement Diffuser Assemblies	128	$600			$ 76,800.00
Induction Units (Q1)	56	$1,400			$ 78,400.00
DOAS w/ ERV (Classrooms) (1) @ 6,000 CFM	6,000 CFM	$9/CFM			$ 54,000.00
DOAS w/ ERV (Classrooms) (4) @ 4,000 CFM	16,000 CFM	$9/CFM			$ 144,000.00
DOAS w/ ERV (Classrooms) (2) @ 2,000 CFM	4,000 CFM	$9/CFM			$ 36,000.00
DOAS w/ ERV (Cafe) 4,000 CFM	4,000 CFM	$9/CFM			$ 36,000.00
AHU (Aud.) (2) 4,000 CFM	8,000 CFM	$5/CFM			$ 40,000.00
AHU (Aud.) 8,000 CFM	8,000 CFM	$5/CFM			$ 40,000.00
HV (Reno Gym) 8,500 CFM	8,500 CFM	$4/CFM			$ 34,000.00
HV (New Gym) 8,500 CFM	8,500 CFM	$4/CFM			$ 34,000.00
ERV (Lockers) (2) @ 1,500 CFM	3,00 CFM	$6/CFM			$ 18,000.00
HV (Kitchen) 4,000 CFM	4,000 CFM	$4/CFM			$ 16,000.00
DOAS w/ ERV (Cafe) 6,000 CFM	6,000 CFM	$9/CFM			$ 54,000.00
(4) 3,600 MBH High-Efficiency Gas-Fired Condensing Boilers	4	$61,460			$ 245,840.00
Pumps (HHW, CHW, Geo, CW) including VFD's	8	$5,500			$ 44,000.00
HHW Piping & Insulation			139,550 ft²	$4/ft²	$ 558,200.00
1500' Deep Geothermal Wells (30 Tons ea.)	4	$50,000			$ 200,000.00
Underground Piping, Coring, Sleeves for Geothermal System					$ 120,000.00
60 Ton Water-to-Water Heat Pumps	2	$55,000			$ 110,000.00
Plate frame heat exchangers	1	$25,000			$ 25,000.00
CHW Piping & Insulation and Condensate (Induction Unit System)			52,000 ft²	$4/ft²	$ 208,000.00
Ductwork including GRD's, Dampers, & General Exhaust Systems			139,550 ft²	$9.5/ft²	$ 1,325,725.00
Controls			139,550 ft²	$4.5/ft²	$ 627,975.00
Demand Ventilation Controls	8	$600			$ 4,800.00
Exhaust Fans (Misc Areas)					$ 25,000.00
				TOTAL	$ 4,155,740.00
				TOTAL ($/FT²)	$ 29.78

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GARCIA • GALUSKA • DESOUSA
Consulting Engineers Inc.
370 Faunce Corner Road, Dartmouth, MA 02747-1217

PROJECT:	Lincoln Public School
JOB NO:	32000500
CLIENT:	The Office of Michael Rosenfeld
DATE:	2/25/2012
BY:	KL

Option 4 - Full Geothermal Displacement Ventilation System

ITEM OF WORK	NO.	UNIT PRICE	AREA	PRICE/S.F.	TOTAL
Displacement Diffuser Assemblies	128	$600			$ 76,800.00
Induction Units (Q1)	56	$1,400			$ 78,400.00
DOAS w/ ERV (Classrooms) (1) @ 6,000 CFM	6,000 CFM	$9/CFM			$ 54,000.00
DOAS w/ ERV (Classrooms) (4) @ 4,000 CFM	16,000 CFM	$9/CFM			$ 144,000.00
DOAS w/ ERV (Classrooms) (2) @ 2,000 CFM	4,000 CFM	$9/CFM			$ 36,000.00
DOAS w/ ERV (Cafe) 4,000 CFM	4,000 CFM	$9/CFM			$ 36,000.00
AHU (Aud.) (2) 4,000 CFM	8,000 CFM	$5/CFM			$ 40,000.00
AHU (Aud.) 8,000 CFM	8,000 CFM	$5/CFM			$ 40,000.00
HV (Reno Gym) 8,500 CFM	8,500 CFM	$4/CFM			$ 34,000.00
HV (New Gym) 8,500 CFM	8,500 CFM	$4/CFM			$ 34,000.00
ERV (Lockers) (2) @ 1,500 CFM	3,00 CFM	$6/CFM			$ 18,000.00
HV (Kitchen) 4,000 CFM	4,000 CFM	$4/CFM			$ 16,000.00
DOAS w/ ERV (Cafe) 6,000 CFM	6,000 CFM	$9/CFM			$ 54,000.00
(2) 3,600 MBH High-Efficiency Gas-Fired Condensing Boilers	2	$61,460			$ 122,920.00
Pumps (HHW, CHW, Geo, CW) including VFD's	8	$5,500			$ 44,000.00
HHW Piping & Insulation			139,550 ft²	$4/ft²	$ 558,200.00
1500' Deep Geothermal Wells (30 Tons ea.)	8	$50,000			$ 400,000.00
Underground Piping, Coring, Sleeves for Geothermal System					$ 200,000.00
60 Ton Water-to-Water Heat Pumps	4	$55,000			$ 220,000.00
Plate frame heat exchangers	2	$25,000			$ 50,000.00
CHW Piping & Insulation and Condensate (Induction Unit System)			118,000 ft²	$4/ft²	$ 472,000.00
Ductwork including GRD's, Dampers, & General Exhaust Systems			139,550 ft²	$9.5/ft²	$ 1,325,725.00
Controls			139,550 ft²	$4.5/ft²	$ 627,975.00
Demand Ventilation Controls	8	$600			$ 4,800.00
Exhaust Fans (Misc Areas)					$ 25,000.00
				TOTAL	$ 4,711,820.00
				TOTAL ($/FT²)	$ 33.76

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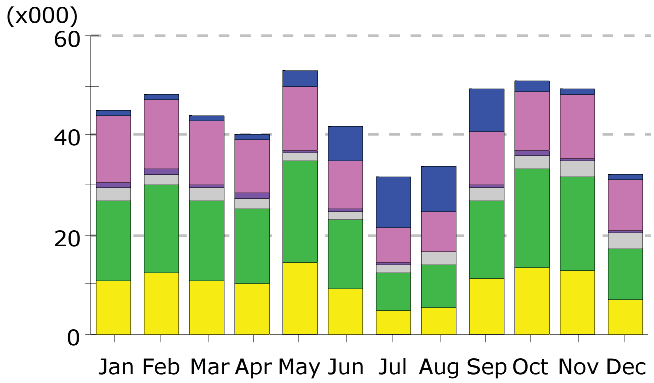
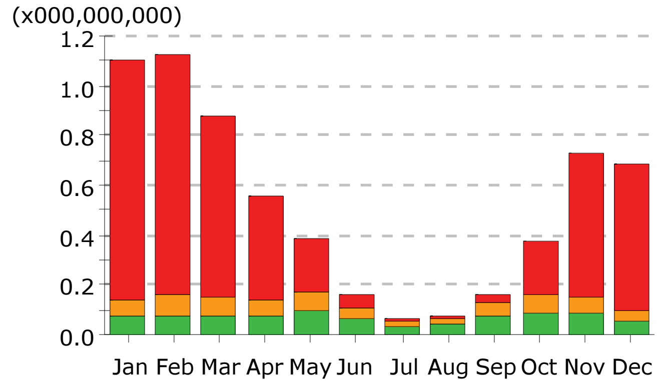
ENERGY PROFILES

Electric Consumption (kWh)



Gas Consumption (Btu)



Electric Consumption (kWh x000)

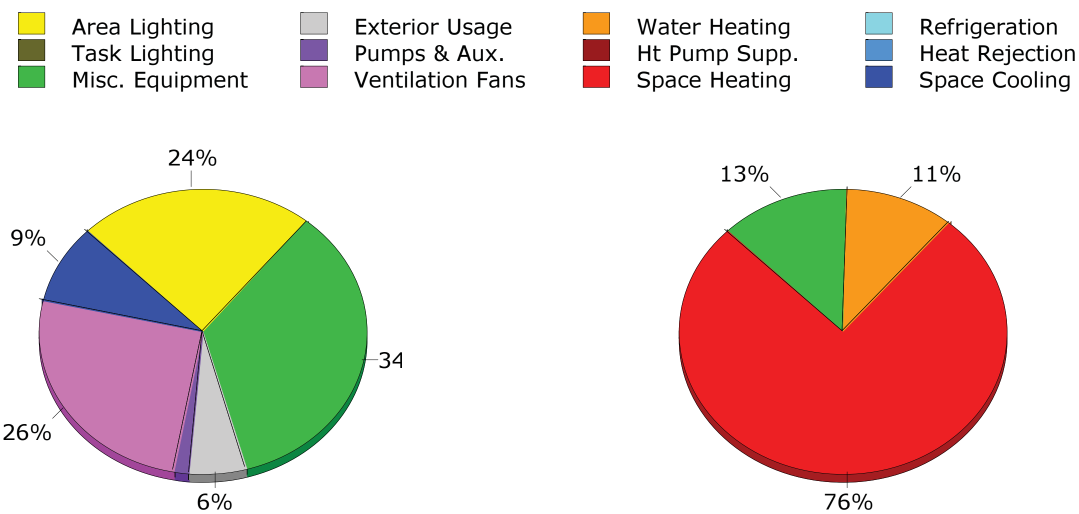
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	1.44	1.38	1.14	1.27	3.43	7.01	9.91	9.22	8.82	1.86	1.23	1.00	47.69
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	-	-	-	-	-	-	-	-	-	-	-	-	-
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	13.42	13.79	12.72	10.84	12.61	9.80	7.03	7.86	10.59	12.12	12.74	9.96	133.49
Pumps & Aux.	0.83	0.83	0.83	0.74	0.60	0.41	0.35	0.36	0.38	0.66	0.84	0.72	7.55
Ext. Usage	2.91	2.23	2.47	2.39	1.71	1.65	1.71	2.78	2.69	2.78	2.81	2.91	29.02
Misc. Equip.	15.81	17.79	16.06	14.99	20.51	13.57	7.39	8.19	15.90	19.67	18.76	10.52	179.17
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	10.82	12.33	10.82	10.20	14.20	9.30	5.00	5.48	11.00	13.64	13.01	6.87	122.66
Total	45.22	48.35	44.04	40.42	53.05	41.75	31.38	33.88	49.38	50.73	49.39	31.98	519.59

Gas Consumption (Btu x000,000,000)

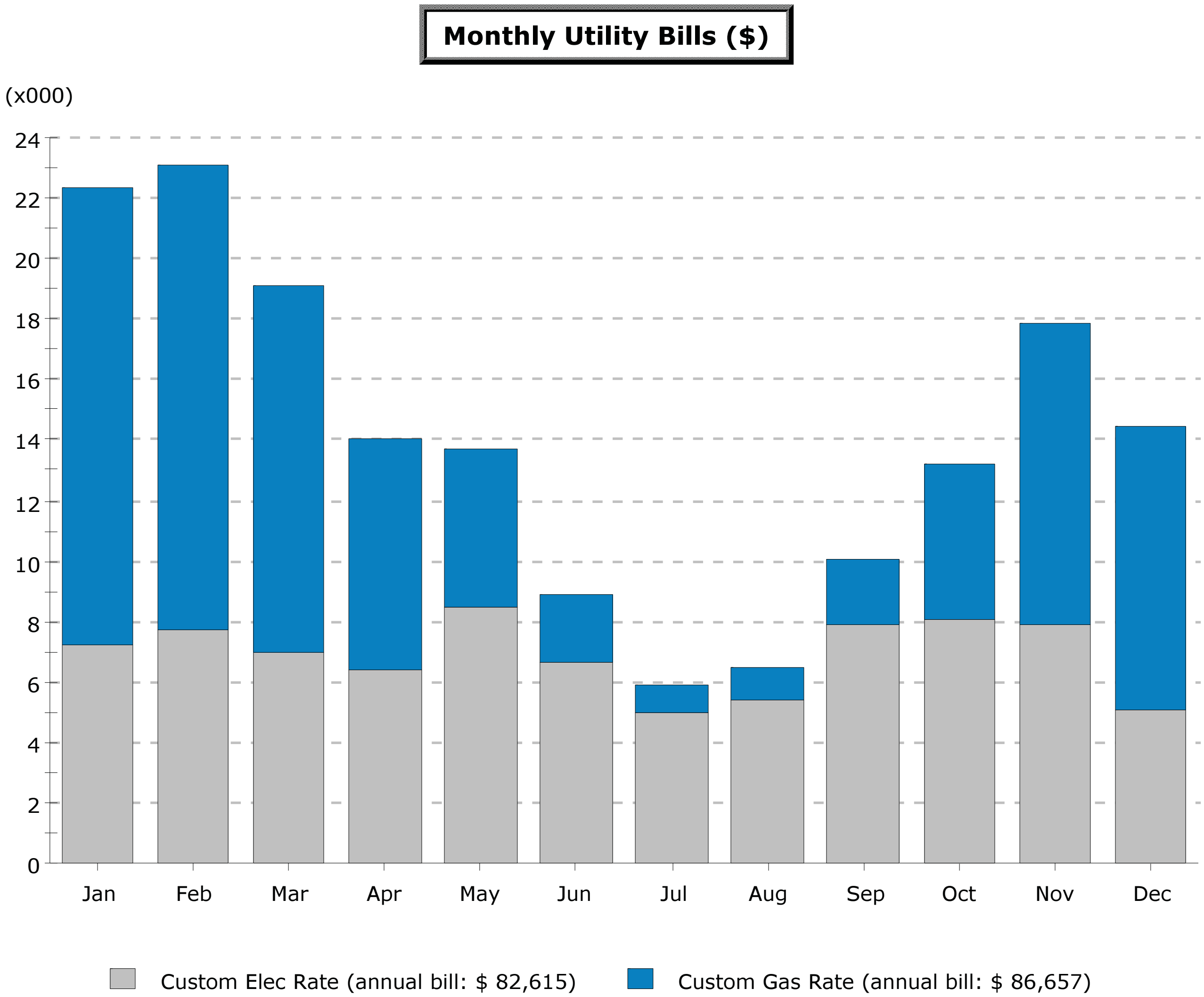
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	0.97	0.97	0.74	0.42	0.21	0.05	0.01	0.02	0.04	0.22	0.58	0.59	4.80
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	0.07	0.08	0.07	0.06	0.08	0.05	0.02	0.02	0.05	0.07	0.07	0.04	0.69
Vent. Fans	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	0.07	0.08	0.08	0.07	0.09	0.06	0.03	0.04	0.07	0.09	0.08	0.06	0.82
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	1.11	1.12	0.88	0.55	0.38	0.16	0.07	0.08	0.16	0.38	0.73	0.68	6.32

Annual Energy Consumption by Enduse

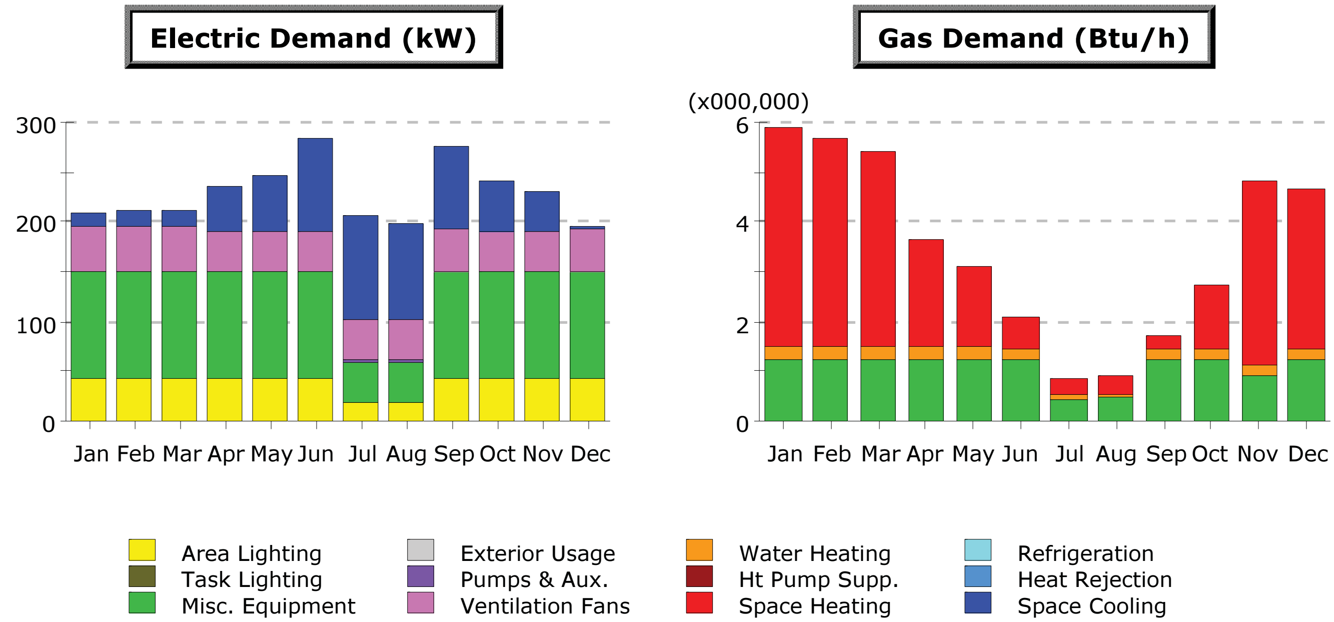
	Electricity kWh (x000)	Natural Gas MBtu	Steam Btu	Chilled Water Btu
Space Cool	47.69	-	-	-
Heat Reject.	-	-	-	-
Refrigeration	-	-	-	-
Space Heat	-	4,803.8	-	-
HP Supp.	-	-	-	-
Hot Water	-	693.9	-	-
Vent. Fans	133.49	-	-	-
Pumps & Aux.	7.55	-	-	-
Ext. Usage	29.02	-	-	-
Misc. Equip.	179.17	823.5	-	-
Task Lights	-	-	-	-
Area Lights	122.66	-	-	-
Total	519.59	6,321.2	-	-



Electricity **Natural Gas**



Total Annual Bill Across All Rates: $ 169,272



Electric Demand (kW)

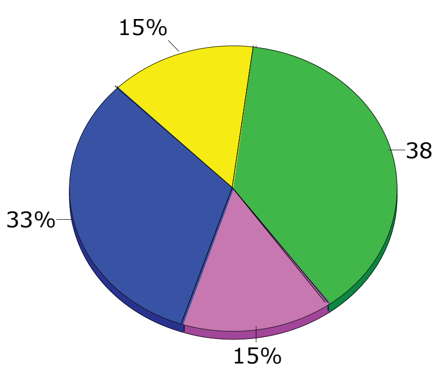
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	15.2	17.0	16.0	46.5	54.6	93.2	104.3	96.2	82.8	49.3	41.0	2.8	618.8
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	-	-	-	-	-	-	-	-	-	-	-	-	-
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	43.3	43.3	43.3	40.7	41.0	41.6	41.2	42.3	43.3	41.3	40.6	42.6	504.5
Pumps & Aux.	1.9	1.8	1.8	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	2.0	11.4
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	107.4	107.4	107.4	107.4	107.4	107.4	41.9	41.9	107.4	107.4	107.4	107.4	1,157.9
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	41.9	41.9	41.9	41.9	41.9	41.9	18.2	18.2	41.9	41.9	41.9	41.9	455.2
Total	209.6	211.4	210.4	237.0	245.4	284.6	206.0	199.1	275.9	240.4	231.4	196.7	2,747.9

Gas Demand (Btu/h x000,000)

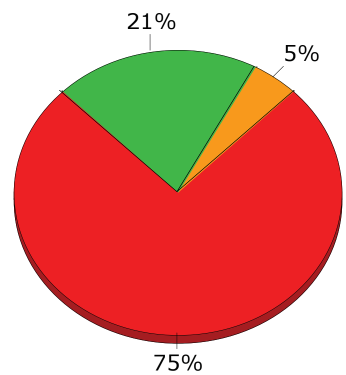
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	4.40	4.16	3.93	2.14	1.62	0.61	0.33	0.34	0.28	1.32	3.70	3.18	26.01
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	0.28	0.29	0.29	0.28	0.26	0.24	0.09	0.08	0.22	0.23	0.24	0.26	2.76
Vent. Fans	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	1.21	1.21	1.21	1.21	1.21	1.21	0.43	0.48	1.21	1.21	0.90	1.21	12.71
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	5.89	5.66	5.43	3.63	3.10	2.07	0.86	0.90	1.71	2.76	4.84	4.65	41.47

Annual Peak Demand by Enduse

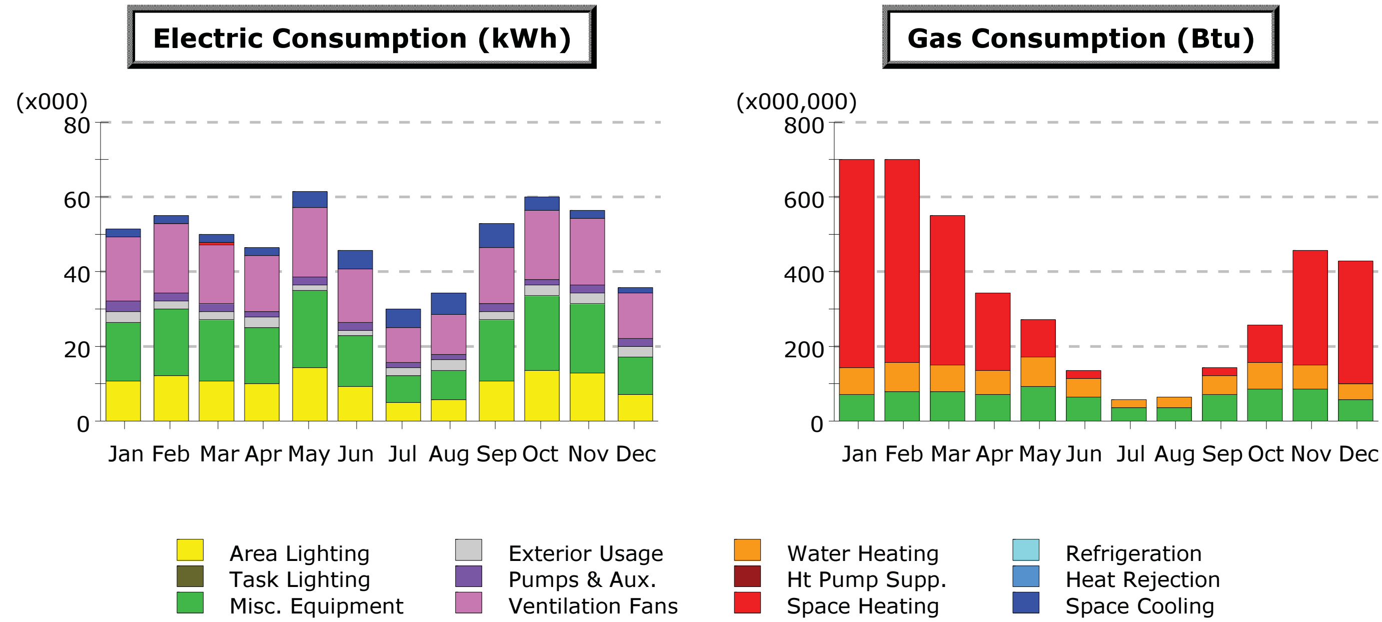
	Electricity kW	Natural Gas Btu/h (x000)	Steam Btu/h	Chilled Water Btu/h
Space Cool	93.22	-	-	-
Heat Reject.	-	-	-	-
Refrigeration	-	-	-	-
Space Heat	-	4,399.4	-	-
HP Supp.	-	-	-	-
Hot Water	-	276.0	-	-
Vent. Fans	41.64	-	-	-
Pumps & Aux.	0.47	-	-	-
Ext. Usage	-	-	-	-
Misc. Equip.	107.40	1,211.7	-	-
Task Lights	-	-	-	-
Area Lights	41.89	-	-	-
Total	284.63	5,887.1	-	-



Electricity



Natural Gas



Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	1.75	2.07	1.93	2.09	4.44	5.36	5.22	5.23	6.49	3.91	2.45	1.13	42.07
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	0.61	0.55	0.47	0.28	0.15	0.06	0.01	0.01	0.04	0.15	0.31	0.42	3.05
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	17.23	18.15	15.94	14.66	18.81	14.31	9.55	10.85	15.30	18.32	17.49	11.65	182.27
Pumps & Aux.	2.25	2.05	2.05	1.90	1.82	1.55	1.39	1.42	1.56	1.86	1.95	2.00	21.82
Ext. Usage	2.91	2.23	2.47	2.39	1.71	1.65	1.71	2.78	2.69	2.78	2.81	2.91	29.02
Misc. Equip.	15.81	17.79	16.06	14.99	20.51	13.57	7.39	8.19	15.90	19.67	18.76	10.52	179.17
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	10.82	12.33	10.82	10.20	14.20	9.30	5.00	5.48	11.00	13.64	13.01	6.87	122.66
Total	51.37	55.18	49.74	46.51	61.62	45.81	30.26	33.97	52.99	60.32	56.79	35.51	580.07

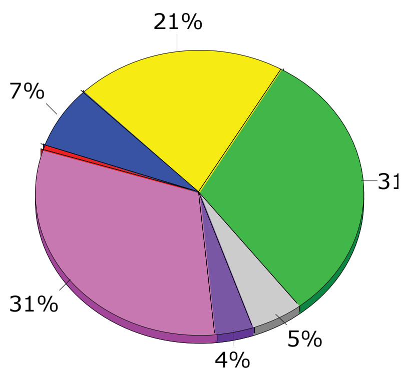
Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	562.9	543.6	404.9	211.0	99.1	21.5	1.8	3.3	15.6	101.9	304.2	328.8	2,598.7
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	67.5	78.8	69.5	64.7	83.3	49.2	23.2	24.4	53.1	69.2	70.6	41.3	694.9
Vent. Fans	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	73.2	78.8	78.1	70.7	91.1	61.8	34.1	39.0	70.7	87.0	82.9	56.1	823.5
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	703.6	701.2	552.6	346.4	273.5	132.5	59.1	66.8	139.4	258.2	457.7	426.1	4,117.1

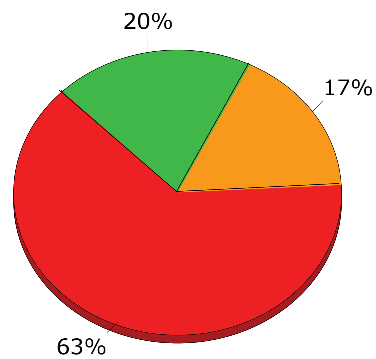
Annual Energy Consumption by Enduse

	Electricity kWh (x000)	Natural Gas MBtu	Steam Btu	Chilled Water Btu
Space Cool	42.07	-	-	-
Heat Reject.	-	-	-	-
Refrigeration	-	-	-	-
Space Heat	3.05	2,598.7	-	-
HP Supp.	-	-	-	-
Hot Water	-	694.9	-	-
Vent. Fans	182.27	-	-	-
Pumps & Aux.	21.82	-	-	-
Ext. Usage	29.02	-	-	-
Misc. Equip.	179.17	823.5	-	-
Task Lights	-	-	-	-
Area Lights	122.66	-	-	-
Total	580.07	4,117.1	-	-

Area Lighting / Task Lighting / Misc. Equipment / Exterior Usage / Pumps & Aux. / Ventilation Fans / Water Heating / Ht Pump Supp. / Space Heating / Refrigeration / Heat Rejection / Space Cooling

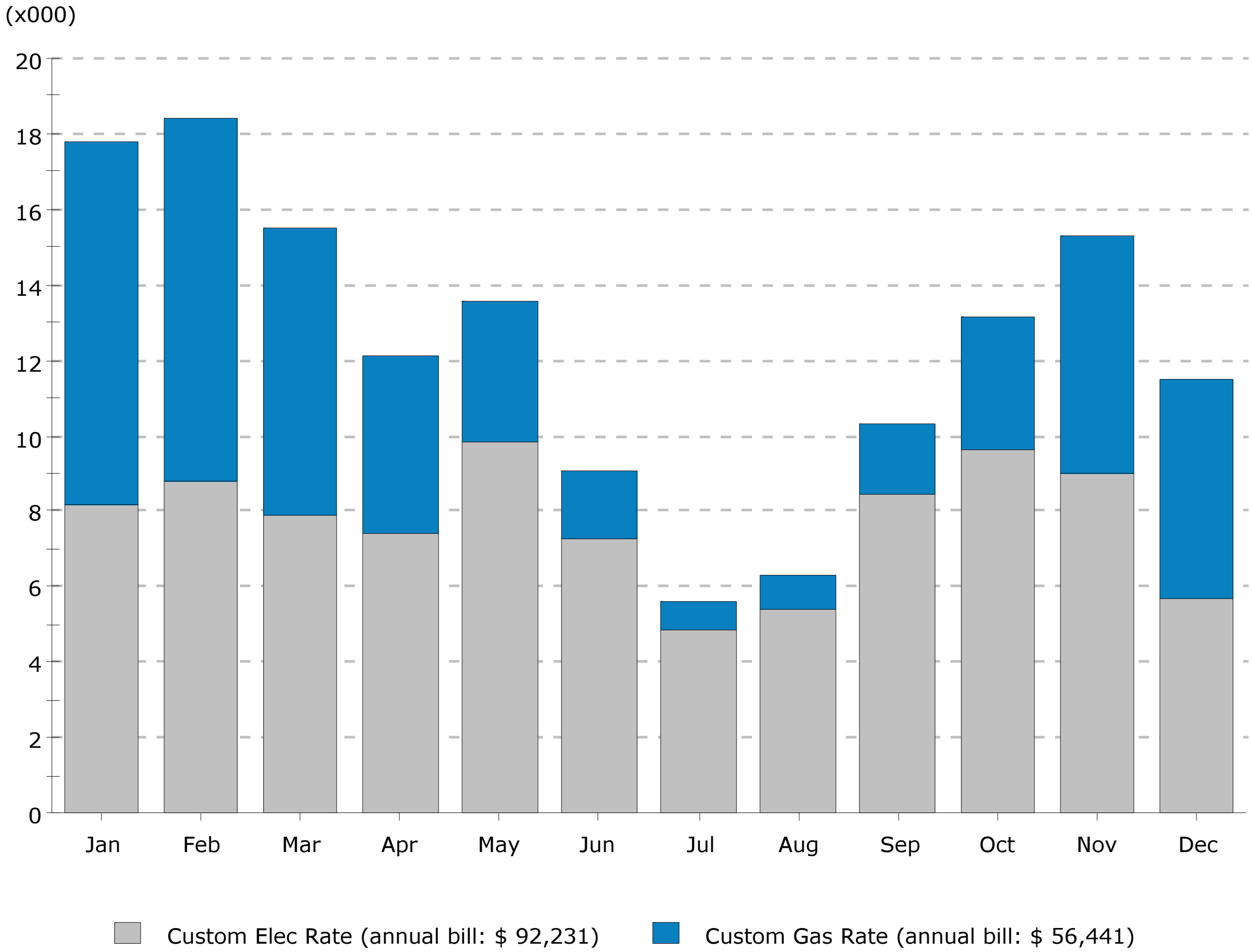


Electricity

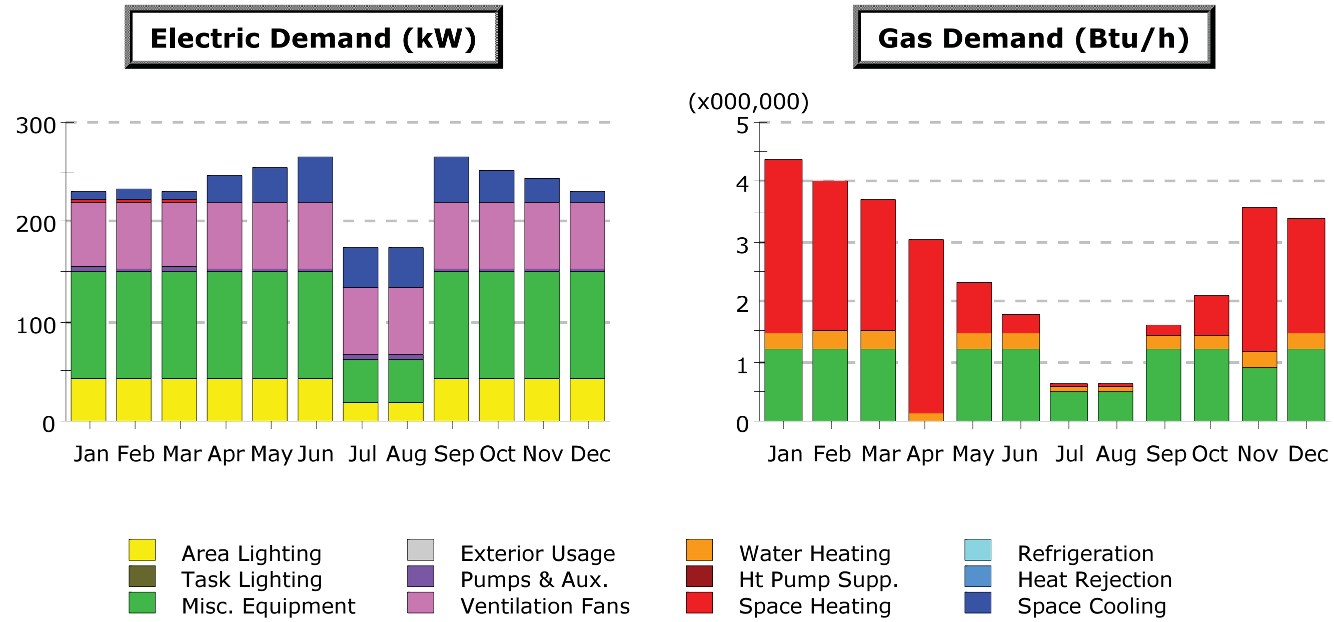


Natural Gas

Monthly Utility Bills ($)



Total Annual Bill Across All Rates: $ 148,672



Electric Demand (kW)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	8.9	10.4	9.7	26.9	33.9	45.6	41.4	40.0	45.1	32.2	25.7	9.2	329.0
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	2.0	1.6	1.7	0.4	0.2	0.1	-	-	0.1	0.1	0.3	1.1	7.8
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	65.9	66.0	65.9	65.1	66.4	66.3	66.8	66.8	67.4	66.5	65.1	65.9	794.2
Pumps & Aux.	5.0	4.6	4.7	4.0	4.0	4.1	4.0	4.0	4.1	4.0	4.0	4.7	51.3
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	107.4	107.4	107.4	107.4	107.4	107.4	44.1	44.1	107.4	107.4	107.4	107.4	1,162.2
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	41.9	41.9	41.9	41.9	41.9	41.9	18.2	18.2	41.9	41.9	41.9	41.9	455.2
Total	231.2	231.9	231.4	245.8	253.8	265.4	174.4	173.1	266.1	252.1	244.4	230.1	2,799.8

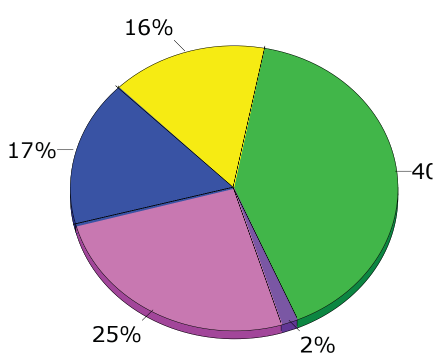
Gas Demand (Btu/h x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	2.87	2.53	2.19	2.90	0.83	0.35	0.08	0.07	0.18	0.66	2.42	1.91	16.96
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	0.28	0.29	0.29	0.13	0.26	0.24	0.09	0.09	0.22	0.23	0.24	0.26	2.60
Vent. Fans	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	1.21	1.21	1.21	0.01	1.21	1.21	0.48	0.48	1.21	1.21	0.90	1.21	11.55
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	4.36	4.02	3.68	3.04	2.30	1.80	0.64	0.63	1.61	2.09	3.56	3.38	31.12

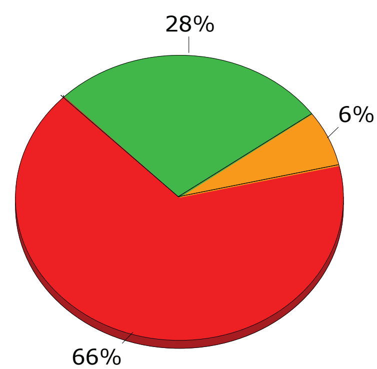
Annual Peak Demand by Enduse

	Electricity kW	Natural Gas Btu/h (x000)	Steam Btu/h	Chilled Water Btu/h
Space Cool	45.11	-	-	-
Heat Reject.	-	-	-	-
Refrigeration	-	-	-	-
Space Heat	0.12	2,869.0	-	-
HP Supp.	-	-	-	-
Hot Water	-	276.0	-	-
Vent. Fans	67.43	-	-	-
Pumps & Aux.	4.11	-	-	-
Ext. Usage	-	-	-	-
Misc. Equip.	107.40	1,211.7	-	-
Task Lights	-	-	-	-
Area Lights	41.89	-	-	-
Total	266.07	4,356.7	-	-

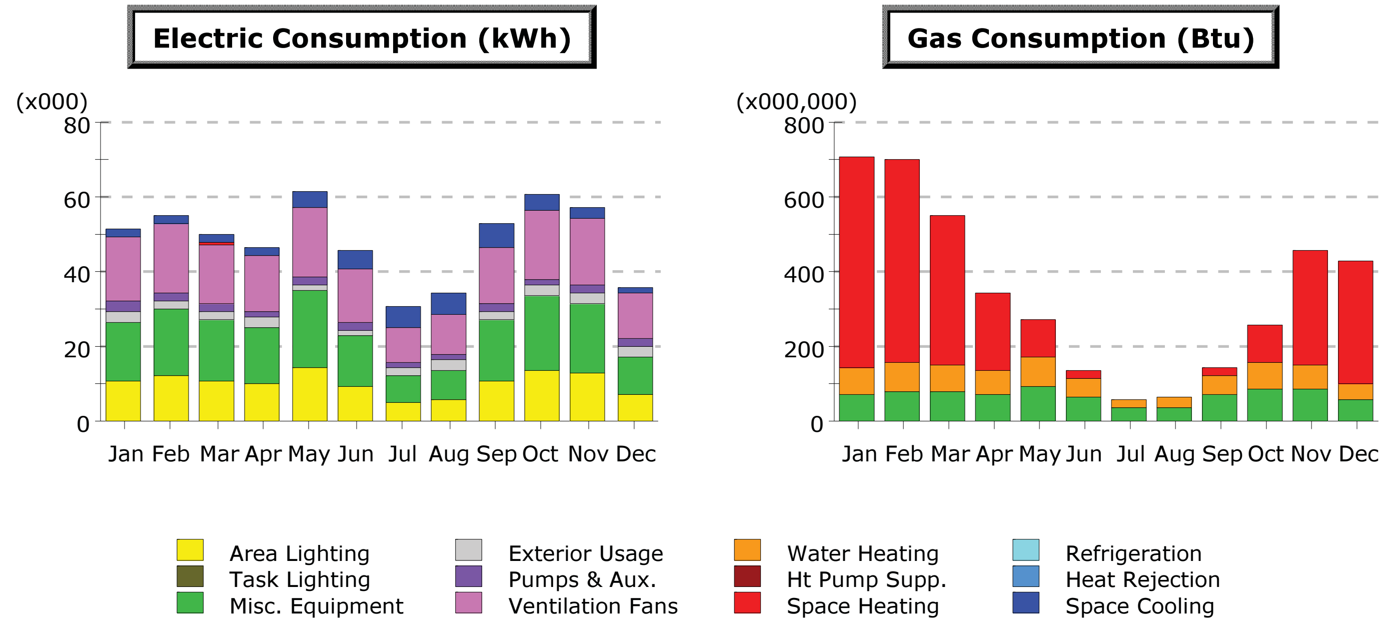
Area Lighting
Task Lighting
Misc. Equipment
Exterior Usage
Pumps & Aux.
Ventilation Fans
Water Heating
Ht Pump Supp.
Space Heating
Refrigeration
Heat Rejection
Space Cooling



Electricity



Natural Gas



Electric Consumption (kWh x000)

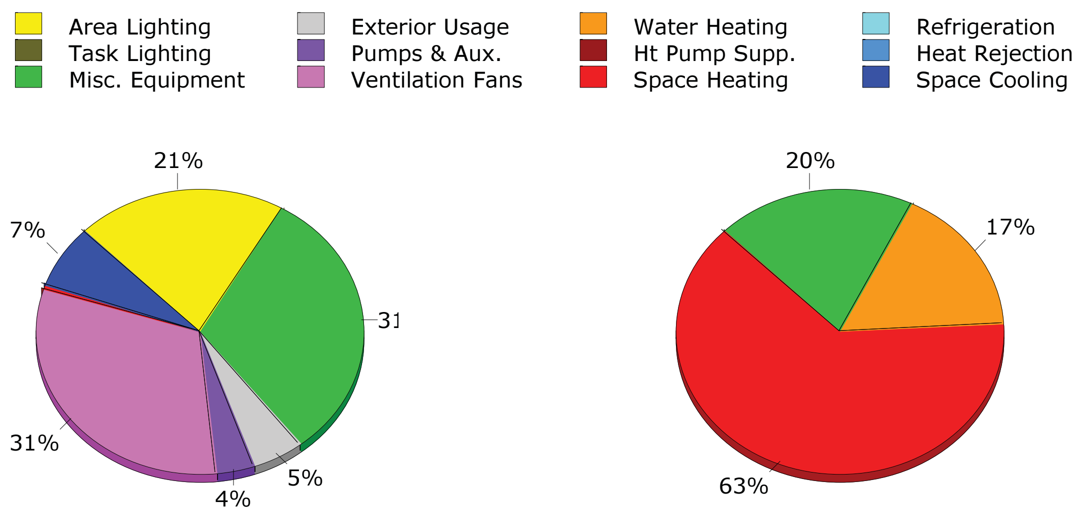
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	1.79	2.07	1.93	2.16	4.49	5.40	5.30	5.29	6.54	3.95	2.49	1.21	42.64
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	0.61	0.55	0.47	0.28	0.15	0.06	0.01	0.01	0.04	0.15	0.31	0.42	3.05
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	17.23	18.15	15.94	14.66	18.81	14.31	9.55	10.85	15.30	18.32	17.49	11.65	182.27
Pumps & Aux.	2.27	2.06	2.04	1.89	1.83	1.57	1.41	1.44	1.59	1.87	1.95	2.01	21.94
Ext. Usage	2.91	2.23	2.47	2.39	1.71	1.65	1.71	2.78	2.69	2.78	2.81	2.91	29.02
Misc. Equip.	15.81	17.79	16.06	14.99	20.51	13.57	7.39	8.19	15.90	19.67	18.76	10.52	179.17
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	10.82	12.33	10.82	10.20	14.20	9.30	5.00	5.48	11.00	13.64	13.01	6.87	122.66
Total	51.44	55.19	49.74	46.57	61.69	45.87	30.36	34.05	53.06	60.37	56.82	35.60	580.75

Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	562.9	543.6	404.9	211.0	99.1	21.5	1.8	3.4	15.6	101.9	304.2	328.8	2,598.7
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	67.5	78.8	69.5	64.7	83.3	49.2	23.2	24.4	53.1	69.2	70.6	41.3	694.9
Vent. Fans	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	73.2	78.8	78.1	70.7	91.1	61.8	34.1	39.0	70.7	87.0	82.9	56.1	823.5
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	703.6	701.2	552.6	346.4	273.5	132.5	59.1	66.8	139.4	258.2	457.7	426.1	4,117.1

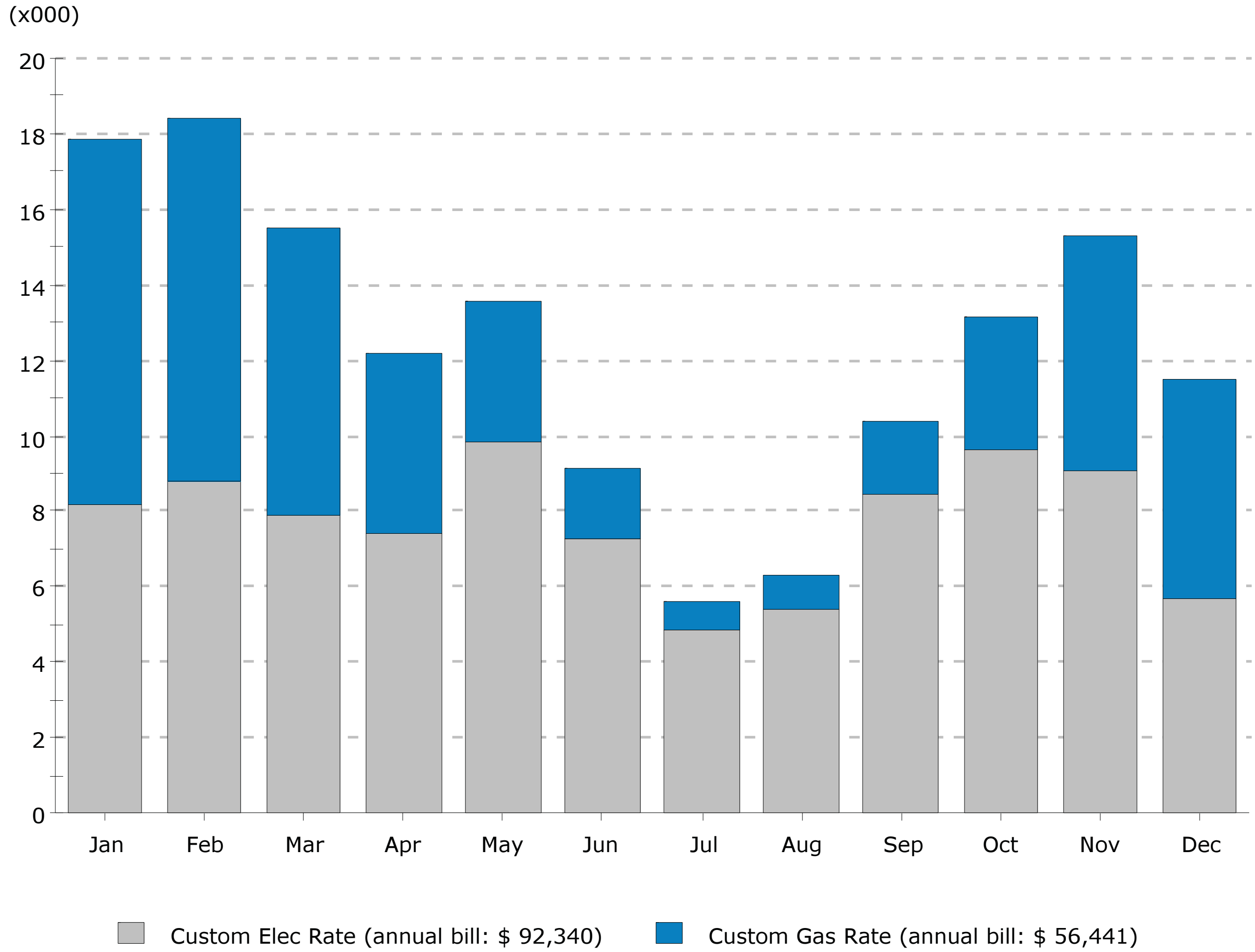
Annual Energy Consumption by Enduse

	Electricity kWh (x000)	Natural Gas MBtu	Steam Btu	Chilled Water Btu
Space Cool	42.64	-	-	-
Heat Reject.	-	-	-	-
Refrigeration	-	-	-	-
Space Heat	3.05	2,598.7	-	-
HP Supp.	-	-	-	-
Hot Water	-	694.9	-	-
Vent. Fans	182.27	-	-	-
Pumps & Aux.	21.94	-	-	-
Ext. Usage	29.02	-	-	-
Misc. Equip.	179.17	823.5	-	-
Task Lights	-	-	-	-
Area Lights	122.66	-	-	-
Total	580.75	4,117.1	-	-

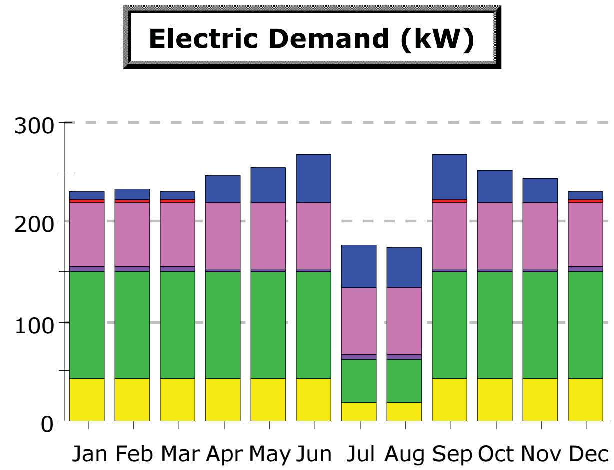


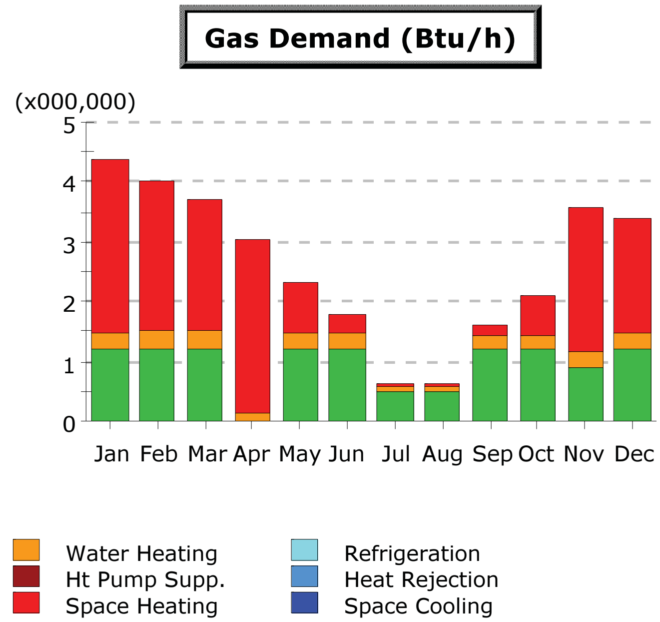
Electricity   **Natural Gas**

Monthly Utility Bills ($)



Total Annual Bill Across All Rates: $ 148,781





Electric Demand (kW)

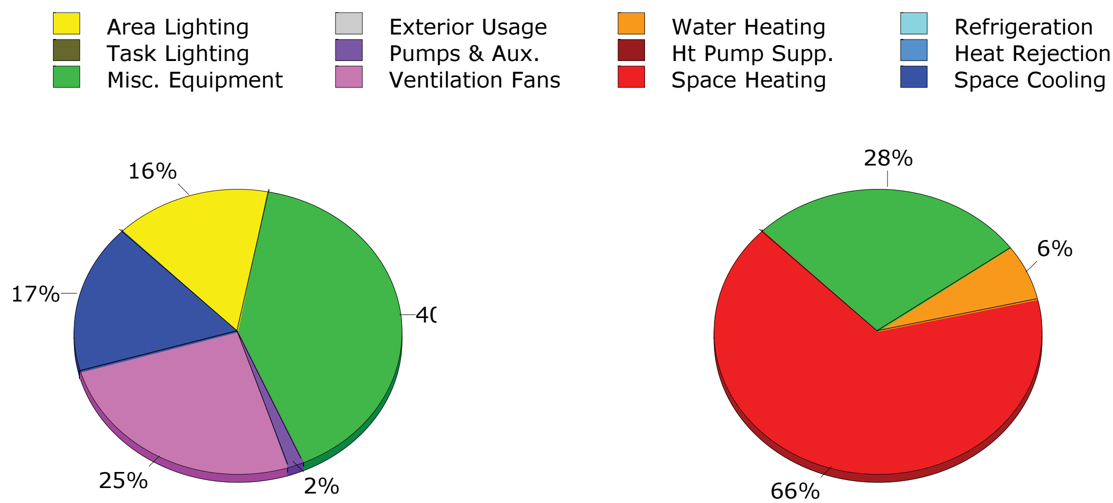
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	9.0	10.3	9.7	27.5	34.4	46.7	42.4	41.0	46.2	32.8	25.9	9.0	334.9
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	2.0	1.6	1.7	0.4	0.2	0.1	-	-	0.1	0.1	0.3	1.1	7.8
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	65.9	66.0	65.9	65.1	66.4	66.3	66.8	66.8	67.4	66.5	65.1	65.9	794.2
Pumps & Aux.	5.2	4.8	4.9	4.1	4.1	4.2	4.1	4.1	4.2	4.1	4.1	4.8	52.8
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	107.4	107.4	107.4	107.4	107.4	107.4	44.1	44.1	107.4	107.4	107.4	107.4	1,162.2
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	41.9	41.9	41.9	41.9	41.9	41.9	18.2	18.2	41.9	41.9	41.9	41.9	455.2
Total	231.4	232.0	231.5	246.5	254.4	266.7	175.6	174.2	267.3	252.8	244.7	230.1	2,807.1

Gas Demand (Btu/h x000,000)

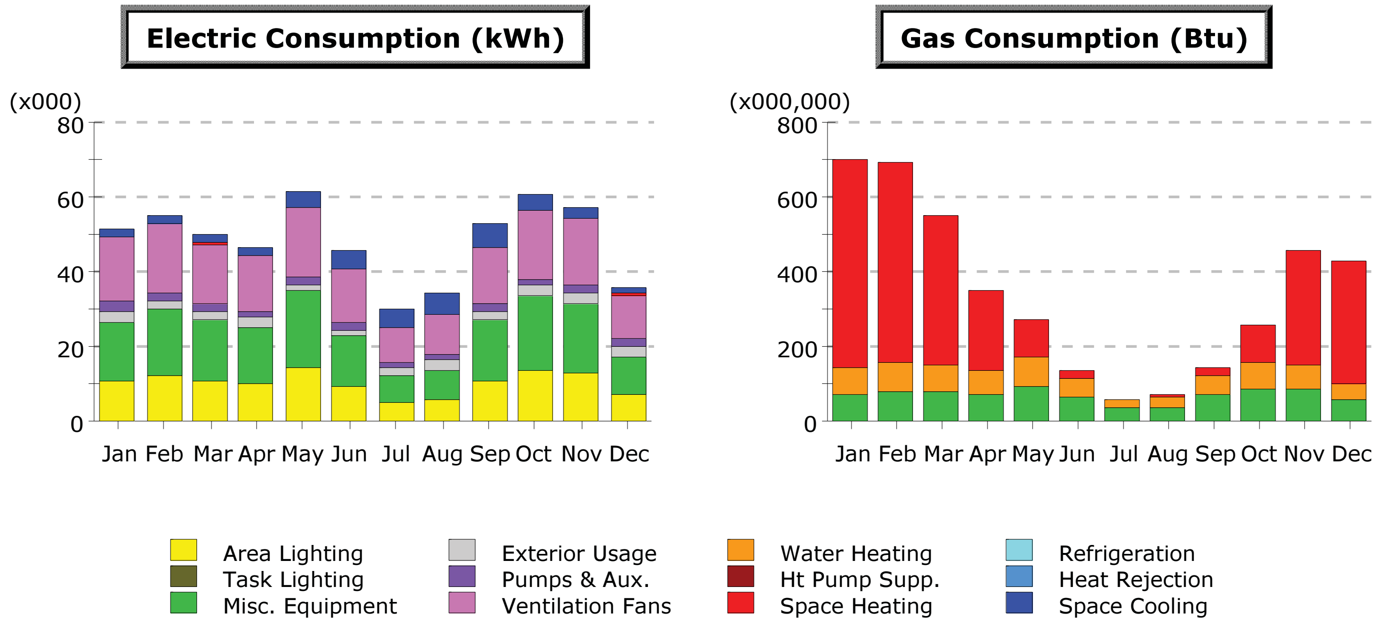
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	2.87	2.53	2.19	2.90	0.83	0.35	0.08	0.07	0.18	0.66	2.42	1.91	16.96
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	0.28	0.29	0.29	0.13	0.26	0.24	0.09	0.09	0.22	0.23	0.24	0.26	2.60
Vent. Fans	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	1.21	1.21	1.21	0.01	1.21	1.21	0.48	0.48	1.21	1.21	0.90	1.21	11.55
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	4.36	4.02	3.68	3.04	2.30	1.80	0.64	0.63	1.61	2.09	3.56	3.38	31.12

Annual Peak Demand by Enduse

	Electricity kW	Natural Gas Btu/h (x000)	Steam Btu/h	Chilled Water Btu/h
Space Cool	46.20	-	-	-
Heat Reject.	-	-	-	-
Refrigeration	-	-	-	-
Space Heat	0.12	2,869.0	-	-
HP Supp.	-	-	-	-
Hot Water	-	276.0	-	-
Vent. Fans	67.43	-	-	-
Pumps & Aux.	4.22	-	-	-
Ext. Usage	-	-	-	-
Misc. Equip.	107.40	1,211.7	-	-
Task Lights	-	-	-	-
Area Lights	41.89	-	-	-
Total	267.28	4,356.7	-	-



Electricity **Natural Gas**



Electric Consumption (kWh x000)

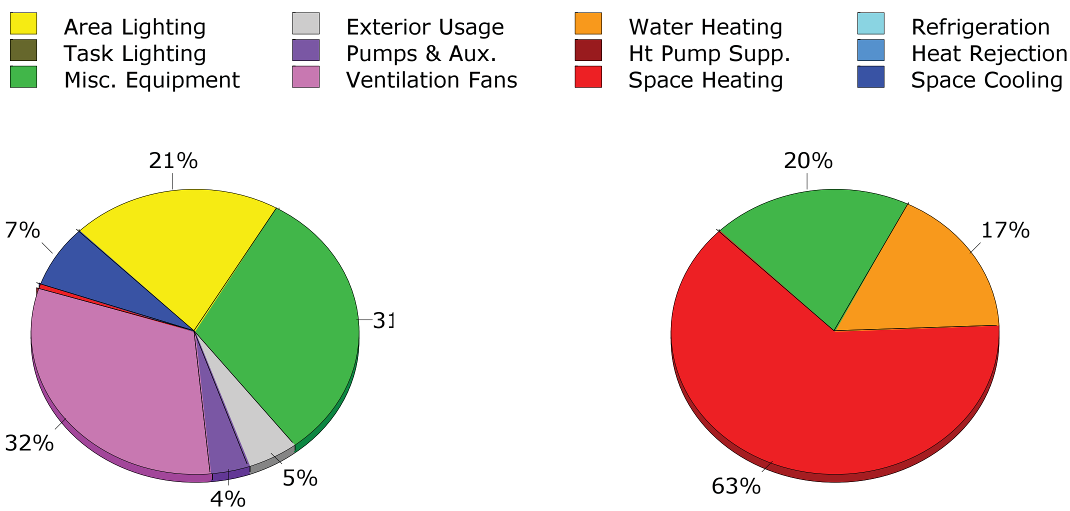
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	1.58	1.86	1.86	2.19	4.47	5.31	5.17	5.15	6.45	3.97	2.43	1.13	41.59
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	0.60	0.54	0.47	0.28	0.14	0.06	0.01	0.01	0.05	0.14	0.31	0.42	3.02
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	17.18	18.15	15.98	14.70	18.89	14.42	9.64	10.95	15.52	18.46	17.54	11.55	182.98
Pumps & Aux.	2.30	2.09	2.09	1.92	1.82	1.55	1.38	1.41	1.57	1.86	1.95	2.02	21.96
Ext. Usage	2.91	2.23	2.47	2.39	1.71	1.65	1.71	2.78	2.69	2.78	2.81	2.91	29.02
Misc. Equip.	15.81	17.79	16.06	14.99	20.51	13.57	7.39	8.19	15.90	19.67	18.76	10.52	179.17
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	10.82	12.33	10.82	10.20	14.20	9.30	5.00	5.48	11.00	13.64	13.01	6.87	122.66
Total	51.20	55.00	49.75	46.66	61.74	45.87	30.29	33.97	53.18	60.51	56.81	35.41	580.40

Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	556.1	534.8	400.8	213.7	100.5	22.3	2.9	4.4	16.3	103.5	302.4	328.8	2,586.5
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	67.5	78.8	69.5	64.7	83.3	49.2	23.2	24.4	53.1	69.2	70.6	41.3	694.9
Vent. Fans	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	73.2	78.8	78.1	70.7	91.1	61.8	34.1	39.0	70.7	87.0	82.9	56.1	823.5
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	696.8	692.3	548.5	349.0	274.9	133.3	60.2	67.9	140.1	259.7	456.0	426.2	4,104.8

Annual Energy Consumption by Enduse

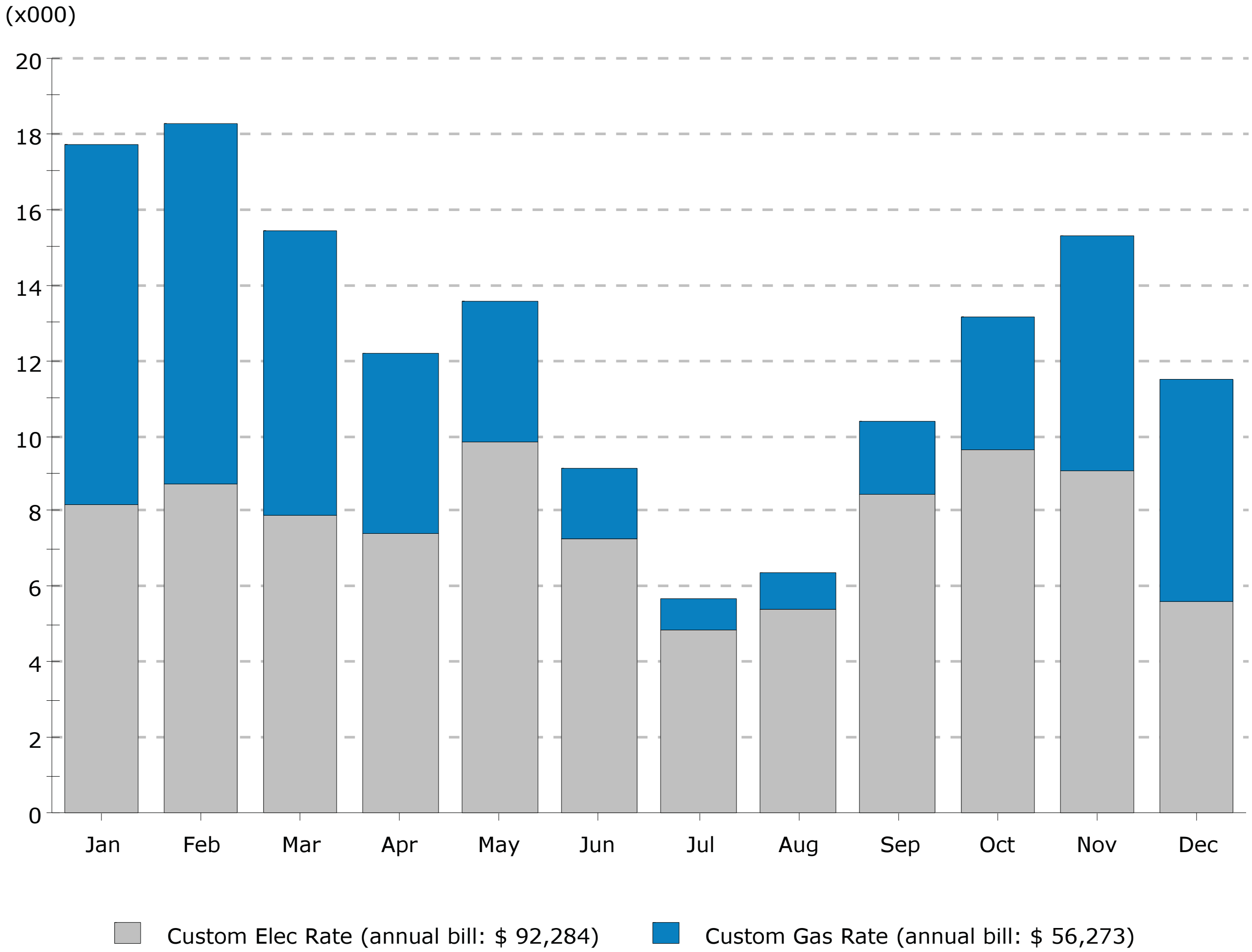
	Electricity kWh (x000)	Natural Gas MBtu	Steam Btu	Chilled Water Btu
Space Cool	41.59	-	-	-
Heat Reject.	-	-	-	-
Refrigeration	-	-	-	-
Space Heat	3.02	2,586.5	-	-
HP Supp.	-	-	-	-
Hot Water	-	694.9	-	-
Vent. Fans	182.98	-	-	-
Pumps & Aux.	21.96	-	-	-
Ext. Usage	29.02	-	-	-
Misc. Equip.	179.17	823.5	-	-
Task Lights	-	-	-	-
Area Lights	122.66	-	-	-
Total	580.40	4,104.8	-	-



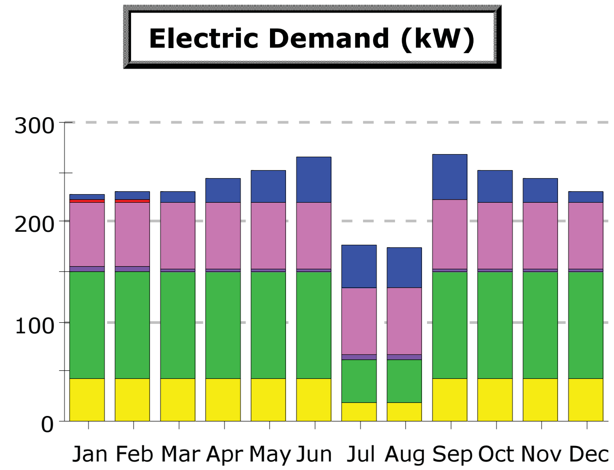
Electricity

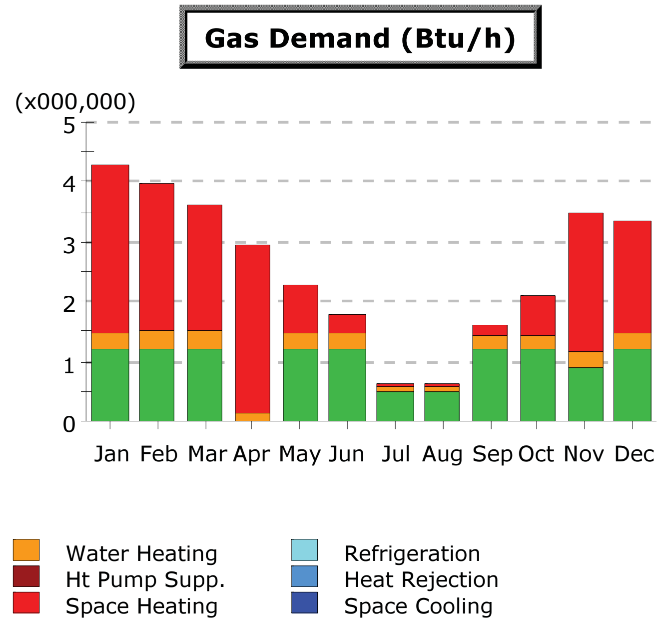
Natural Gas

Monthly Utility Bills ($)



Total Annual Bill Across All Rates: $ 148,557





Electric Demand (kW)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	7.6	7.9	9.6	25.7	32.6	44.7	41.6	40.0	44.9	31.8	24.7	10.3	321.4
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	1.6	1.5	0.6	0.4	0.2	0.1	-	-	0.1	0.1	0.3	0.6	5.8
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	65.6	65.7	65.2	65.2	66.7	67.1	68.0	68.0	68.9	67.3	65.2	65.2	798.0
Pumps & Aux.	4.8	4.7	4.4	4.1	4.1	4.2	4.2	4.2	4.3	4.1	4.1	4.3	51.5
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	107.4	107.4	107.4	107.4	107.4	107.4	44.1	44.1	107.4	107.4	107.4	107.4	1,162.2
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	41.9	41.9	41.9	41.9	41.9	41.9	18.2	18.2	41.9	41.9	41.9	41.9	455.2
Total	228.9	229.2	229.1	244.7	252.9	265.4	176.0	174.4	267.5	252.6	243.6	229.8	2,794.1

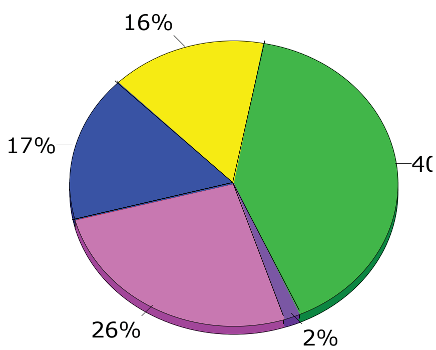
Gas Demand (Btu/h x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	2.78	2.47	2.12	2.81	0.82	0.35	0.07	0.07	0.19	0.65	2.35	1.86	16.52
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	0.28	0.29	0.29	0.13	0.26	0.24	0.09	0.08	0.22	0.23	0.24	0.26	2.60
Vent. Fans	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	1.21	1.21	1.21	0.01	1.21	1.21	0.48	0.48	1.21	1.21	0.90	1.21	11.55
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	4.26	3.97	3.62	2.95	2.29	1.81	0.63	0.63	1.62	2.09	3.49	3.33	30.68

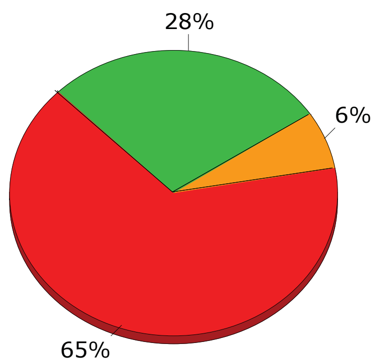
Annual Peak Demand by Enduse

	Electricity kW	Natural Gas Btu/h (x000)	Steam Btu/h	Chilled Water Btu/h
Space Cool	44.92	-	-	-
Heat Reject.	-	-	-	-
Refrigeration	-	-	-	-
Space Heat	0.12	2,775.7	-	-
HP Supp.	-	-	-	-
Hot Water	-	276.0	-	-
Vent. Fans	68.86	-	-	-
Pumps & Aux.	4.26	-	-	-
Ext. Usage	-	-	-	-
Misc. Equip.	107.40	1,211.7	-	-
Task Lights	-	-	-	-
Area Lights	41.89	-	-	-
Total	267.46	4,263.4	-	-

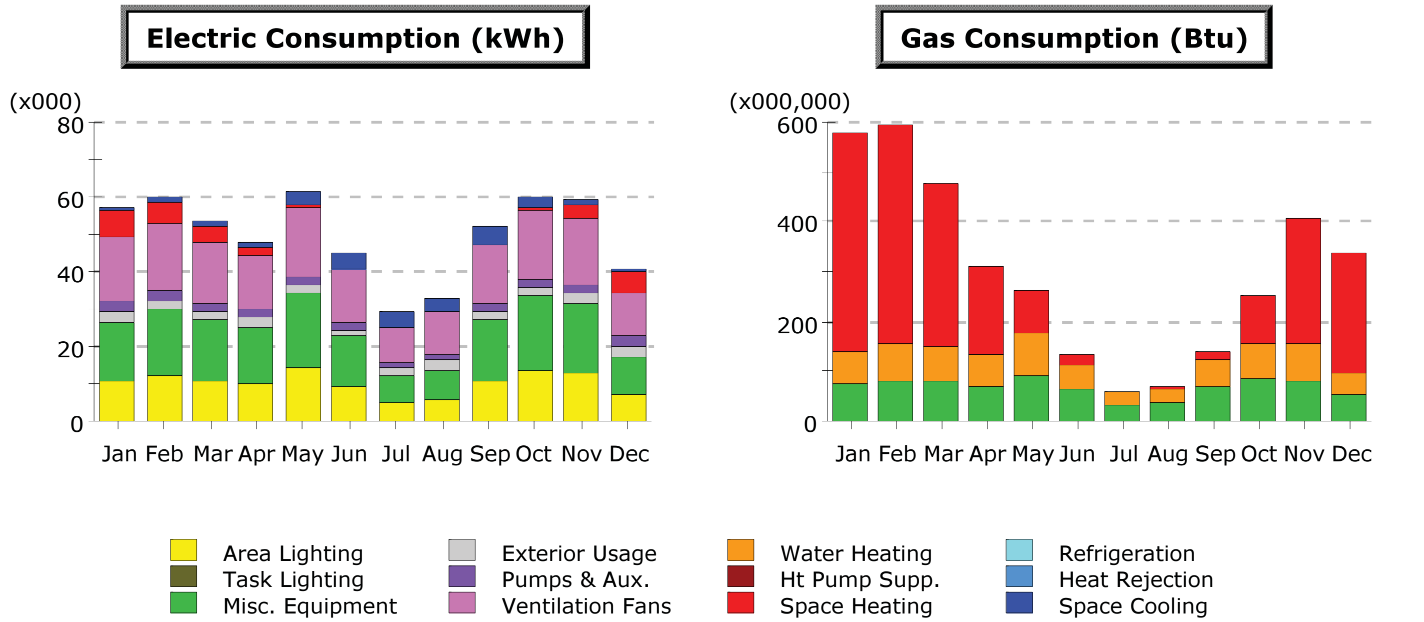
Area Lighting
Task Lighting
Misc. Equipment
Exterior Usage
Pumps & Aux.
Ventilation Fans
Water Heating
Ht Pump Supp.
Space Heating
Refrigeration
Heat Rejection
Space Cooling



Electricity



Natural Gas



Electric Consumption (kWh x000)

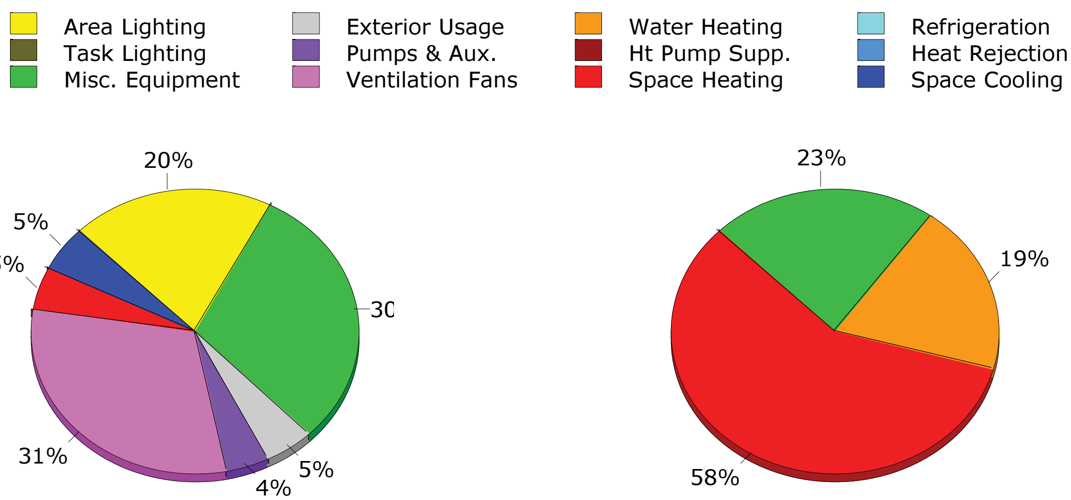
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0.77	1.04	1.10	1.63	3.72	4.29	4.11	4.10	5.08	3.34	1.76	0.61	31.55
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	7.27	5.80	4.53	2.05	0.35	0.05	0.01	0.02	0.04	0.25	3.39	5.57	29.34
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	17.22	18.18	16.01	14.73	18.91	14.44	9.65	10.97	15.55	18.48	17.56	11.58	183.29
Pumps & Aux.	2.72	2.46	2.49	2.19	2.01	1.73	1.52	1.58	1.80	2.06	2.14	2.34	25.05
Ext. Usage	2.91	2.23	2.47	2.39	1.71	1.65	1.71	2.78	2.69	2.78	2.81	2.91	29.02
Misc. Equip.	15.81	17.79	16.06	14.99	20.51	13.57	7.39	8.19	15.90	19.67	18.76	10.52	179.17
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	10.75	12.26	10.75	10.13	14.11	9.24	4.97	5.45	10.93	13.55	12.93	6.83	121.89
Total	57.44	59.76	53.41	48.11	61.32	44.98	29.36	33.09	51.99	60.13	59.36	40.36	599.31

Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	435.3	438.9	327.4	174.3	90.1	21.0	3.5	4.7	15.4	96.0	252.6	240.5	2,099.7
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	67.5	78.8	69.5	64.7	83.3	49.2	23.2	24.4	53.1	69.2	70.6	41.3	694.9
Vent. Fans	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	73.2	78.8	78.1	70.7	91.1	61.8	34.1	39.0	70.7	87.0	82.9	56.1	823.5
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	576.0	596.4	475.0	309.7	264.5	132.0	60.8	68.2	139.2	252.2	406.2	337.9	3,618.1

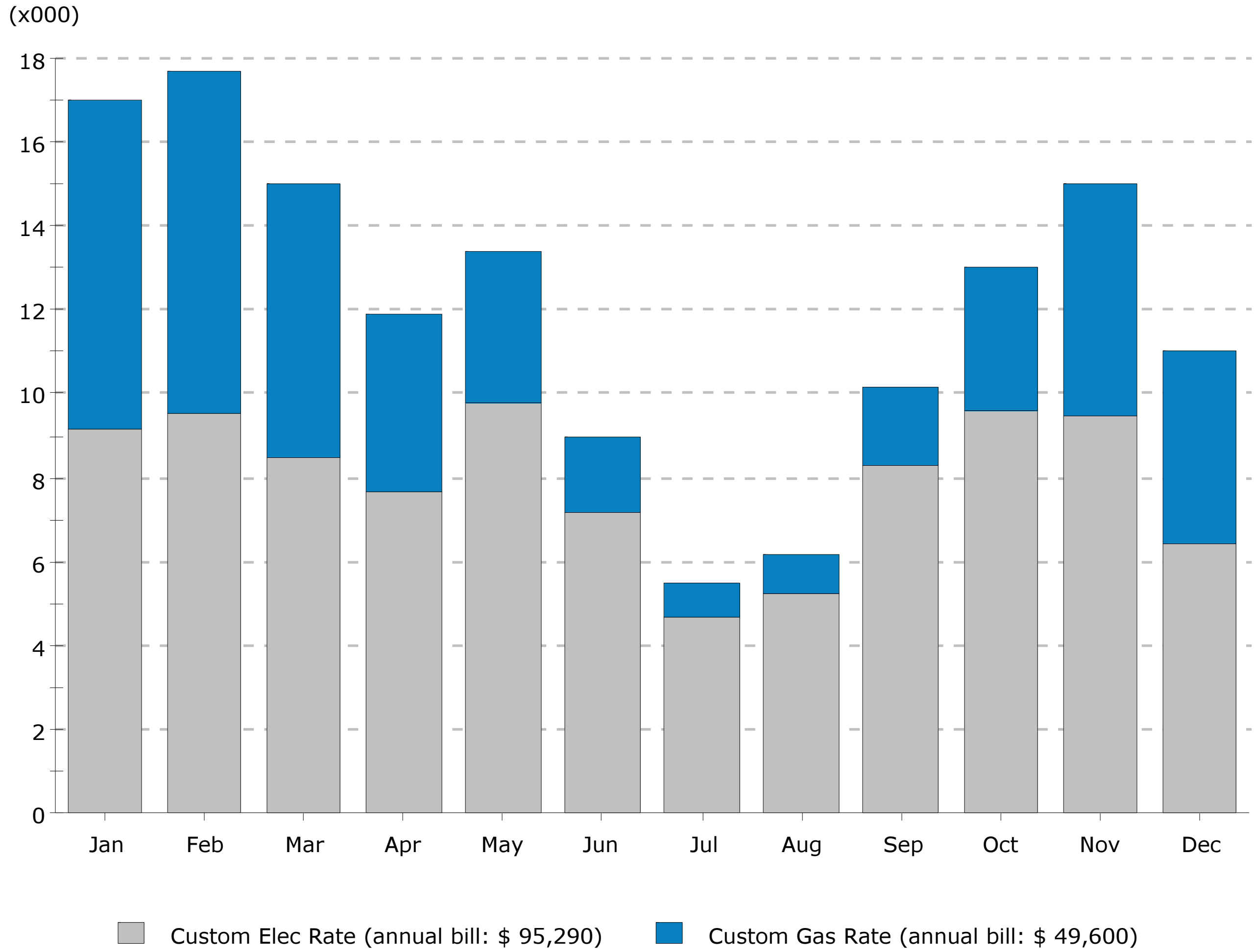
Annual Energy Consumption by Enduse

	Electricity kWh (x000)	Natural Gas MBtu	Steam Btu	Chilled Water Btu
Space Cool	31.55	-	-	-
Heat Reject.	-	-	-	-
Refrigeration	-	-	-	-
Space Heat	29.34	2,099.7	-	-
HP Supp.	-	-	-	-
Hot Water	-	694.9	-	-
Vent. Fans	183.29	-	-	-
Pumps & Aux.	25.05	-	-	-
Ext. Usage	29.02	-	-	-
Misc. Equip.	179.17	823.5	-	-
Task Lights	-	-	-	-
Area Lights	121.89	-	-	-
Total	599.31	3,618.1	-	-

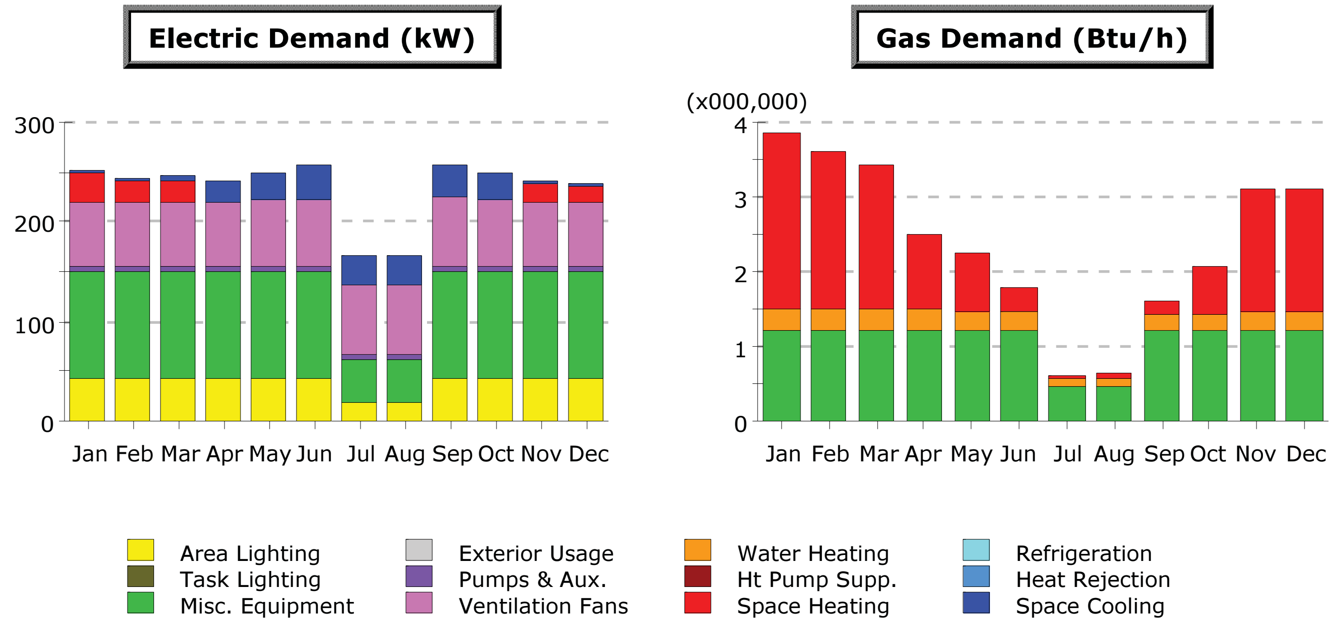


Electricity **Natural Gas**

Monthly Utility Bills ($)



Total Annual Bill Across All Rates: $ 144,890



Electric Demand (kW)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	2.6	2.4	3.2	21.3	27.9	34.9	31.5	30.9	34.0	26.1	3.2	2.6	220.5
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	27.7	20.5	22.1	0.3	0.2	0.1	0.2	-	0.1	0.1	17.9	15.4	104.7
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	65.7	65.7	65.5	65.2	66.7	67.2	68.1	68.2	69.1	67.4	65.5	65.4	799.6
Pumps & Aux.	5.7	5.8	5.4	5.1	5.5	5.5	5.4	5.4	5.6	5.3	5.4	5.5	65.5
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	107.4	107.4	107.4	107.4	107.4	107.4	44.1	44.1	107.4	107.4	107.4	107.4	1,162.2
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	41.6	41.6	41.6	41.6	41.6	41.6	18.0	18.0	41.6	41.6	41.6	41.6	452.4
Total	250.7	243.3	245.2	241.1	249.3	256.6	167.3	166.6	257.8	247.9	241.0	238.0	2,804.8

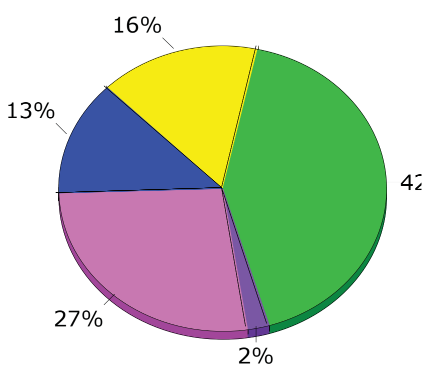
Gas Demand (Btu/h x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	2.39	2.12	1.95	1.02	0.77	0.34	0.05	0.07	0.19	0.62	1.66	1.65	12.83
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	0.28	0.29	0.29	0.28	0.26	0.24	0.09	0.09	0.22	0.23	0.24	0.26	2.76
Vent. Fans	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	1.21	1.21	1.21	1.21	1.21	1.21	0.48	0.48	1.21	1.21	1.21	1.21	13.07
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	3.87	3.62	3.44	2.52	2.25	1.80	0.62	0.63	1.62	2.06	3.12	3.12	28.65

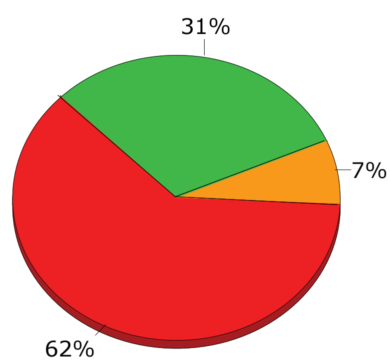
Annual Peak Demand by Enduse

	Electricity kW	Natural Gas Btu/h (x000)	Steam Btu/h	Chilled Water Btu/h
Space Cool	34.04	-	-	-
Heat Reject.	-	-	-	-
Refrigeration	-	-	-	-
Space Heat	0.11	2,386.7	-	-
HP Supp.	-	-	-	-
Hot Water	-	276.0	-	-
Vent. Fans	69.08	-	-	-
Pumps & Aux.	5.57	-	-	-
Ext. Usage	-	-	-	-
Misc. Equip.	107.40	1,211.7	-	-
Task Lights	-	-	-	-
Area Lights	41.63	-	-	-
Total	257.84	3,874.5	-	-

Area Lighting
Task Lighting
Misc. Equipment
Exterior Usage
Pumps & Aux.
Ventilation Fans
Water Heating
Ht Pump Supp.
Space Heating
Refrigeration
Heat Rejection
Space Cooling

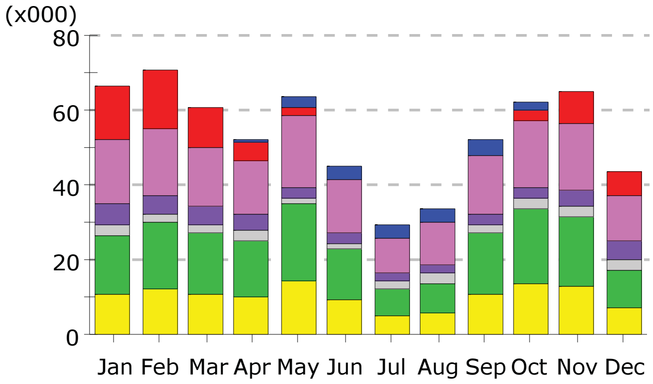


Electricity

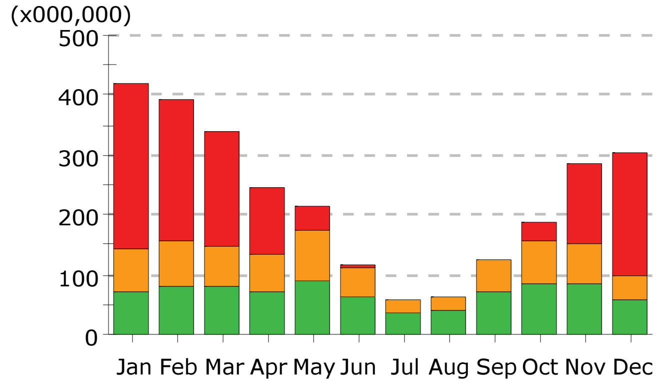


Natural Gas

Electric Consumption (kWh)



Gas Consumption (Btu)



Area Lighting
Task Lighting
Misc. Equipment
Exterior Usage
Pumps & Aux.
Ventilation Fans
Water Heating
Ht Pump Supp.
Space Heating
Refrigeration
Heat Rejection
Space Cooling

Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0.21	0.27	0.38	0.59	2.67	3.78	3.59	3.61	4.46	2.17	0.57	0.22	22.53
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	14.55	15.48	10.69	5.08	2.23	0.07	-	0.00	0.10	2.66	8.67	6.60	66.13
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	17.22	18.19	16.01	14.73	18.92	14.44	9.65	10.97	15.56	18.48	17.56	11.59	183.32
Pumps & Aux.	5.24	4.48	4.62	4.29	3.07	2.51	2.17	2.31	2.74	2.90	3.95	4.92	43.21
Ext. Usage	2.91	2.23	2.47	2.39	1.71	1.65	1.71	2.78	2.69	2.78	2.81	2.91	29.02
Misc. Equip.	15.81	17.79	16.06	14.99	20.51	13.57	7.39	8.19	15.90	19.67	18.76	10.52	179.17
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	10.82	12.33	10.82	10.20	14.20	9.30	5.00	5.48	11.00	13.64	13.01	6.87	122.66
Total	66.75	70.78	61.05	52.26	63.30	45.32	29.52	33.34	52.46	62.29	65.35	43.63	646.04

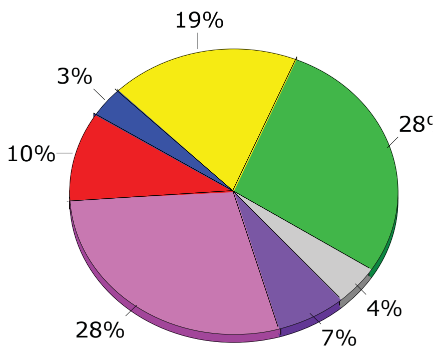
Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	280.8	237.2	193.6	111.1	38.0	7.0	-	0.3	2.7	31.3	130.0	206.7	1,238.6
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	67.5	78.8	69.5	64.7	83.3	49.2	23.2	24.4	53.1	69.2	70.6	41.3	694.9
Vent. Fans	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	73.2	78.8	78.1	70.7	91.1	61.8	34.1	39.0	70.7	87.0	82.9	56.1	823.5
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	421.5	394.8	341.3	246.4	212.4	117.9	57.3	63.8	126.5	187.6	283.6	304.0	2,757.0

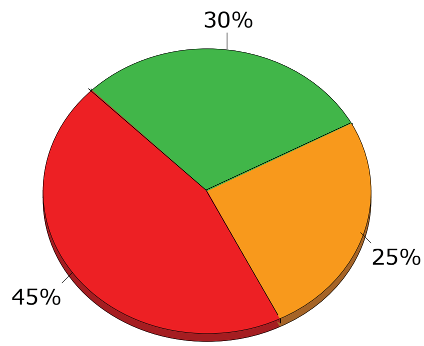
Annual Energy Consumption by Enduse

	Electricity kWh (x000)	Natural Gas MBtu	Steam Btu	Chilled Water Btu
Space Cool	22.53	-	-	-
Heat Reject.	-	-	-	-
Refrigeration	-	-	-	-
Space Heat	66.13	1,238.6	-	-
HP Supp.	-	-	-	-
Hot Water	-	694.9	-	-
Vent. Fans	183.32	-	-	-
Pumps & Aux.	43.21	-	-	-
Ext. Usage	29.02	-	-	-
Misc. Equip.	179.17	823.5	-	-
Task Lights	-	-	-	-
Area Lights	122.66	-	-	-
Total	646.04	2,757.0	-	-

Area Lighting
Task Lighting
Misc. Equipment
Exterior Usage
Pumps & Aux.
Ventilation Fans
Water Heating
Ht Pump Supp.
Space Heating
Refrigeration
Heat Rejection
Space Cooling

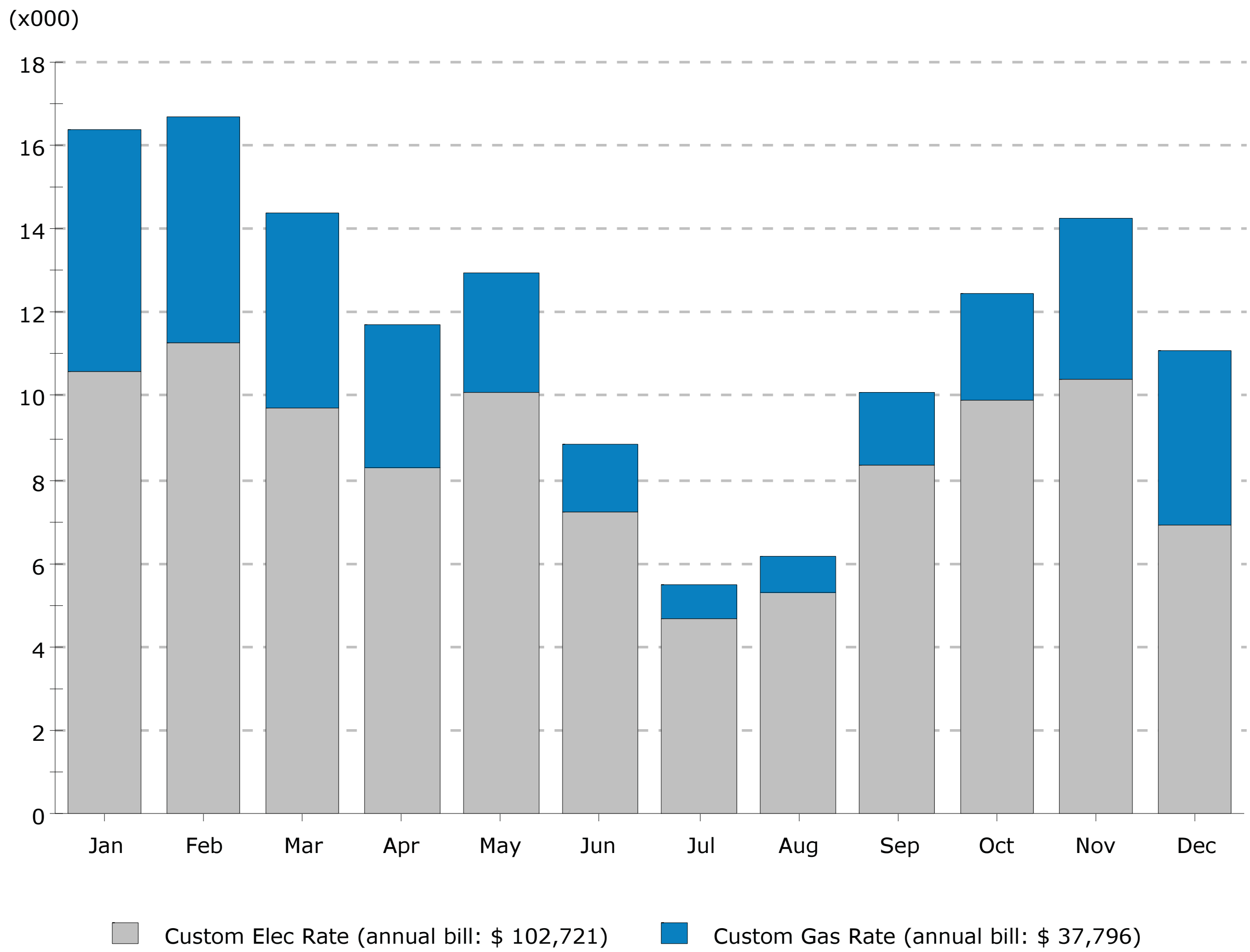


Electricity

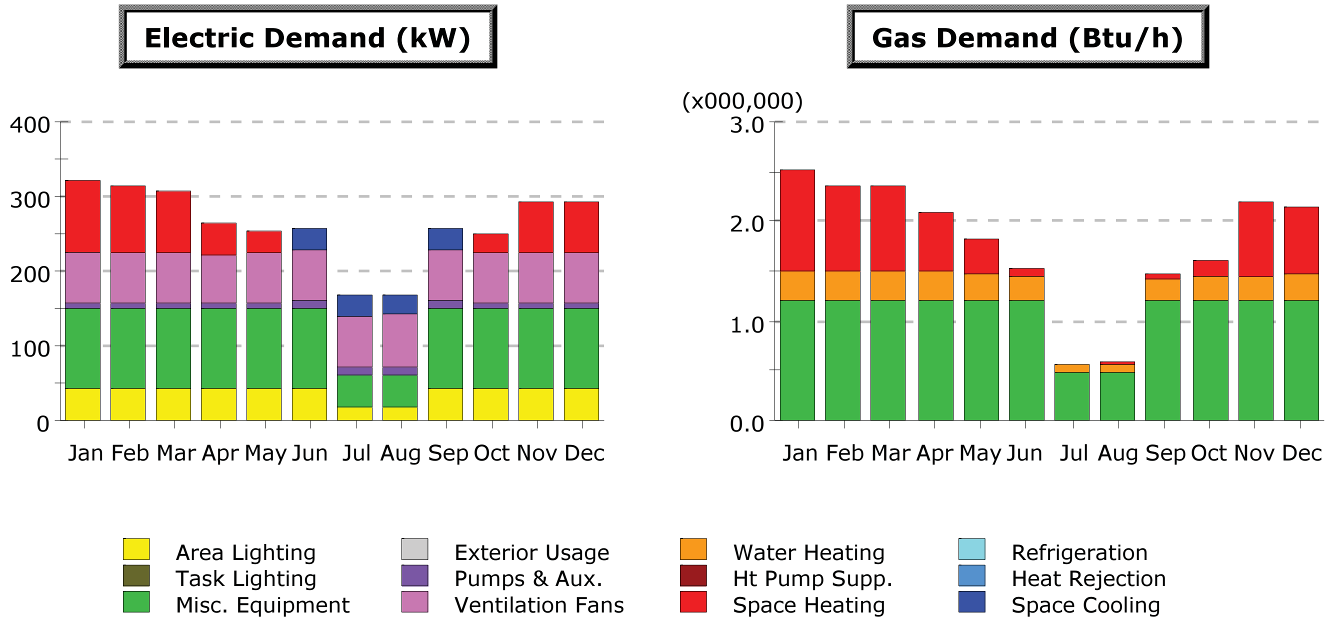


Natural Gas

Monthly Utility Bills ($)



Total Annual Bill Across All Rates: $ 140,517



Electric Demand (kW)

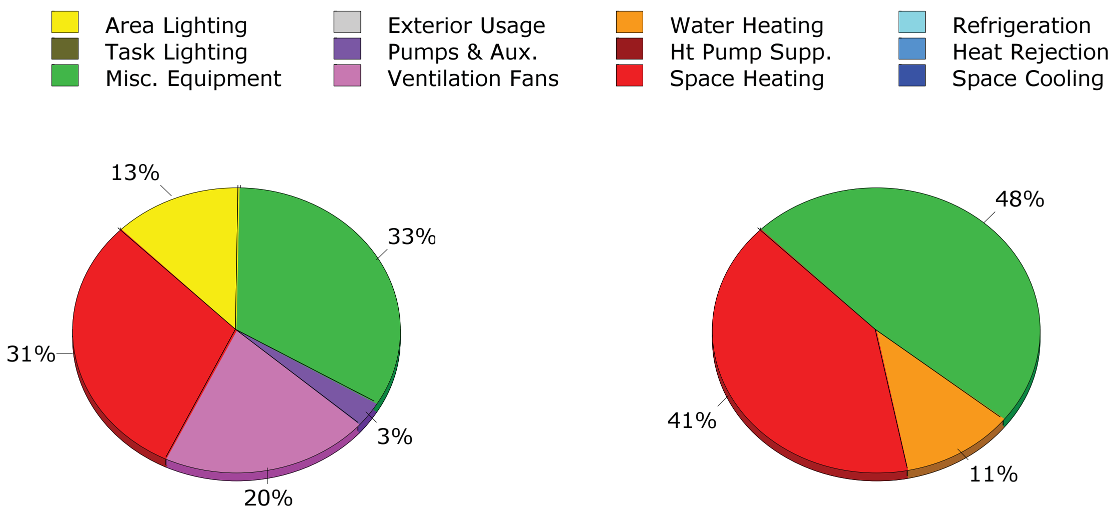
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	28.1	26.7	25.8	27.9	-	-	-	108.5
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	99.0	90.8	83.4	40.5	31.7	-	-	-	-	26.1	67.7	70.2	509.5
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	65.7	65.7	65.7	65.3	65.6	67.2	66.9	68.2	69.1	65.8	65.7	65.7	796.7
Pumps & Aux.	8.9	8.7	8.7	8.5	8.5	11.0	10.9	10.8	11.0	8.6	8.6	8.6	112.7
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	107.4	107.4	107.4	107.4	107.4	107.4	44.1	44.1	107.4	107.4	107.4	107.4	1,162.2
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	41.9	41.9	41.9	41.9	41.9	41.9	18.2	18.2	41.9	41.9	41.9	41.9	455.2
Total	322.8	314.6	307.1	263.7	255.2	255.5	166.7	167.0	257.3	249.8	291.3	293.9	3,144.8

Gas Demand (Btu/h x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	1.02	0.86	0.87	0.60	0.35	0.06	-	0.03	0.05	0.17	0.73	0.67	5.41
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	0.28	0.29	0.29	0.28	0.26	0.24	0.09	0.09	0.22	0.23	0.24	0.26	2.76
Vent. Fans	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	1.21	1.21	1.21	1.21	1.21	1.21	0.48	0.48	1.21	1.21	1.21	1.21	13.07
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	2.51	2.36	2.37	2.09	1.82	1.52	0.56	0.59	1.48	1.61	2.19	2.14	21.24

Annual Peak Demand by Enduse

	Electricity kW	Natural Gas Btu/h (x000)	Steam Btu/h	Chilled Water Btu/h
Space Cool	-	-	-	-
Heat Reject.	-	-	-	-
Refrigeration	-	-	-	-
Space Heat	98.96	1,022.5	-	-
HP Supp.	-	-	-	-
Hot Water	-	276.2	-	-
Vent. Fans	65.66	-	-	-
Pumps & Aux.	8.87	-	-	-
Ext. Usage	-	-	-	-
Misc. Equip.	107.40	1,211.7	-	-
Task Lights	-	-	-	-
Area Lights	41.89	-	-	-
Total	322.78	2,510.3	-	-



Electricity **Natural Gas**

4.8 Fire Protection

Please refer to attached fire protection narrative from Garcia, Galuska, and DeSousa Consulting Engineers.

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Lincoln K-8 School
Lincoln, MA
J#320 005 00.00
L#35507/Page 1/June 7, 2012

FIRE PROTECTION SYSTEMS

NARRATIVE REPORT

The following is the Fire Protection system narrative, which defines the scope of work and capacities of the Fire Protection system as well as the Basis of Design.

1. CODES

   A. All work installed under Section 210000 shall comply with the MA Building Code and all state, county, and federal codes, laws, statutes, and authorities having jurisdiction.

2. DESIGN INTENT

   A. All work is new and consists of furnishing all materials, equipment, labor, transportation, facilities, and all operations and adjustments required for the complete and operating installation of the Fire Protection work and all items incidental thereto, including commissioning and testing.

3. GENERAL

   A. In accordance with the provisions of the Massachusetts Building Code, a school building greater than 12,000 square feet in floor area must be protected with an automatic sprinkler system.

4. DESCRIPTION

   A. The building will be served by a new fire service, double check valve assembly, wet alarm valve complete with electric bell, and a fire department connection meeting local thread standards.

   B. System will be a combined standpipe/sprinkler system with control valve assemblies to limit each sprinkler area to less than 52,000 square feet as required by NFPA 13-2007. Control valve assemblies shall consist of a supervised shutoff valve, check valve, flow switch and test connection with drain. Standpipes, meeting the requirements of NFPA 14-2007, shall be provided on both sides of the Stage area.

   C. All areas of the buildings including all finished and unfinished spaces, combustible concealed spaces, all electrical rooms and closets will be sprinklered.

   D. All sprinkler heads will be quick response, pendent or fully concealed heads in hung ceiling areas and upright heads in unfinished areas.

   E. Fire department valves including 50 foot hose racks and cabinets will be provided on each side of the Stage Area.

5. BASIS OF DESIGN

A. The mechanical rooms, kitchen, science classrooms, and storage rooms are considered Ordinary Hazard Group 1; Stage area is considered Ordinary Hazard Group 2; all other areas are considered light hazard.

B. Required Design Densities:

Light Hazard Areas	0.10 GPM over 1,500 s.f.
Ordinary Hazard Group 1	0.15 GPM over 1,500 s.f.
Ordinary Hazard Group 2	0.20 GPM over 1,500 s.f.

C. Sprinkler spacing (max.):

Light Hazard Areas =	225 s.f.
Ordinary Hazard Areas =	130 s.f.

D. Based on Town record hydrant flow test performed in May 2010 on the municipal main in Lincoln Road there is adequate water to serve the project without a fire pump. A hydrant flow test on the School yard hydrants will be performed.

6. PIPING

A. Sprinkler piping 1-1/2" and smaller shall be ASTM A-53, Schedule 40 black steel pipe. Sprinkler piping 2” and larger shall be ASTM A-135, Schedule 10 black steel pipe.

7. FITTINGS

A. Fittings on fire service piping, 2" and larger, shall be Victaulic Fire Lock Ductile Iron Fittings conforming to ASTM A-536 with integral grooved shoulder and back stop lugs and grooved ends for use with Style 009-EZ or Style 005 couplings. Branch line fittings shall be welded or shall be Victaulic 920/920N Mechanical Tees. Schedule 10 pipe shall be roll grooved. Schedule 40 pipe, where used with mechanical couplings, shall be roll grooved and shall be threaded where used with screwed fittings. Fittings for threaded piping shall be malleable iron screwed sprinkler fittings.

8. JOINTS

A. Threaded pipe joints shall have an approved thread compound applied on male threads only. Teflon tape shall be used for threads on sprinkler heads. Joints on piping, 2" and larger, shall be made up with Victaulic, or equal, Fire Lock Style 005, rigid coupling of ductile iron and pressure responsive gasket system for wet sprinkler system as recommended by manufacturer.

9. DOUBLE CHECK VALVE ASSEMBLY

A. Double check valve assembly shall be MA State approved, U.L./F.M. approved, with iron body bronze mounted construction complete with supervised O.S. & Y. gate valves and test cocks. Furnish two (2) spare sets of gaskets and repair kits.

B. Double check valve assembly shall be of one of the following:

1. Watts Series 757-OSY
2. Wilkins 350A-OSY
3. Conbraco Series 4S-100
4. Or approved equal

4.9 Electrical

Please refer to attached electrical narrative from Garcia, Galuska, and DeSousa Consulting Engineers.

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Lincoln K-8 School
Lincoln, MA
J#320 005 00.00
L#35526/Page 1/June 7, 2012

ELECTRICAL SYSTEMS

NARRATIVE REPORT

The following is the Electrical system narrative, which defines the scope of work and capacities of the Power and Lighting system as well as the Basis of Design. The electrical systems shall be designed and constructed for ***MA-CHPS*** or ***LEED for Schools***.

1. CODES

All work installed under Division 26 shall comply with the Massachusetts State Building Code and all local, county, and federal codes, laws, statutes, and authorities having jurisdiction.

2. DESIGN INTENT

The work of Division 26 is as described in this Narrative. All work is new and consists of furnishing all materials, equipment, labor, transportation, facilities, and all operations and adjustments required for the complete and operating installation of the Electrical work and all items incidental thereto, including commissioning and testing.

3. SEQUENCE OF OPERATIONS AND INTERACTIONS

A. Classroom and corridor lighting will be controlled via “smart panels”, which is achieved through programming self-contained solenoid operated circuit breakers. The control of the circuit breakers shall be by automatic means such as an occupancy sensor in each classroom. The system will be interfaced with the DDC control system for schedule functions. The controllability shall be in conformance with credit ***MA-CHPS and LEED for Schools.*** The occupancy sensor shall have auxiliary contacts for DDC input functions.

B. Exterior lighting will be controlled by photocell “on” and “smart panel” for “off” operation. The parking area lighting will be controlled by “zones” and have dual level control.

C. Emergency and exit lighting will be run through life safety panels to be on during normal power conditions as well as power outage conditions. The emergency lighting system will have time control so that lights are “on” only when building is occupied.

D. Existing lighting controls in the Link Building will be brought to present code.

4. DESCRIPTION OF THE SYSTEMS

A. Electrical Distribution System:

1. New construction service ratings are designed for a demand load of 10 watts/s.f. The service capacity will be sized for 2000 amperes with 100% rating at 277/480 volt, 3∅, 4wire. New lighting and power panels will be provided to accommodate respective loads. The equipment will be located in dedicated rooms or closets.

2. The equipment will be sub-metered for load shedding purposes as well as building “dashboard” monitoring control of solenoid circuit breakers will be accomplished through the DDC system.

3. Existing equipment in Link Building will be re-used and re-fed from new distribution system. Additional computer grade panels will be provided.

B. Interior Lighting System:

1. Classroom lighting fixtures consist of pendant mounted direct/indirect fluorescent luminaries with T5HO lamps and electronic dimming ballasts. The fixtures will be pre-wired for dimming control where natural daylight is available and also for multi-level switching. Two daylight zones will be provided in each classroom. Classroom lighting in the Link Building will be re-used. New lamps and ballasts will be provided for energy code compliance.

2. Office lighting fixtures will consist of pendant mounted direct/indirect fluorescent luminaries with T5HO lamps and electronic ballasts. Offices on the perimeter with windows shall have daylight dimming controls similar to classrooms. The classroom power density will be targeted for less than 0.6 watts/sq. ft.

   In general lighting power density will be 30-40% less than IECC 2009. The power density reduction relates to ***MA-CHPS and LEED for Schools.***

3. Lighting levels will be approximately 30 foot candles in classrooms and offices. The daylight dimming footcandle level will be in compliance with ***MA-CHPS and LEED for Schools.***

4. Gymnasium lighting will be comprised of direct fluorescent fixtures with slots for an up light component with T5H0 lamps and electronic ballasts. The fixtures will be provided with protective wire guards. The light level will be designed for approximately 50 foot candles. New lighting will be provided at the two existing gyms.

   Daylight dimming will be provided within 15 feet of skylights or glazing. Daylight dimming controls will be similar in operation to classrooms.

5. Corridor lighting will be comprised of linear indirect lighting using LED light source. The corridor light level will be designed for approximately 15 foot candles. Corridor lighting will be on time clock control and only “ON” during occupied hours. The corridor lighting will have two level controlled by schedule on DDC system. The existing Link Building lighting will be updated to recessed fluorescent with two level control.

6. Cafeteria lighting will be recessed indirect fluorescent fixtures with electronic ballasts. The light levels will be designed for approximately 20 foot candles. Daylighting controls will be provided on perimeter light fixtures with 15 feet of glazing.

7. House lighting in auditorium will be dimmable fluorescent and controlled by theatrical house dimming system.

8. Kitchen and servery lighting will consist of recessed 2’x4’ acrylic lensed gasketed troffers with aluminum frame doors with (3) T5 lamps and electronic ballasts. Light levels will be approximately 50 foot candles.

9. Media Center lighting will consist of pendant linear fixtures with T5 lamps and electronic ballasts. Light levels will be approximately 30 foot candles. The existing fixtures will not be re-used.

   Daylight dimming will be provided within 15 feet of skylights or glazing. Daylight dimming controls will be similar in operation to classrooms.

10. Each area will be locally switched and designed for multi-level controls. Each classroom, office space and toilet rooms will have an occupancy sensor to turn lights off when unoccupied. Daylight sensors will be installed in each room where natural light is available for dimming of light fixtures. The control system shall be in accordance with ***MA-CHPS and LEED for schools.***

11. The entire school will be controlled with an automatic lighting control system using the DDC control system for programming lights on & off.

C. Emergency Lighting System:

1. An exterior 75 kw diesel emergency generator with sound attenuated enclosure will be provided. Light fixtures and LED exit signs will be installed to serve all egress areas such as corridors, intervening spaces, toilets, stairs and exit discharge exterior doors. The administration area lighting will be connected to the emergency generator. The existing 160 kw diesel generator will be re-used for optional standby loads.

2. The generators will serve fire safety systems, boilers and circulating pumps, refrigeration equipment, communications systems, gym and cafeteria ventilation and heating, kitchen, etc.

D. Site Lighting System ***MA-CHPS Credit SC5-2***

1. Fixtures for area lighting will be pole mounted cut-off ‘LED’ luminaries in the parking area and roadways. Pole heights will be 20 feet. The exterior lighting will be connected to the automatic lighting control system for photocell on and timed off operation. The site lighting fixtures will be dark sky compliant. The illumination level is 0.5fc minimum for parking areas in accordance with Illuminating Engineering Society.

2. Building perimeter fixtures will be ‘LED’ wall mounted cut-off over exterior doors for exit discharge.

E. Wiring Devices:

1. Each classroom will have a minimum of (2) duplex receptacles per teaching wall and (2) double duplex receptacles on dedicated circuits at classroom computer workstations. The teacher’s workstation will have a double duplex receptacle also on a dedicated circuit.

2. Office areas will generally have (1) duplex outlet per wall. At each workstation a double duplex receptacle will be provided.

3. Corridors will have a cleaning receptacle at approximately 25 foot intervals.

4. Exterior weatherproof receptacles with lockable enclosures will be installed at exterior doors.

5. A system of computer grade panelboards with double neutrals and transient voltage surge suppressors will be provided for receptacle circuits.

6. Certain plug loads such as copiers, printers, electric water coolers will be controlled by the DDC system for shutdown on a schedule basis.

7. New computer grade receptacles will be provided in media center and classrooms in the Link Building.

F. Fire Alarm System:

1. A fire alarm and detection system will be provided with battery back-up. The system will be of the addressable type where each device will be identified at the control panel and remote annunciator by device type and location to facilitate search for origin of alarms.

2. Smoke detectors will be provided in open areas, corridors, stairwells and other egress ways.

3. The sprinkler system will be supervised for water flow and tampering with valves.

4. Speaker/strobes will be provided in egress ways, classrooms, assembly spaces, open areas and other large spaces. Strobe only units will be provided in single toilets and conference rooms.

5. Manual pull stations will be provided at exit discharge doors and at each egress stairwell not located at grade level.

6. The system will be remotely connected to automatically report alarms to fire department via an approved method by the fire department.

G. Lightning Preventor System:

1. A lightning preventor will be provided with 20’ high mast located on the roof. The system will be installed in accordance with manufacturer’s guidelines and will consist of early streamer emission air terminals, down conductors, ground rods, etc.

5. TESTING REQUIREMENTS

The Electrical Contractor shall provide testing of the following systems with the Owner and Owner’s representative present:

- Lighting and power panels for correct phase balance.
- Emergency generator.
- Lighting control system (interior and exterior).

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- Fire alarm system.
- Security system.

Testing reports shall be submitted to the engineer for review and approval before providing to the Owner.

6. OPERATION MANUALS AND MAINTENANCE MANUALS:

When the project is completed, the Electrical Contractor shall provide operation and maintenance manuals to the Owner.

7. RECORD DRAWINGS AND CONTROL DOCUMENTS:

When the project is completed, an as-built set of drawings, showing all lighting and power requirements from contract and addendum items, will be provided to the Owner.

8. COMMISSIONING

The project will be commissioned per Section 018100 of the specifications.

9. CCTV

A Closed Circuit TV system will consist of computer servers with image software, computer monitors and IP based closed circuit TV cameras. The head end server will be located in the head end MDF room and will be rack mounted. The system can be accessed from any PC within the facility or externally via an IP address. Each camera can be viewed independently. The network video recorders NVR's will record all cameras and store this information for 21days at 15 images per second (virtual real time).

The location of the cameras is generally on the exterior building perimeter. The exterior cameras are both fixed and pan-tilt-zoom type.

The system will fully integrate with the access control system to allow viewing of events from a single alarm viewer. Camera images and recorded video will be linked to the access system to allow retrieval of video that is associated with an event.

10. INTRUSION SYSTEM

An intrusion system will consists of security panel, keypads, motion detectors and door contacts. The system is addressable which means that each device will be identified when an alarm occurs. The system is designed so that each perimeter classroom with grade access will have dual tech sensors along the exterior wall and corridors, door contacts at each exterior door.
The system can be partitioned into several zones. Therefore, it is possible to use the Gym area while the remainder of the school remains alarmed.

The system will include a digital transmitter to summons the local police department in the event of an alarm condition

The intrusion system will be connected to the automated lighting control system to automatically turn on lighting upon an alarm.

11. CARD ACCESS

A card access system includes a card access controller, door controllers and proximity readers/keypads. Proximity readers will be located at various locations. Each proximity reader will have a distinctive code to identify the user and a log will be kept in memory. The log within the panel can be accessed through a computer.

The alarm condition will also initiate real time recording on the integrated CCTV System. The system may be programmed with graphic maps allowing the end-user to quickly identify alarm conditions and lock/unlock doors.

The system is modular and may be easily expanded to accommodate any additional devices.

12. PHASING

The Work will be conducted in several phases to provide the least possible interference to the activities of the School.

4.10 Information Technology

Please refer to attached information technology narrative from Garcia, Galuska, and DeSousa Consulting Engineers.

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Lincoln K-8 School
Lincoln, MA
J#320 005 00.00
L#35527/Page 1/June 7, 2012

TECHNOLOGY SYSTEMS

NARRATIVE REPORT

The following is the Technology System narrative, which defines the scope of work and capacities of the Communications system infrastructure and Security system as well as the Basis of Design.

1. CODES

   A. All work installed under Section 270000 shall comply with the Massachusetts Building Code and all local, county, and federal codes, laws, statues, and authorities having jurisdiction.

2. DESIGN INTENT

   A. All work is new and consists of furnishing all materials, equipment, labor, transportation, facilities, and all operations and adjustments required for the complete and operating installation of the Technology and Security work and all items incidental thereto, including commissioning and testing.

3. TECHNOLOGY

   A. The data system infrastructure will consist of fiber optic backbone cabling horizontal wiring will consist of Category 6 UTP cabling for both data and telephone systems for gigabit connectivity. CAT 6A will be utilized for wireless access node outlets. The telephone infrastructure will accommodate PBX, or VOIP based voice systems. The existing Avaya IP office telephone system will be re-used. The existing system will be completely updated included Link Building.

   B. Each classroom will have 4 data outlets for student computers. Two data, one voice with video and audio connections to a wall mounted projector will be provided at teacher's station with interconnectivity to a interactive whiteboard. A wall phone outlet with 2 way ceiling speaker will be provided for communications with administration. Clocks will be wireless, part of a GPS/LAN based centralized clock system. Wireless access points will be provided in all classrooms and other spaces.

   C. A central paging system will be provided and integrated with the telephone system.

   D. A wireless GPS/LAN based master clock system will be provided with 120V wireless remote clocks that act as transceivers.

   E. The Main Distribution Frame (MDF) will contain all core network switching and IP voice switch. Intermediate Distribution Frames (IDFs) will serve each floor/wing of the school. A fiber optic backbone will be provided from each IDF to MDF.

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4. TESTING REQUIREMENTS

A. The Technology and Security Contractors shall provide testing of the following systems with the Owner and Owner's representative present:

- Telephone and data cabling
- Fiber optic backbone cabling
- Paging system
- Wireless clock system
- A/V wiring for classrooms

Testing reports shall be submitted to the engineer for review and approval before providing to the Owner.

5. OPERATION MANUALS AND MAINTENANCE MANUALS:

A. When the project is completed, the Technology Contractor shall provide operation and maintenance manuals to the Owner.

6. RECORD DRAWINGS AND CONTROL DOCUMENTS:

A. When the project is completed, an as-built set of drawings, showing all lighting and power requirements from contract and addendum items, will be provided to the Owner.

7. COMMISSIONING

A. The project shall be commissioned per Commissioning Section of the specifications.

8. PHASING

A. The existing telephone, internet and cable-TV services will be slightly impacted by phasing.