Rochester School District
Primary Schools Space Study

Fall 2011
Comprehensive Report

LAVALLEE I BRENSINGER ARCHITECTS

The following report includes the assessments and recommendations for the Rochester School District's Pre-School through 8th Grade facilities as prepared during the summer of 2011. The information included in this report was created by Lavallee Brensinger Architects in cooperation with The Rochester School District, it's administrators, and the administrators at each of the Primary Schools considered. This document reflects assessments of the existing schools created through tours of each facility, interviews with school principals and assistant principals, building programming (based on current curriculum), current building codes, and NH State Education Standards.

Table of Contents

Project Goals

- This report shall seek to understand current space issues within the eight Rochester Elementary Schools and Rochester Middle School. It shall also recommend improvements to resolve any space issues encountered. To accomplish these goals, this project shall:

1. Analyze all classroom spaces at eight elementary schools and the Rochester Middle School.
2. Provide an educational needs analysis for each school based on their current curriculum and operations.
3. Understand the need for full size 900 square feet classroom spaces and which classrooms are currently undersized by NH Department of Education standards.
4. Understand the need for Core Education Areas including art, physical education, music, library, and cafeteria areas at each building.
5. Understand the need for Special Education and Intervention space at each building.
6. Understand the need for professional/staff/faculty areas within each school.
7. Build upon previous studies which analyzed life safety and building code issues (including accessibility).
8. Understand the current space utilization at each school.
9. Understand current site planning issues as each school including traffic flow, parking, and outdoor student space.
10. Identify apparent interior environment issues affecting education areas such as acoustics, comfort (temperature), daylighting, and air quality.
11. Propose improvements to each school resolving identified issues, including:
    a. Possible changes in the space use (organization)
    b. Possible modifications to the spaces within each building (renovations)
    c. Possible additions to each school (eliminate portable classrooms)
    d. Possible site improvements at each school
12. Create an educational facilities Master Plan for the district. This may be used to develop an asset protection plan and a five year Capital Improvement Plan for the district.

Process

- In order to ensure an accurate assessment of the current education space needs, Lavallee Brensinger Architects pursued a specific approach:

  - Understood Educational Goals for the Rochester School District's primary schools
  - Understood population trends within Rochester for school planning
  - Interviewed current School Administrators to understand current and foreseeable needs and short-comings of existing facilities
  - Evaluated Existing Facilities in terms of educational goals and current and foreseeable needs
  - Identified facility needs and priorities
  - Provided options and strategies to meet these needs
  - Worked with Rochester School Department to develop an implementation plan for facilities rejuvenation
  - Created Rochester School District primary schools Facility Master Plan

Resources

- Information for this report was gathered from several sources including the following:

  - Michael Hopkins, Superintendent of Schools, Rochester School Department
  - Richard Bickford, Facilities Director, Rochester School Department
  - Vallerie McKenney, Principal Rochester Middle School
  - Chris Foley, Principal William Allen School
  - Maureen Oakman, Principal Nancy Loud School
  - Steve LeClair, Principal Chamberlain School
  - Colby Troidl, Principal East Rochester School
  - Gwen Rhodes, Principal Gonic School
  - Robin Brown, Principal Maple Street School
  - Arlene Walker, Principal McClelland School
  - Nancy Booth, Principal School Street School
  - Miscellaneous School Staff encountered during tours
  - Lance Whitehead, Lavallee Brensinger Architects
  - Chris Drobat, Lavallee Brensinger Architects

- Additionally, previous reports and data gathered by the school district were also considered. Reports and information included:
  - Facility Needs Study dated 2002
  - Current utility consumption data
  - Special Education Study dated 2011
  - Capital Improvement Plans for 2012 and 2013
  - Capital Improvements accomplished 2003-current
  - Honeywell Efficiency Study dated 2002
  - School Enrollment Projections dated 2008
  - City of Rochester GIS data currently available online through City of Rochester

Existing Assessment

Existing Building Condition

The Chamberlain Street school is a 1961 School (originally a Junior High School) with Kindergarten additions erected in 2000. The exterior envelope is in good condition and provides for a comfortable interior environment. No comfort issues within classroom areas were reported by staff. Interior finishes are in generally good condition and appear to be well maintained. Lighting fixtures throughout the classrooms are direct T8 fluorescent (inefficient compared to today's standards) and should be scheduled for replacement. There are three portable structures on site, housing 4 classrooms and 1 intervention space.

Existing Site

Parking appears adequate for school hours, and drop-off area for busses works well. Queuing for parent drop off was reported to back up onto Chamberlain Street, causing some traffic issues. Outdoor athletics and play space are adequate and appropriately located for student access.

Safety, Security and Code Compliance

The front entrance is not supervisable due to configuration and lines of sight, resulting in a poorly secured facility. Administration noted that they would also like to be able to supervise their secondary entrance adjacent to the Kitchen and Multi-Purpose room. This entrance is used for deliveries during the day, school staff, and students using parent drop-off and pick up.
Accessibility issues include no accessible access to areas on and adjacent to the stage. These areas are currently being used for Guidance, English Speakers of other Languages, Music (on stage), and the school counselor

Acoustics and Daylighting

Classroom acoustics and daylighting are adequate. Poor acoustic separation was noted at the Guidance area, being adjacent to the stage, and within the resource room for behaviorally impaired students.

Programming / Space Needs

Overview of Space Needs

The Chamberlain Street school is lacking both education areas as well as core areas, as is evident by the use of Portable Structures. The school is currently lacking the following spaces:

- Student Rest rooms
- Staff/Adult Rest rooms
- Art Classroom (currently provide art-on-a-cart)
- Music Classroom (currently offered on stage which has no acoustic separation from MP room making music instruction difficult)
- Conference rooms
- Storage Space
- Computer Labs (Current CPU lab is undersized)
- Guidance Office (Current office is not in accessible location)
- ESOL Area (Current area is undersized and not in accessible location)
- 5th Grade Classrooms (Currently in Portable)
- Intervention Space (One currently in Portable)
- Speech areas (Currently taking space from the Library)
- Additional appropriately sized Kindergarten room (currently converted one from a former classroom)
- Potentially one more 1st grade classroom (bordering on needing another based on population)

Lack of storage should be addressed for general school supplies, art supplies, and technology equipment. Above photo is of only storage room in building housing all three.

A former classroom is used as a Resource room, Special education area, and Intervention spaces. Administrators noted this open flexible concept works well, if they had more.

Programming / Space Needs Calculations

Chamberlain School Program Based on Enrollment

Education Program Areas

Course/Subject	# Students	Max Students/ Teaching Space	Utilization (90%)	# of Sections	Offered	Required Teaching Spaces (adjusted)	Number of Appropriately sized spaces in existing building	Required additional spaces	Notes
Kindergarten	46	18	0.90	2.84	Full Day	**3**	3	0	
1st Grade	66	20	0.90	3.67	Full Day	**4**	3	1	3 Classrooms would be adequate at 22 students/class
2nd Grade	56	21	0.90	2.96	Full Day	**3**	3	0	
3rd Grade	58	21	0.90	3.07	Full Day	**3**	3	0	
4th Grade	67	25	0.90	2.98	Full Day	**3**	3	0	
5th Grade	75	25	0.90	3.33	Full Day	**4**	0	4	Excludes Portables
Total Enrollment	368					**20**			

Core Program Areas

Space	Student Access Per week (periods)	# of Students Served	# of Classes/wk	Calculated SF of Space (Per Standards)	Periods per week Offered***	# Spaces Required	Number of Appropriately sized spaces in existing building (or size of existing space)	Required additional spaces	Notes
Computer Lab	1	368	20		30	**1**	0	1	CPU lab is undersized. Possible convert to other use.
Art	1	322	20		30	**1**	0	1	
Music	1	322	17		30	**1**	0	1	Stage not counted since it is not acoustically sealed for Instruction
Physical Education	1	322	20		15	**2**	1	1	Could be satisfied through dividing curtain
Media Center	1	368	20	1472	30	**1**	1121	351	Net Square Feet
Cafeteria	5	368	20	1380	15	**2**	4640	-3260	Net Square Feet
Special Education Student Areas*	5	85	212		30	**8**	8	0	Calculations assume 2 students/area
Intervention / Small Group Areas**	5	92	153		30	**6**	5	1	Calculations assume 3 students/area
Professional Areas								7	(1) Conference Room for 12 , (1) accessible Guidance Office, (2) Speech rooms, (1) accessible Councelor Office, (1) accessible ESOL office, (1) Guidance Meeting area for 4

* 23% of students identified to receive special services by District Special Education .

** 25% of students identified to receive Tier 2 or Tier 3 Intervention (Title 1) instruction

*** Standard 8 period day, allowing for no specials during first and last periods.

Dept of Ed allowable:	Age Group	Enrollment	SF/Pupil	Utilization	Total Building (NSF)	
For New Construction	Grade 1-5	322	120	0.90	42,933	
	Kindergarten - Trans	46	150	0.90	7,667	
					50,600	Total Allowable by NH DOE standards for new construction

Existing Analysis / Capacity

Current Enrollment	**368**	
Current Building Size (gsf)	39,382	Excluding Portables
Estimated Building Capacity Based solely on size of building	Based on Average NH School Construction of 120sf/student for Grades 1-5 and 150sf/student in K @ 90% Utilization: 284	Students

	# Classrooms*	Max Seats/ Classroom **	Utilization (90%)	Utilized Seats	Theoretical Student Capacity	
Education Areas Capacity	12	22	0.9	237.6	**238**	
Specialty Classrooms (Art.Music, Cpu, Etc)	3	20	0.9	54		See notes below
Current Utilization / Capacity					**154.88%**	

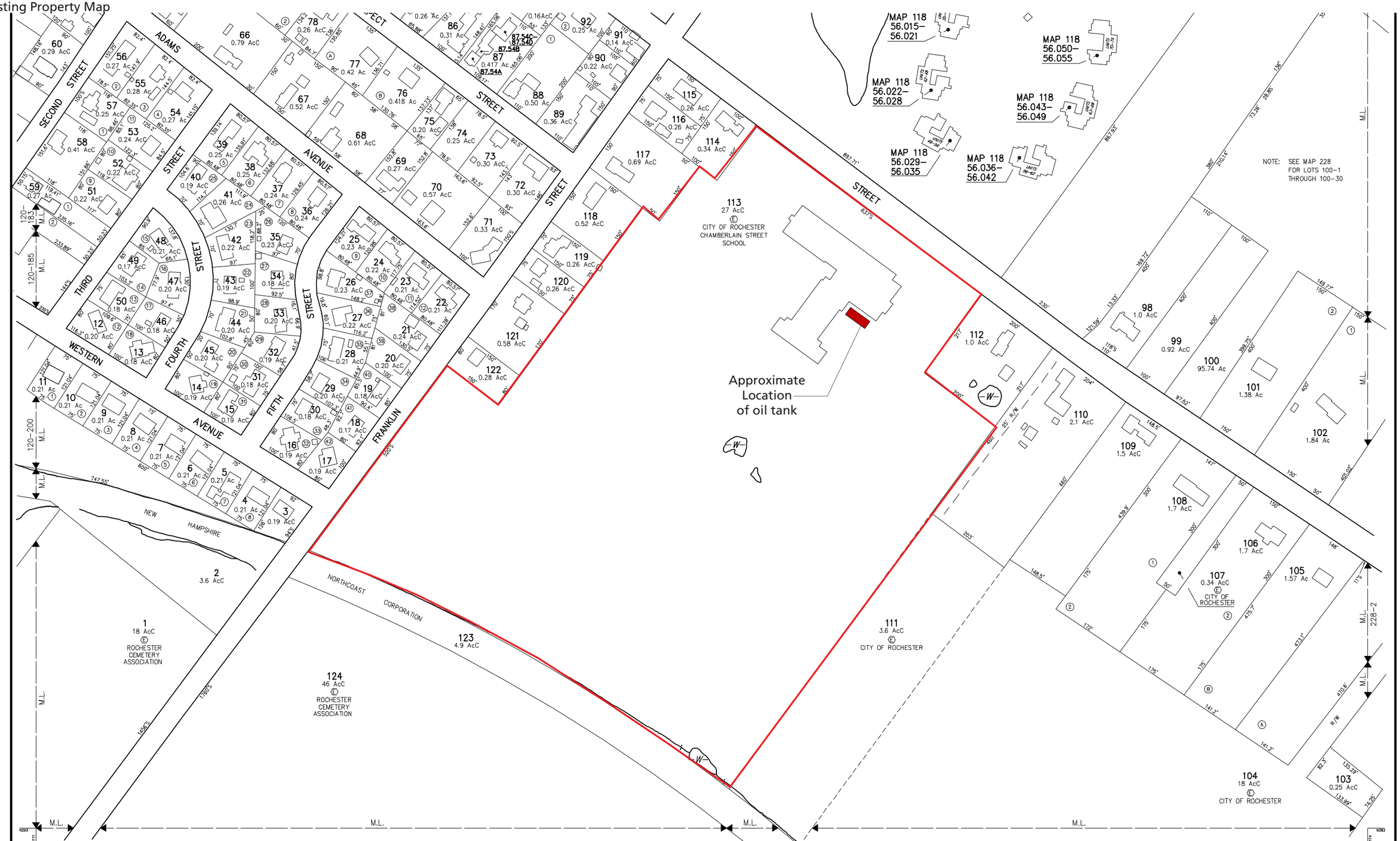
*Currently, there are 15 Homerooms. Deduct one each for the following: Art, CPU Lab, Intervention

** Averaging K-2 Class Sizes (16 for Kindergarten, 24 for Grades 1 and 2)

*** Standard 8 period day, allowing for no specials during first and last periods.

Core Capacity	Size of Area (sf)	Appropriately Sized?	Seats/persons	Utilization (90%)	Periods per week Offered***	Theoretical Student Capacity	
Art	760	N	22	0.9	30	594	Slightly Undersized Area - If restored from a classroom
Music	760	N	22	0.9	30	594	Slightly Undersized Area - If restored from a classroom
Media Center	1121	N	ed @ Students x .10 x 40 sf			280	
Gymnasium	4640	Y	44	0.9	15	594	If Gym allows 2 classes/period
CPU Lab	540	N	22	0.9	30	594	
Cafeteria	4640	Y	258	0.9	15	696	Shared Café-Gym

Existing Property Map



THIS MAP IS FOR ASSESSMENT PURPOSES. IT IS NOT VALID FOR LEGAL DESCRIPTION OR CONVEYANCE.

THE HORIZONTAL DATUM IS THE NEW HAMPSHIRE STATE PLANE COORDINATE SYSTEM.

PHOTOGRAPHY DATE: APRIL 28, 1990

COMPLETION DATE: JUNE 30, 1992

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LEGEND

AREA SURVEYED . . . . . Ac
AREA CALCULATED . . . . . AcC
RECORD DIMENSION . . . . . 100'
SCALED DIMENSION . . . . . 100'S
MATCH LINE . . . . . M.L.
WATER . . . . . -W-

EXEMPT PROPERTY. . . . . (E)
SUBDIVISION LOT NO. . . . . (2)
BUILDING . . . . . ☐
RIGHT OF WAY. . . . . R/W
COMMON OWNERSHIP. . . . . OR
WETLANDS . . . . . ⚘

SCALE 1" = 100'
FEET 50 0 100 200 300
METERS 25 0 25 50 75

REVISED TO : APRIL 1, 2010

PROPERTY MAPS
ROCHESTER
NEW HAMPSHIRE

INDEX DIAGRAM
117 118 228
120
125 126 239
GN N

MAP NO.
119

Chamberlain Street School

Existing Assessment

Undersized Classroom

Note: These classrooms cannot feasibly be expanded to 900sf standards. To meet NH DOE standards of 36sf per student, each of these classrooms should be limited to 21 students

Speech room reduces Library Space (poorly located)

Lacking Art Classroom

These areas non-accessible and suffer from poor acoustic separation

Lacking Music Classroom (stage lacks acoustic separation).

Lack of restrooms for both students adults

Lack administrative conference rooms

Poor lines of site create a non-super-visable entrance

- CIRCULATION
- CLASSROOMS
- SPECIAL EDUCATION / INTERVENTION
- SPECIALTY CLASSROOMS
- STAFF / FACILITY
- SUPPORT

Recommended Improvements

Aerial Site - Courtesy of Bing Maps

Existing Assessment

Existing Assessment

Existing Building Condition

The Nancy Loud school (also known as the East Rochester Annex) is an 1880 School with stair tower additions serving the Multi-Purpose room erected recently. The exterior envelope is in good condition and provides for a comfortable interior environment. While the Main and Upper floors are comfortable environments, the basement is damp and lacking both fresh air and natural light (typical of basement space). Interior finishes are classic materials and are in generally good condition (it should be noted that the wood frame and flooring creates squeaky floors which is not reported to be an issue here). Lighting fixtures throughout the classrooms are direct T8 lensed fluorescent (inefficient compared to today's standards) and should be scheduled for replacement to improve light quality and energy efficiency.

Existing stairs original to the building have wood handrails which are not compliant with current codes (for graspability and height). They appear to be functioning adequately at this time, however, replacement of these handrails should be considered as part of any major renovation. Stairs from the first floor to the basement are quite steep, exceeding current code in terms of riser height. Elimination of student access to the basement area would deem these stairs adequate for storage access.

Existing Site

Parking was noted as adequate for school hours, as was parent drop off. The drop-off area for busses is approximately 200 feet from the primary entrance, however was reported to work well during summer months. It was noted that the walking path from the bus drop off to the school during the winter months was poorly maintained. This path should re-graded and provided with a maintainable surface. Outdoor athletics and play space are dirt surfaced and contain several timbers addressing minor grade changes.

Safety, Security and Code Compliance

The front entrance is not immediately supervisable due to configuration and lines of sight, however, Administration noted that this has not been an issue for them, being such a small school. The existing building does not lend itself toward creating an entrance which is easily supervisable by the main office through minor renovations. Major additions or improvements to this school should seek to address this to provide a secure environment.

This school does not have an elevator and is therefore non-accessible. Furthermore, rest rooms are not accessible by current standards. Any major improvement or addition to this school should include an elevator and an accessible rest room open to both students and faculty.

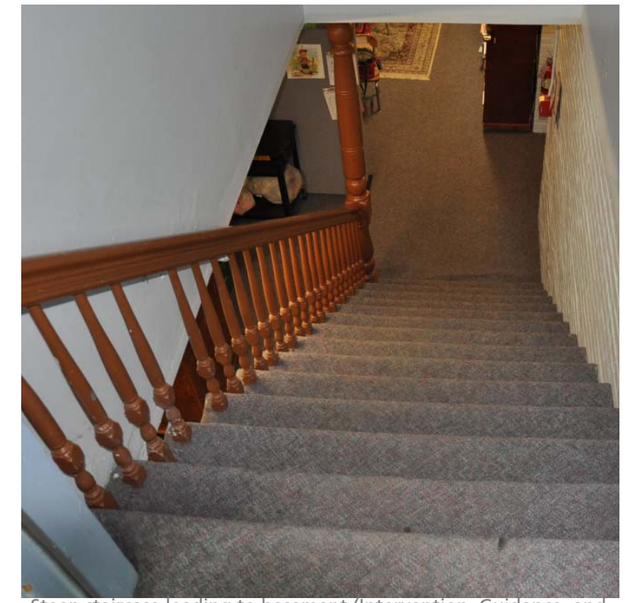
Acoustics and Daylighting

Classroom acoustics good, having suspended ceilings and carpet in many rooms, with the only complaint being that of creaky floors. Daylighting is excellent with high ceilings and large windows throughout (characteristic of historic schools).

Programming / Space Needs

Overview of Space Needs

While sizes of existing classrooms and corridors throughout the Nancy Loud school are excellent (characteristic of a historic school of this vintage), with the exception of the Kindergarten Classroom, the school lacks enough education areas, preventing it from becoming a K-5 School similar to other schools in the district. To achieve educational goals and equality as a K-5, the Nancy Loud School would need to add:



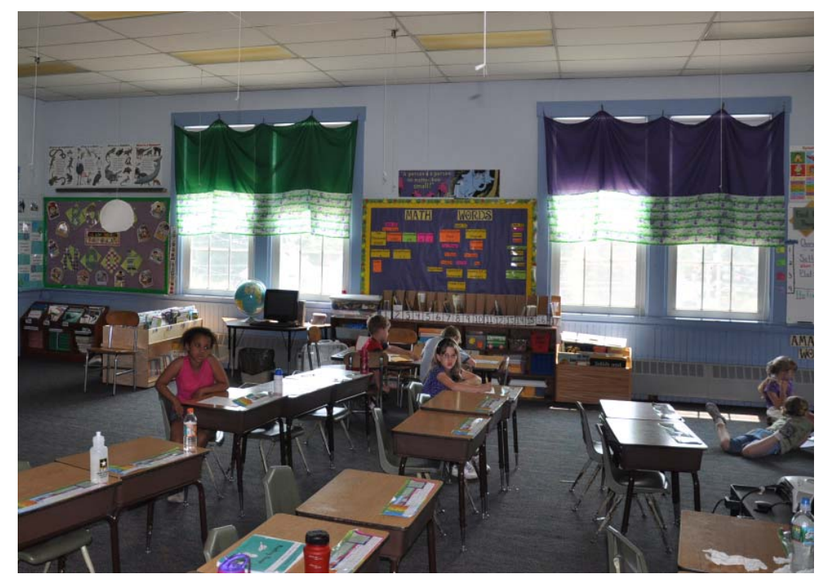
Steep staircase leading to basement (Intervention, Guidance, and Speech Therapy)

Programming / Space Needs (con'd)

- Potential Kindergarten Classroom (allowing re-purpose of current space for other listed needs)
- 4th grade Classroom
- 5th grade Classroom
- Shared Specialty Room for Art, Music, Chorus, and Computer Lab
- Intervention spaces (these are currently located in the basement and were being provided within the stairwells and corridors prior to the Fire Marshal's visit)**.
- Guidance and Speech Area (currently located in the basement)**
- Nurse / Health Office **
- Accessible rest rooms**
- Accessible means to access all floors (elevator and entrance ramp)**
- Media Center/Library Space**

** These improvements should be considered even without moving to a K-5 model.

The basement intervention space also houses storage of classroom supplies, serves as access to storage and mechanical areas and guidance, and is little more than a re-purposed corridor.



Nicely proportioned classrooms.

Nancy Loud School Program Based on Enrollment

Education Program Areas

Course/Subject	# Students	Max Students/ Teaching Space	Utilization (90%)	# of Sections	Offered	Required Teaching Spaces (adjusted)	Number of Appropriately sized spaces in existing building	Required additional spaces	Notes
Kindergarten	19	18	0.90	1.17	Full Day	**1**	0	1	1 K Classroom undersized
1st Grade	23	20	0.90	1.28	Full Day	**2**	2	0	1 Classrooms would be adequate at 23 students/class
2nd Grade	33	22	0.90	1.67	Full Day	**2**	2	0	
3rd Grade	20	22	0.90	1.01	Full Day	**1**	1	0	
4th Grade (future)	24	25	0.90	1.07	Full Day	**1**	0	1	Future 4th grade would require additional classroom
5th Grade (future)	24	25	0.90	1.07	Full Day	**1**	0	1	Future 5th grade would require additional classroom
Total Enrollment	143					**8**			

Core Program Areas

Space	Student Access Per week (periods)	# of Students Served	# of Classes/wk	Calculated SF of Space (Per Standards)	Periods per week Offered***	# Spaces Required	Number of Appropriately sized spaces in existing building (or size of existing space)	Required additional spaces	Notes
Computer Lab	1	143	8		30	**0.21**	0	0	Can continue shared use of MP room if no more classes are added (6 classroom max for a single shared room). Addition of more classes would require (1) additional shared specialty classroom for Art, Music, Chorus, and Computers
Art	1	124	8		30	**0.24**	0	0	
Music	1	124	7		30	**0.24**	0	1	
Physical Education	1	124	8		15	**1**	1	0	
Media Center	1	143	8	572	30	**1**	0	572	Net Square Feet
Cafeteria	5	143	20	536	15	**2**	1857	0	Net Square Feet
Special Education Student Areas*	5	33	82		30	**3**	0	3	Calculations assume 2 students/area
Intervention / Small Group Areas**	5	36	60		30	**2**	0	2	Calculations assume 3 students/area
Professional Areas								6	(1) Speech, (1) Guidance, (1) Reading Specialist, (1) Spec Education, (1) testing area, (1) Nurse/Health Office

* 23% of students identified to receive special services by District Special Education .

** 25% of students identified to receive Tier 2 or Tier 3 Intervention (Title 1) instruction

*** Standard 8 period day, allowing for no specials during first and last periods.

Dept of Ed allowable:	Age Group	Enrollment	SF/Pupil	Utilization	Total Building (NSF)	
For New Construction	Grade 1-5	124	144	0.90	19,840	
	Kindergarten - Trans	19	150	0.90	3,167	
					23,007	Total Allowable by NH DOE standards for new construction

Existing Analysis / Capacity

Current Enrollment	**95**	
Current Building Size (gsf)	15,870	Excluding Basement (7935 total - 500 sf used now for education)
Estimated Building Capacity Based solely on size of building	Based on Average NH School Construction of 144sf/student for Grades 1-5 and 150sf/student in K @ 90% Utilization: 99	

	# Classrooms*	Max Seats/ Classroom **	Utilization (90%)	Utilized Seats	Theoretical Student Capacity	
Education Areas Capacity	5	22	0.9	99	**99**	
Specialty Classrooms (Art.Music, Cpu, Etc)	0	22	0.9	0		See notes below
Current Utilization / Capacity					**95.96%**	

*Currently, there are 6 Homerooms. Deduct one for the special education, speech, guidance.

** Averaging K-5 Class Sizes (16 for Kindergarten, 24 for Grades 1 through 5)

*** Standard 8 period day, allowing for no specials during first and last periods.

Core Capacity	Size of Area (sf)	Appropriately Sized?	Seats/persons	Utilization (90%)	Periods per week Offered***	Theoretical Student Capacity	
Art	0	N	22	0.9	30	99	If all in Multi-purpose room
Music	0	N	22	0.9	30	99	If all in Multi-purpose room
Media Center	0	N	ed @ Students x .10 x 40 sf			0	None
Gymnasium	1857	Y	44	0.9	15	99	If all in Multi-purpose room
CPU Lab	0	N	22	0.9	30	99	If all in Multi-purpose room
Cafeteria	1857	Y	103	0.9	15	278.55	

Note: This programming shown reflects creating K-5 School (existing K-3)

Nancy Loud School Program Based on Enrollment

Education Program Areas

Course/Subject	# Students	Max Students/ Teaching Space	Utilization (90%)	# of Sections	Offered	Required Teaching Spaces (adjusted)	Number of Appropriately sized spaces in existing building	Required additional spaces	Notes
Kindergarten	19	18	0.90	1.17	Full Day	**1**	0	1	1 K Classroom undersized
1st Grade	23	20	0.90	1.28	Full Day	**2**	2	0	1 Classrooms would be adequate at 23 students/class
2nd Grade	33	22	0.90	1.67	Full Day	**2**	2	0	
3rd Grade	20	22	0.90	1.01	Full Day	**1**	1	0	
4th Grade	0	25	0.90	0.00	Full Day	**0**	0	0	Future 4th grade would require additional classroom
5th Grade	0	25	0.90	0.00	Full Day	**0**	0	0	Future 5th grade would require additional classroom
Total Enrollment	95					**6**			

Core Program Areas

Space	Student Access Per week (periods)	# of Students Served	# of Classes/wk	Calculated SF of Space (Per Standards)	Periods per week Offered***	# Spaces Required	Number of Appropriately sized spaces in existing building (or size of existing space)	Required additional spaces	Notes
Computer Lab	1	95	6		30	**0.32**	0	0	Can continue shared use of MP room if no more classes are added (6 classroom max for a single shared room)
Art	1	76	6		30	**0.39**	0	0	
Music	1	76	5		30	**0.39**	0	0	
Physical Education	1	76	6		15	**1**	1	0	
Media Center	1	95	6	380	30	**1**	0	380	Net Square Feet
Cafeteria	5	95	20	356	15	**0.16**	1857	0	Net Square Feet
Special Education Student Areas*	5	22	55		30	**2**	0	2	Calculations assume 2 students/area
Intervention / Small Group Areas**	5	24	40		30	**2**	0	2	Calculations assume 3 students/area
Professional Areas								6	(1) Speech, (1) Guidance, (1) Reading Specialist, (1) Spec Education, (1) testing area, (1) Nurse/Health Office

* 23% of students identified to receive special services by District Special Education .

** 25% of students identified to receive Tier 2 or Tier 3 Intervention (Title 1) instruction

*** Standard 8 period day, allowing for no specials during first and last periods.

Dept of Ed allowable:	Age Group	Enrollment	SF/Pupil	Utilization	Total Building (NSF)	
For New Construction	Grade 1-3	76	144	0.90	12,160	
	Kindergarten - Trans	19	150	0.90	3,167	
					15,327	Total Allowable by NH DOE standards for new construction

Existing Analysis / Capacity

Current Enrollment	**95**	
Current Building Size (gsf)	15,870	Excluding Basement (7935 total - 500 sf used now for education)
Estimated Building Capacity Based solely on size of building	Based on Average NH School Construction of 144sf/student for Grades 1-5 and 150sf/student in K @ 90% Utilization: 99	

	# Classrooms*	Max Seats/ Classroom **	Utilization (90%)	Utilized Seats	Theoretical Student Capacity	
Education Areas Capacity	5	22	0.9	99	**99**	
Specialty Classrooms (Art.Music, Cpu, Etc)	0	22	0.9	0		See notes below
Current Utilization / Capacity					**95.96%**	

*Currently, there are 6 Homerooms. Deduct one for the special education, speech, guidance.

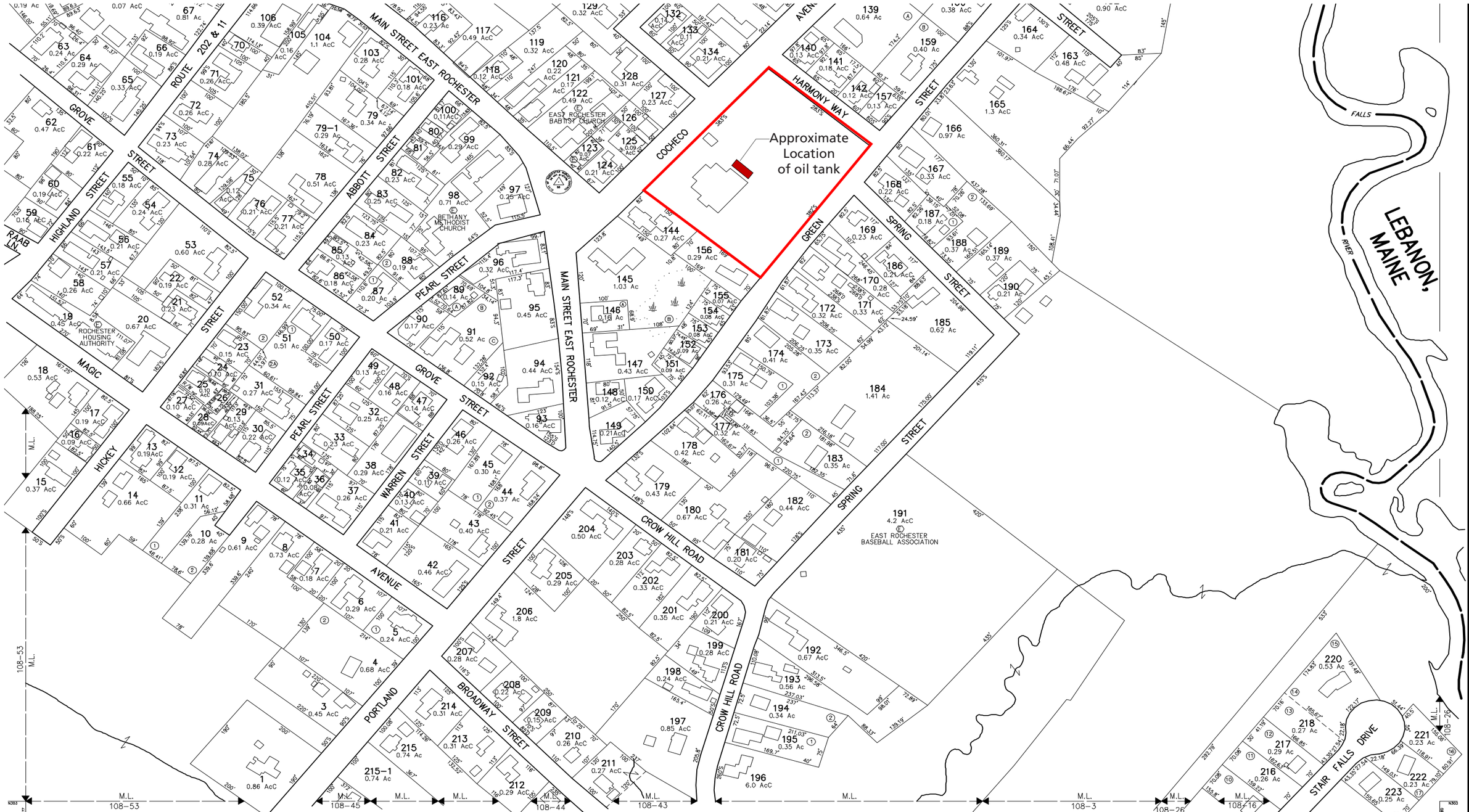
** Averaging K-5 Class Sizes (16 for Kindergarten, 24 for Grades 1 through 5)

*** Standard 8 period day, allowing for no specials during first and last periods.

Core Capacity	Size of Area (sf)	Appropriately Sized?	Seats/persons	Utilization (90%)	Periods per week Offered***	Theoretical Student Capacity	
Art	0	N	22	0.9	30	99	If all in Multi-purpose room
Music	0	N	22	0.9	30	99	If all in Multi-purpose room
Media Center	0	N	ed @ Students x .10 x 40 sf			0	None
Gymnasium	1857	Y	44	0.9	15	99	If all in Multi-purpose room
CPU Lab	0	N	22	0.9	30	99	If all in Multi-purpose room
Cafeteria	1857	Y	103	0.9	15	278.55	

Note: This programming shown reflects Maintaining K-3 School

Existing Property Map



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LEGEND

AREA SURVEYED . . . . . Ac
AREA CALCULATED . . . . . AcC
RECORD DIMENSION . . . . . 100'
SCALED DIMENSION . . . . . 100'S
MATCH LINE . . . . . M.L.
WATER . . . . . -W-

EXEMPT PROPERTY . . . . . (E)
SUBDIVISION LOT NO. . . . . (2)
BUILDING . . . . . .
RIGHT OF WAY . . . . . R/W
COMMON OWNERSHIP . . . . . OR
WETLANDS . . . . . .

SCALE 1" = 100'
FEET 50 0 100 200 300
METERS 25 0 25 50 75

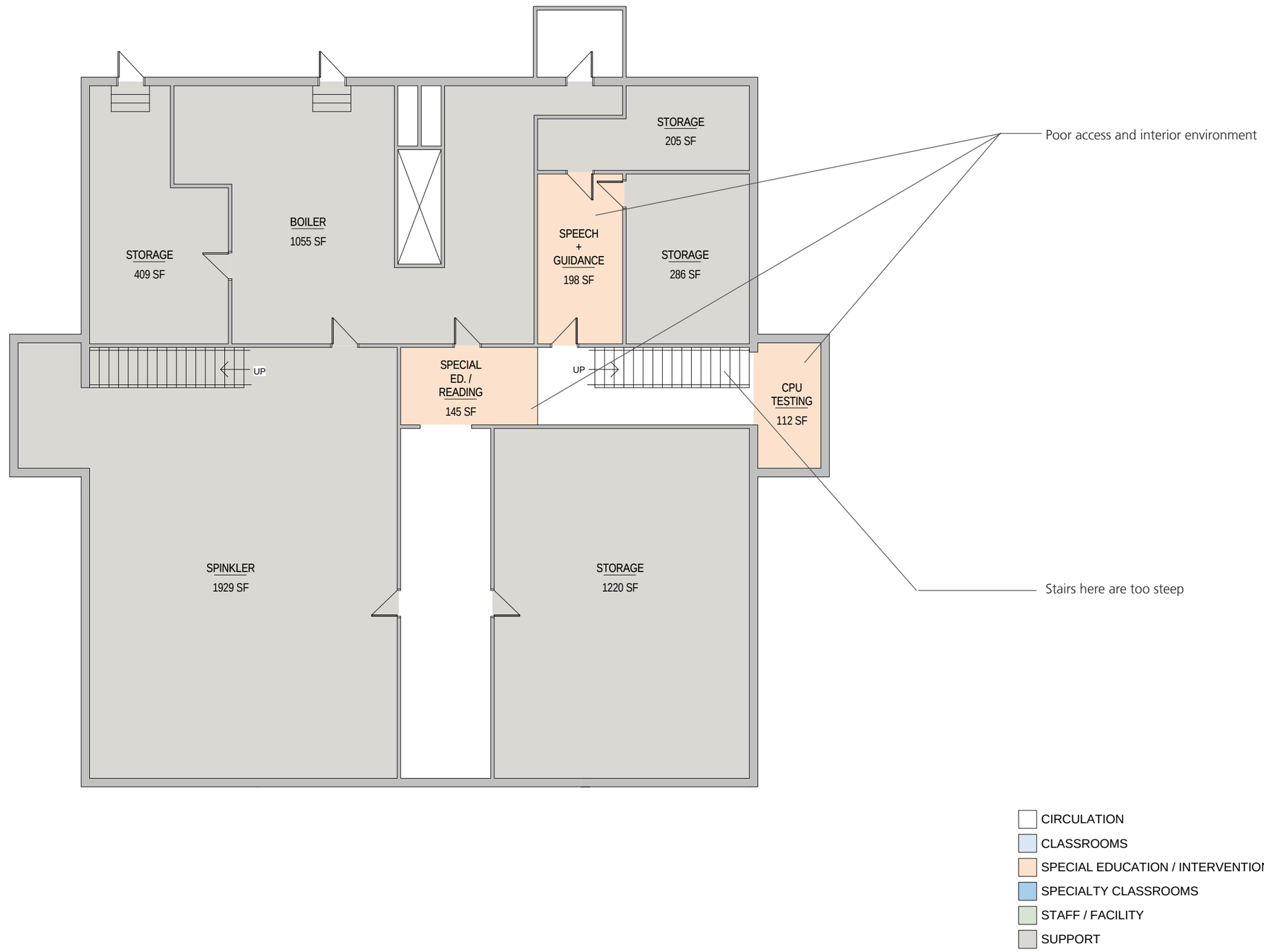
REVISED TO : APRIL 1, 2010

PROPERTY MAPS
ROCHESTER
NEW HAMPSHIRE

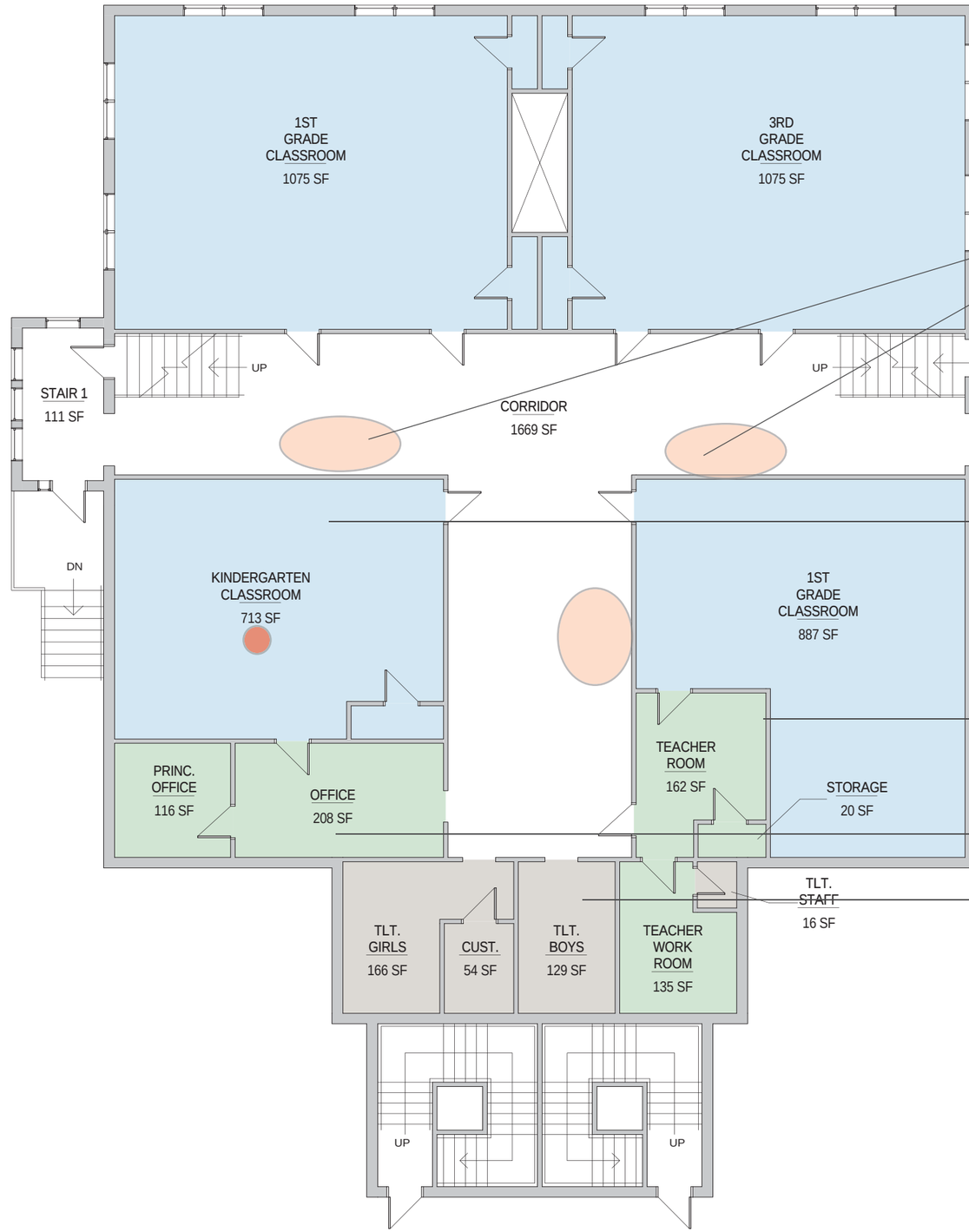
INDEX DIAGRAM
101 102 212
104 213
107 108

MAP NO.
103

Existing Assessment - Basement



Existing Assessment - Main Level



Undersized Classroom

Note: some classrooms shown here are undersized by NH DOE standards of 900sf, however, do meet standards for requirement of 36sf per student.

Formerly used as Intervention Space (stopped per Fire Marshal orders

Until additional space is created, Nancy Loud School should consider swapping this room with the 1st grade classroom across the corridor as Kindergarten rooms should be larger by DOE standards than typical classrooms. If used as 1st Grade, this room will still be undersized, but closer to the recommended standard.

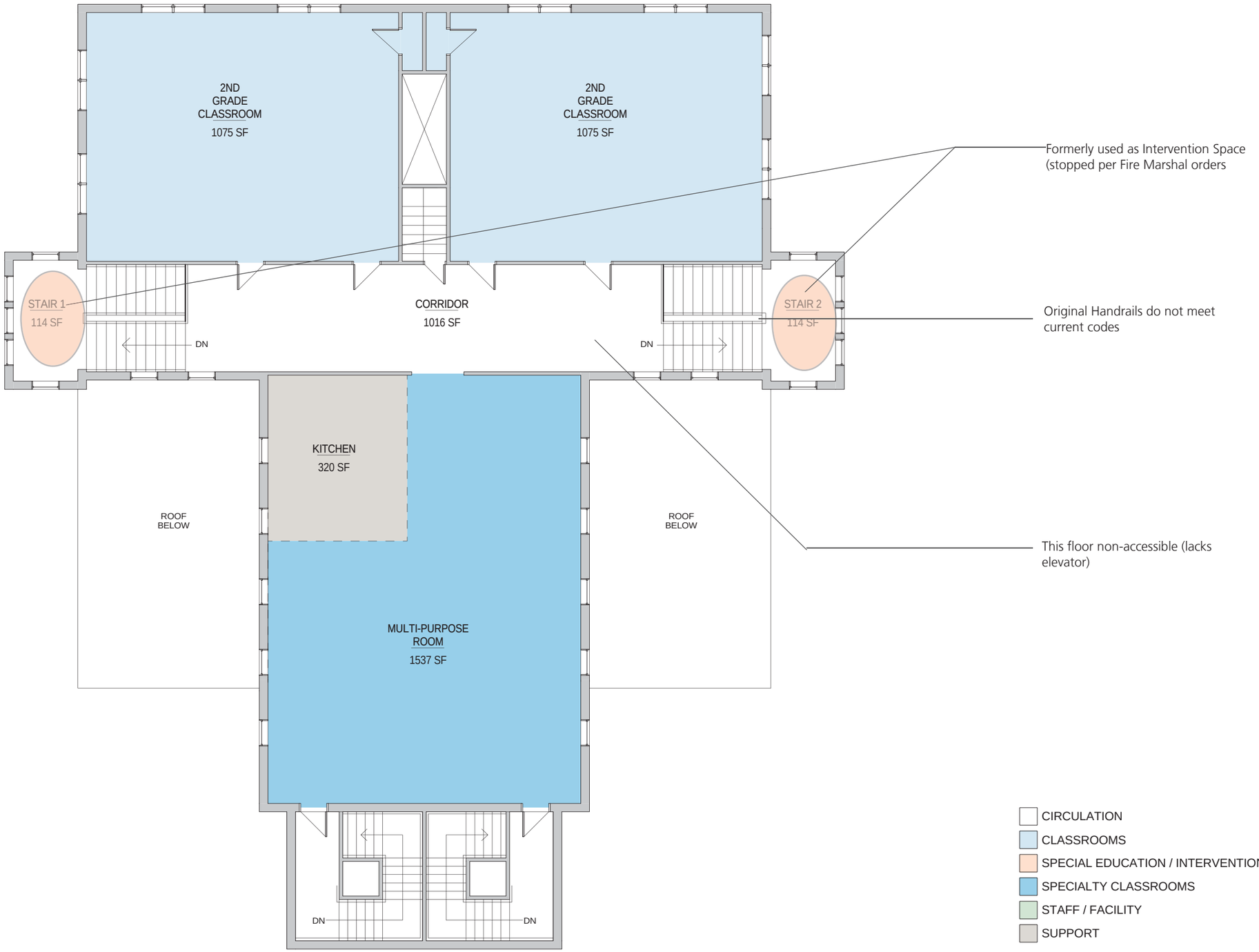
This area lacks acoustic separaton as walls are not full height

Office is poorly located to maintain a secure supervisable entrance

Accessibility issues include lack of elevator access as well as accessible restrooms

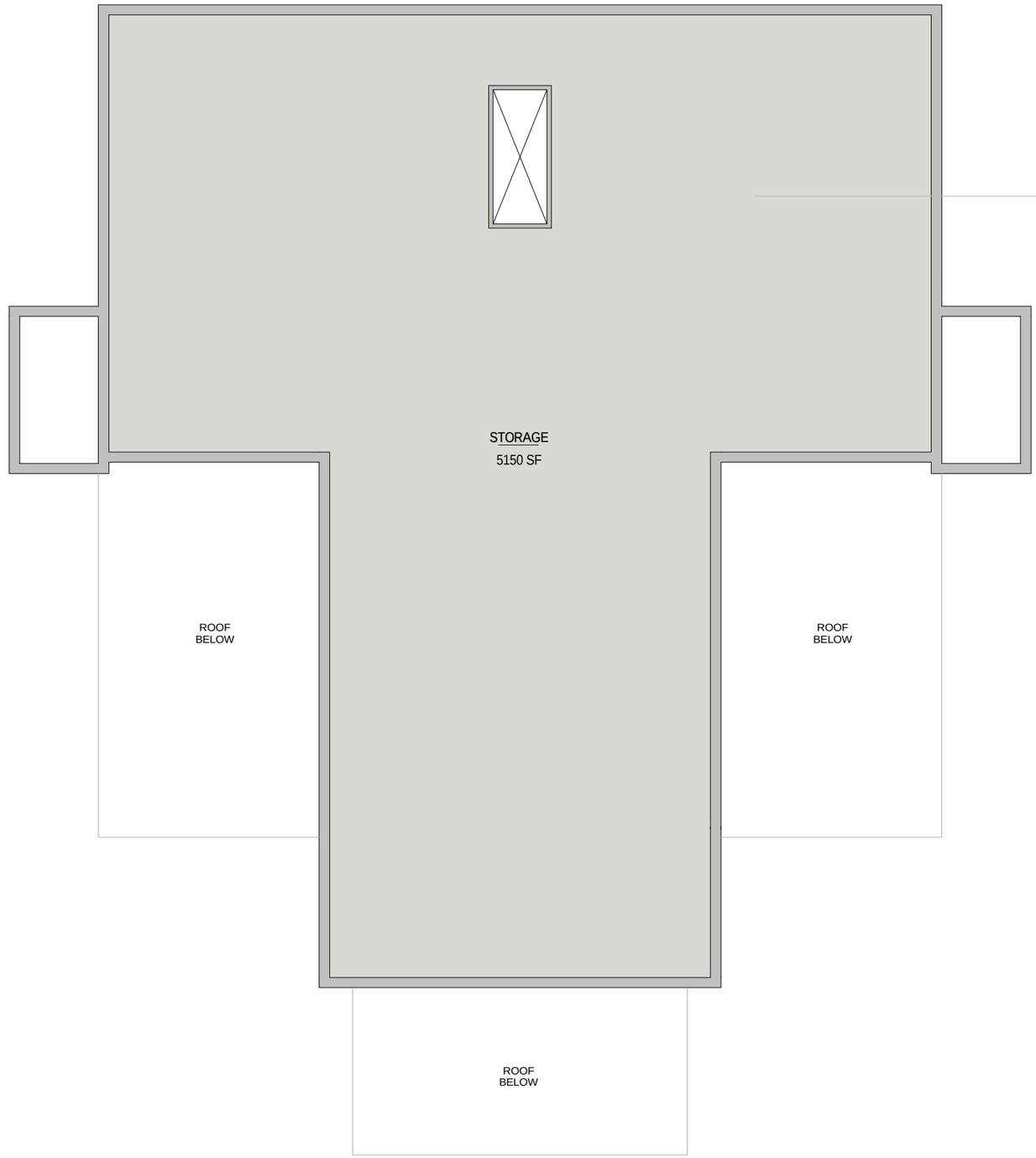
- CIRCULATION
- CLASSROOMS
- SPECIAL EDUCATION / INTERVENTION
- SPECIALTY CLASSROOMS
- STAFF / FACILITY
- SUPPORT

Existing Assessment - Level 2



- CIRCULATION
- CLASSROOMS
- SPECIAL EDUCATION / INTERVENTION
- SPECIALTY CLASSROOMS
- STAFF / FACILITY
- SUPPORT

Existing Assessment - Attic



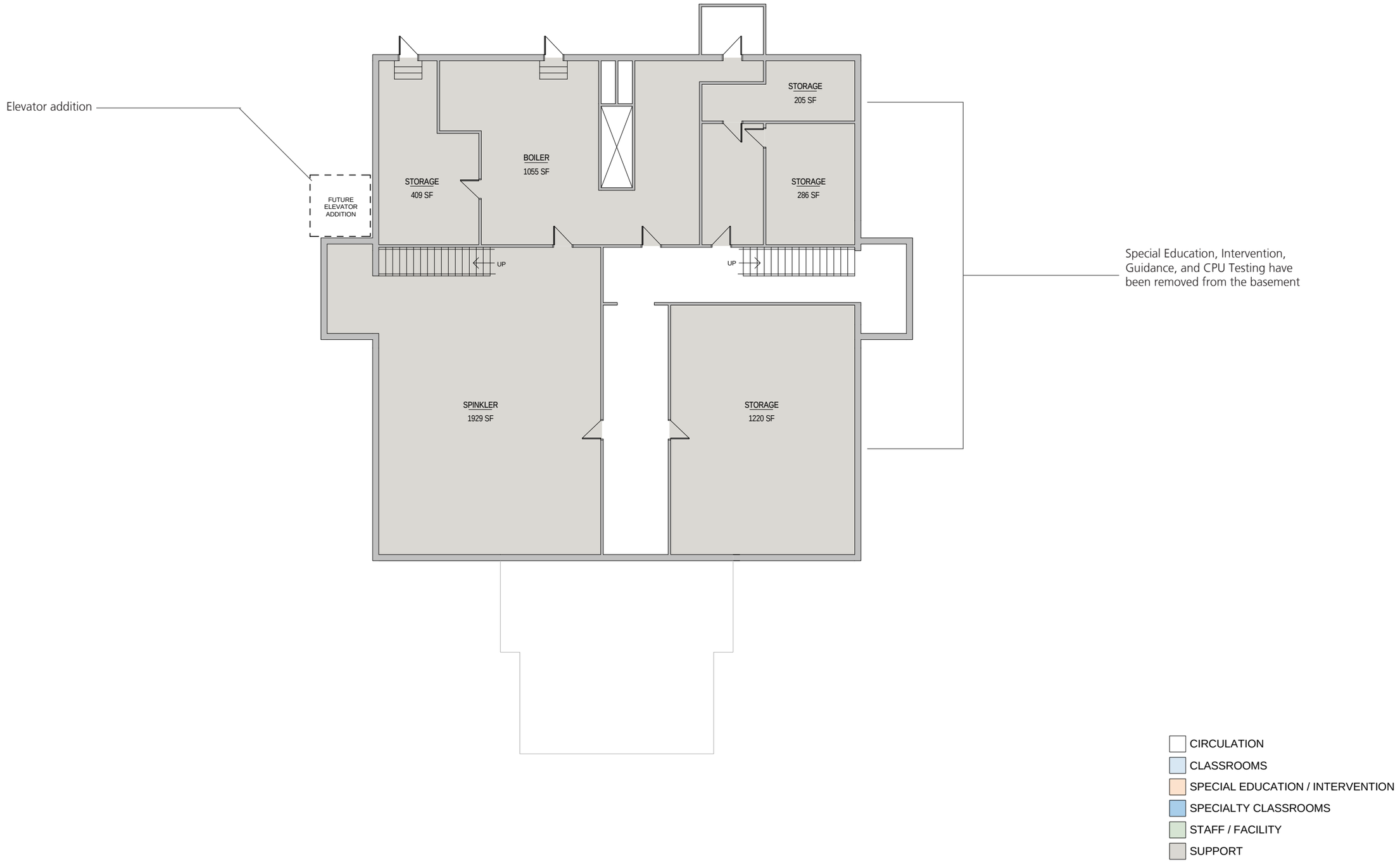
Attic Space not easily suitable for education space due to mechanical equipment and air quality

- CIRCULATION
- CLASSROOMS
- SPECIAL EDUCATION / INTERVENTION
- SPECIALTY CLASSROOMS
- STAFF / FACILITY
- SUPPORT

Recommended Improvements

Aerial Site - Courtesy of Bing Maps

Proposed Plan - Basement



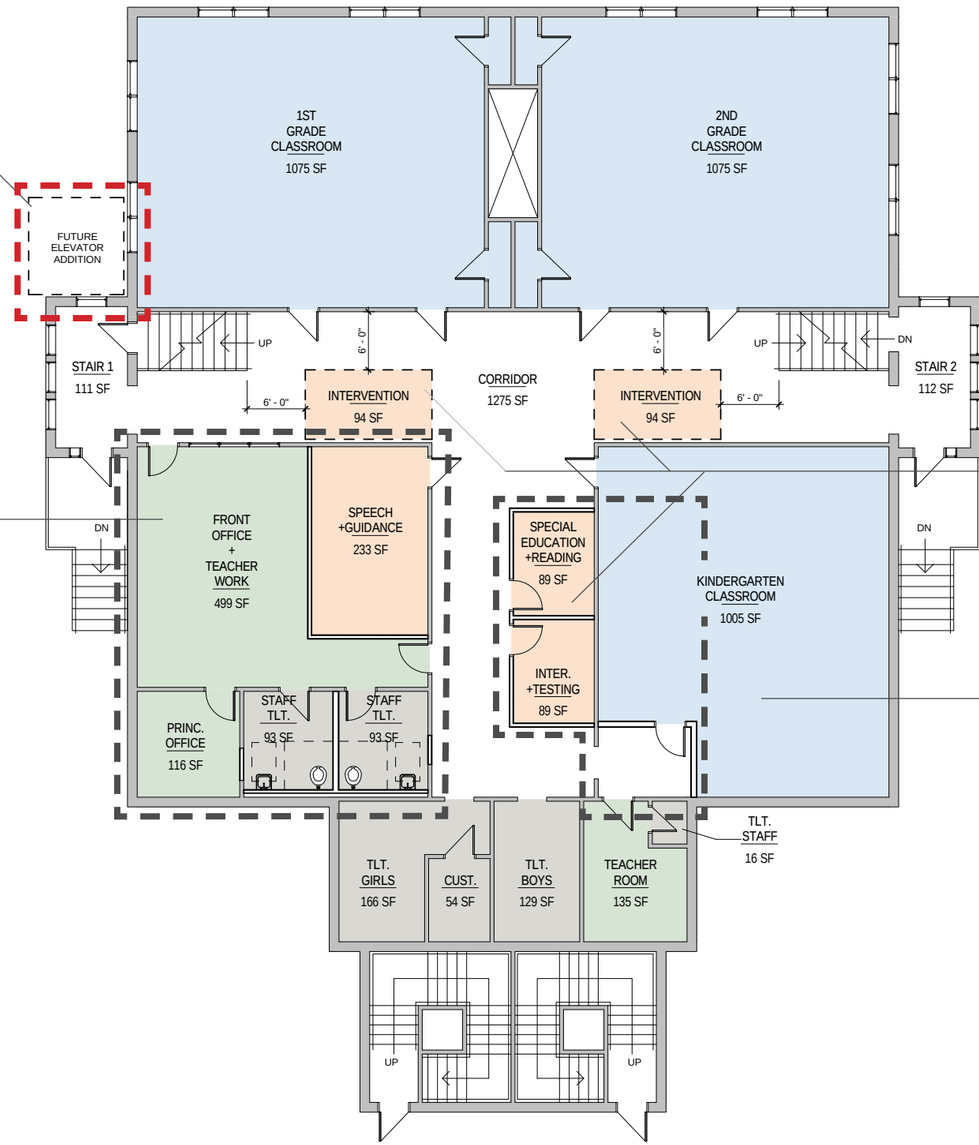
Proposed Plan - Main Level

Elevator addition

Renovate existing Kindergarten Classroom to allow for a better located front office / work room, two accessible rest rooms, and Speech / Guidance area.

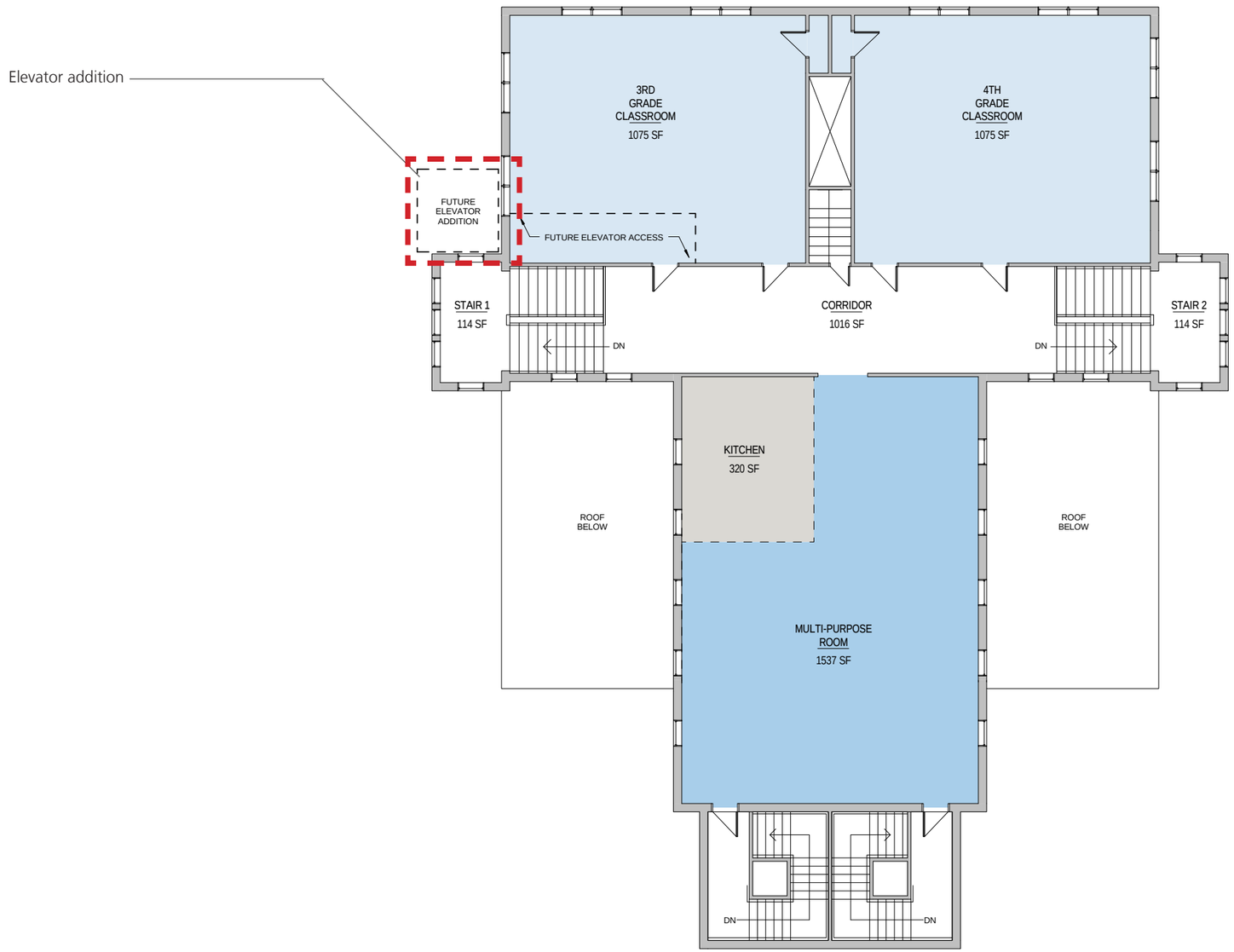
Intervention space provided in corridors. Sized to maintain appropriate corridor width for proper egress.

Teacher room relocated to allow for appropriately sized Kindergarten classroom



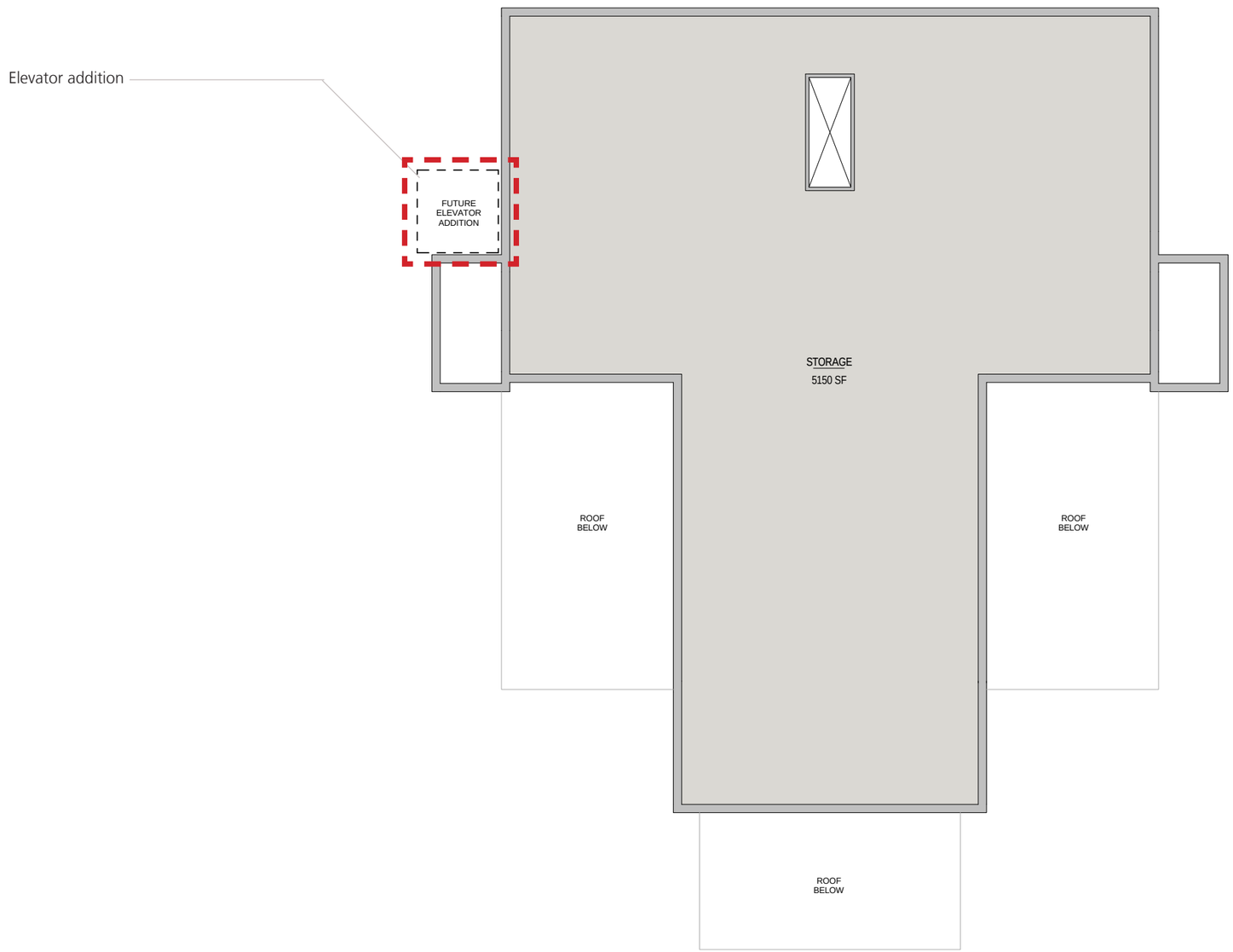
- CIRCULATION
- CLASSROOMS
- SPECIAL EDUCATION / INTERVENTION
- SPECIALTY CLASSROOMS
- STAFF / FACILITY
- SUPPORT

Proposed Plan - Level 2



- CIRCULATION
- CLASSROOMS
- SPECIAL EDUCATION / INTERVENTION
- SPECIALTY CLASSROOMS
- STAFF / FACILITY
- SUPPORT

Proposed Plan - Attic



- CIRCULATION
- CLASSROOMS
- SPECIAL EDUCATION / INTERVENTION
- SPECIALTY CLASSROOMS
- STAFF / FACILITY
- SUPPORT

Existing Assessment

Existing Building Condition

The Gonic school is a 1897 School with major additions erected in 1987. The exterior envelope is in good condition, however some mechanical / ventilation issues were reported (likely resulting from equipment issues rather than envelop shortcomings). Heating issues include poor ventilation in rooms 10A, 201A, and 102A, repeated unit failure in room 98A (Kindergarten Classroom), and uneven heating within the main office space. It was also noted that the Library is not air conditioned which causes an issue given the amount of computers in use here.
In addition to Gonic's lack of space (discussed below), there are a few shortcomings which should be addressed as part of any improvements to the Gonic School. Classrooms should be equipped with higher quality white boards (currently most are low quality type with seams which are beginning to break down). Sinks should be provided at Art rooms and K-1 classrooms. HVAC systems and controls should be upgraded to remedy issues report able.

Existing Site

While parking appears adequate for school use during warmer months, it was noted that only 38 of the required 60-70 spaces for school use were available year around. Slope roofs and snow plowing render several spaces unusable in the winter. Added parking area should be developed at the north side of the existing parking lot to accommodate 30 more parking spaces.
Similar to other schools in the district, this school also has a playground which must be accessed by crossing a driveway. The driveway is used primarily for staff and busses, but also serves as a delivery route to the rear of the building. While the principal has noted that they employ crossing guards (assisted with fences) to ensure student safety, consideration should be given to reducing the use of this drive and restricting it to busses only (or relocating it all together). The one-way loop also presents a problem in that staff cannot get to the parking lot without traversing the bus-drop off on this side.

Safety, Security and Code Compliance

The largest safety issue at the Gonic School is winter access and egress The sloped roofs render several entrances unusable in the winter, and create many danger zones for falling snow and ice. Solutions to this issue are not easily accomplished, likely requiring the addition of several canopies and landscape barriers around the building.
Classroom door hardware should also be replaced, as it was noted that all interior doors in this school do not lock (preventing a school lock-down).
It is evident that the previous addition went to great lengths to improve accessibility to the Gonic School, with only one room remaining in a non-accessible location: 10A, the Art room (which also doubles as OT and SLP).

Acoustics and Daylighting

Classroom acoustics and daylighting are excellent in most rooms, which the exception of room 10A. Acoustic separation should also be improved at Special Education areas currently divided with temporary partitions in room 101.

Programming / Space Needs

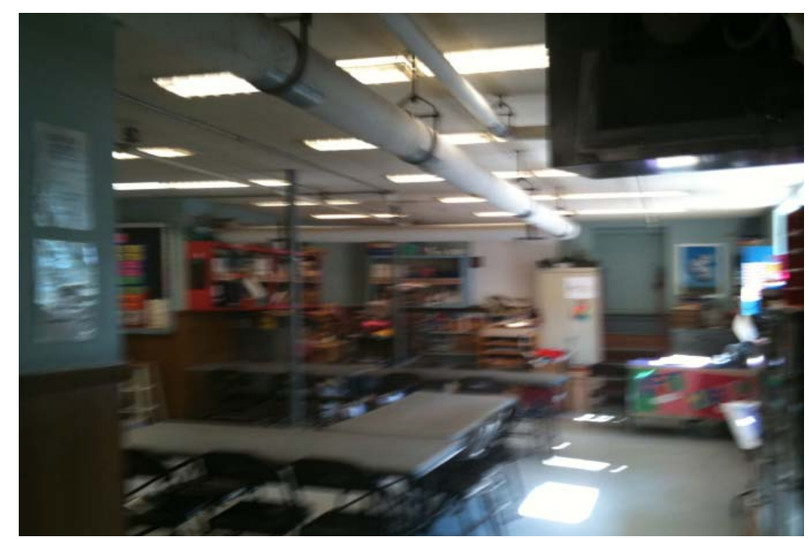
Overview of Space Needs

While typical education areas (classrooms) appear to be adequate in both size and quantity to serve the current student population at the Gonic School, the building lacks professional areas, as well as rest rooms, and Special Education/ Intervention Areas.

Programming / Space Needs (con'd)

To meet the needs of the current Gonic School Population, the following areas should be added:

- Rest rooms throughout the facility including (at a minimum): one set of student rest rooms and one staff rest room on floor 3, one staff rest room on floor 2, one set of student rest rooms and on floor 1, one rest room for the Nurses Office, and two rest rooms for the main office areas.
- Two Kindergarten Classrooms with Rest rooms (currently have two, but one is undersized)
- One 2nd grade classroom (could be restored from current Kindergarten Classroom)
- Three adequately size special education / intervention areas (distributed throughout school by grade)
- One specialty classroom for Music & Art
- One stand alone Computer lab
- One Office for Speech and Occupational Therapy
- One Special Education Area for Instruction and Behavioral response
- One Conference room (requested to seat 12)
- One Staff break area (requested to seat 20)
- One Staff Work Room



The current Art and Music room is undersized and is located in an in-accessible area with poor light, acoustics, and provides for a poor interior environment.

Gonic School Program Based on Enrollment

Education Program Areas

Course/Subject	# Students	Max Students/ Teaching Space	Utilization (90%)	# of Sections	Offered	Required Teaching Spaces (adjusted)	Number of Appropriately sized spaces in existing building	Required additional spaces	Notes
Kindergarten	40	18	0.90	2.47	Full Day	**3**	1	2	1 K Classroom undersized and dosnt have a bathroom or sink.
1st Grade	36	20	0.90	2.00	Full Day	**2**	2	0	
2nd Grade	46	22	0.90	2.32	Full Day	**3**	2	1	
3rd Grade	43	22	0.90	2.17	Full Day	**2**	2	0	
4th Grade	48	25	0.90	2.13	Full Day	**2**	2	0	
5th Grade	43	25	0.90	1.91	Full Day	**2**	2	0	
Total Enrollment	256					**14**			

Core Program Areas

Space	Student Access Per week (periods)	# of Students Served	# of Classes/wk	Calculated SF of Space (Per Standards)	Periods per week Offered***	# Spaces Required	Number of Appropriately sized spaces in existing building (or size of existing space)	Required additional spaces	Notes
Computer Lab	1	256	14		30	**1**	0	1	Shared with Library - consider creating separate space
Art	1	216	14		30	**1**	0	1	Shared with Music - not accesible
Music	1	216	11		30	**1**	0	1	Shared with Art - not accesible
Physical Education	1	216	14		15	**1**	1	0	
Media Center	1	256	14	1024	30	**1**	1132	-108	Net Square Feet
Cafeteria	5	256	20	960	15	**2**	5657	-4697	Net Square Feet
Special Education Student Areas*	5	38	96		30	**4**	5	-1	Calculations assume 2 students/area average
Intervention / Small Group Areas**	5	77	128		30	**5**	1	4	Calculations assume 3 students/area average
Professional Areas								7	(1) Speech & OT office area (1) Instructional/behavior Response, (1) staff room for 20, (1) Nurse area with restroom (1) 12 person conference room, (1) staff work room, (1) supply closet, and several staff restrooms.

* 15% of students identified to receive special services by District Special Education .
** 30% of students identified to receive Tier 2 or Tier 3 Intervention (Title 1) instruction
*** Standard 8 period day, allowing for no specials during first and last periods.

Dept of Ed allowable:	Age Group	Enrollment	SF/Pupil	Utilization	Total Building (NSF)	
For New Construction	Grade 1-5	216	144	0.90	34,560	
	Kindergarten - Trans	40	150	0.90	6,667	
					41,227	Total Allowable by NH DOE standards for new construction

Existing Analysis / Capacity

Current Enrollment	**256**	
Current Building Size (gsf)	37,239	(Note: gsf shown excludes approximately 4300gsf of basement space not suited for education space)
Estimated Building Capacity Based solely on size of building	Based on Average NH School Construction of 144sf/student for Grades 1-5 and 150sf/student in K @ 90% Utilization: 231	

	# Classrooms*	Max Seats/ Classroom **	Utilization (90%)	Utilized Seats	Theoretical Student Capacity	
Education Areas Capacity	10	22	0.9	198	**198**	
Specialty Classrooms (Art.Music, Cpu, Etc)	1	22	0.9	19.8		See notes below
Current Utilization / Capacity					**129.29%**	

*Currently, there are 11 Homerooms. Deduct one each for the Art and Music
** Averaging K-5 Class Sizes (16 for Kindergarten, 24 for Grades 1 -5)
*** Standard 8 period day, allowing for no specials during first and last periods.

Core Capacity	Size of Area (sf)	Appropriately Sized?	Seats/persons	Utilization (90%)	Periods per week Offered***	Theoretical Student Capacity	
Art	778	N	22	0.9	15	297	Shared room - Art/Music
Music	778	N	22	0.9	15	297	Shared room - Art/Music
Media Center	1132	Y	ed @ Students x .10 x 40 sf			283	
Gymnasium	5657	Y	44	0.9	15	594	If Gym allows 2 classes/period
CPU Lab	650	N	22	0.9	15	297	Part of Mdeia Center
Cafeteria	5657	Y	314	0.9	15	848.55	Shared Café-Gym

Existing Property Map

Existing Assessment - Main Level

Existing Assessment - Level 2

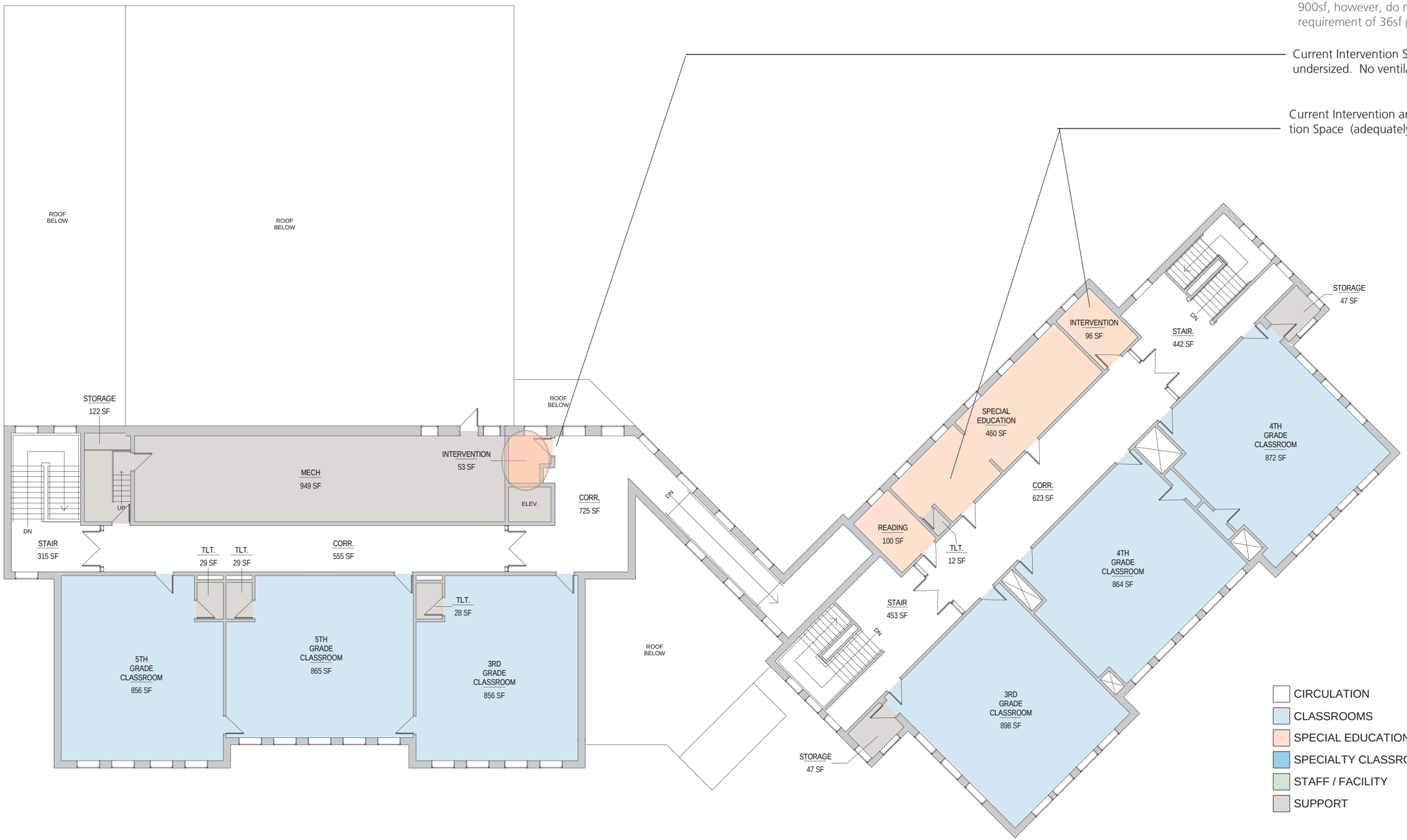
Existing Assessment - Level 3

Undersized Classroom

Note: some classrooms shown here are undersized by NH DOE standards of 900sf, however, do meet standards for requirement of 36sf per student.

Current Intervention Space undersized. No ventilation.

Current Intervention and Special Education Space (adequately sized)



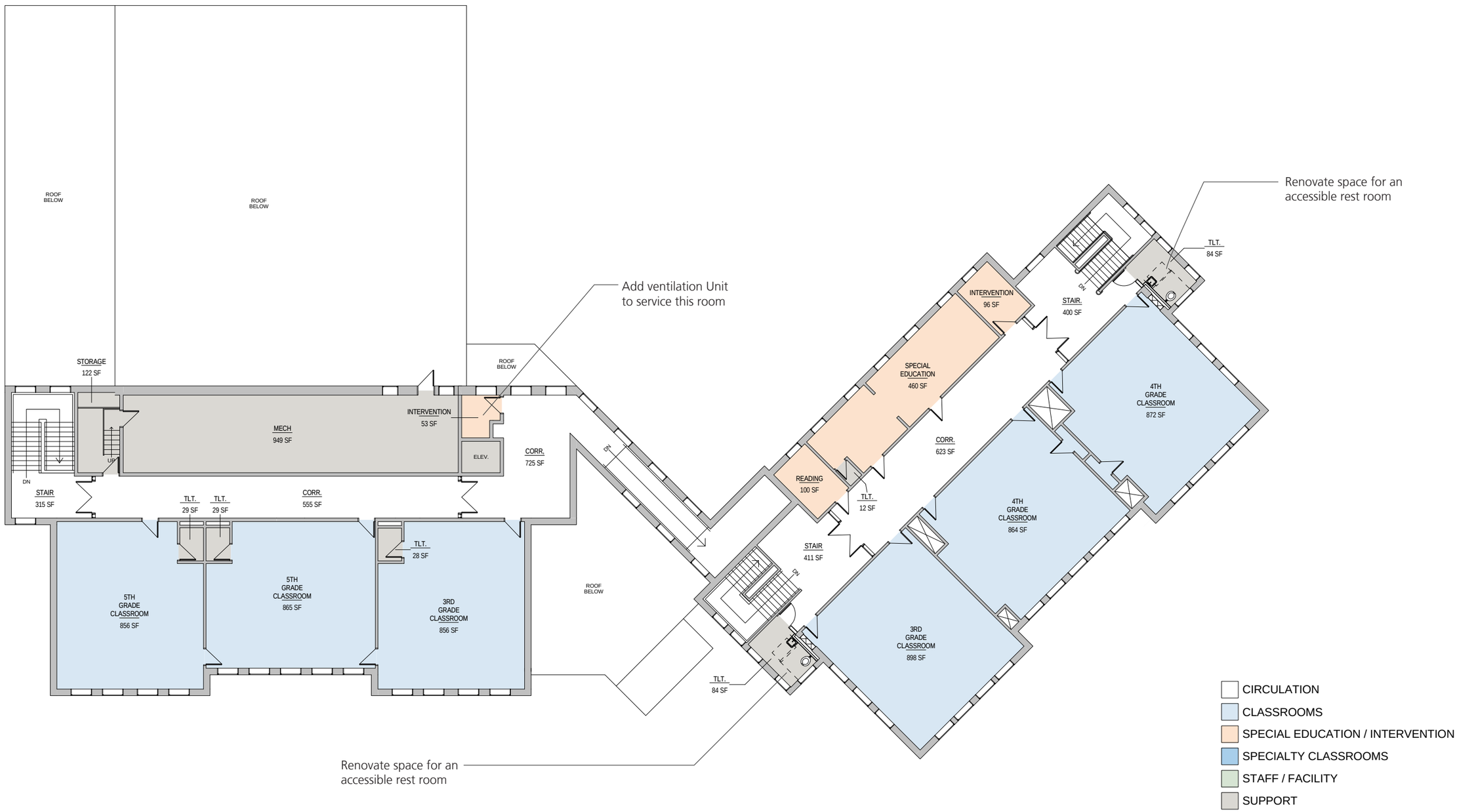
Recommended Improvements

Aerial Site - Courtesy of Bing Maps

Proposed Plan - Main Level

Proposed Plan - Level 2

Proposed Plan - Level 3



Existing Assessment

Existing Building Condition

The Maple Street school is a small1928 School serving grades K through 3. The exterior envelope is in good condition and provides for a comfortable interior environment. No comfort issues within classroom areas were reported by staff. It should also be noted that the Classrooms, although small, are well designed with high ceilings, lots of natural light, and built-in storage. Interior finishes are in generally good condition and appear to be well maintained. Lighting fixtures throughout the classrooms are direct T8 lensed fluorescent (inefficient compared to today's standards) and should be scheduled for replacement.

Existing Site

Parking is very limited, with only 13 spaces on site. An additional 7 spaces should be added to accommodate staff. With nearly all parents, students, and visitors walking to this school, the drop-off area (and lack of visitor parking) is adequate at this time. The Maple Street School community should be applauded for this. Should this school modify it's district (becoming a Magnet school or other regional school), the drop-off area would need to be increased and a few visitor parking spaces added.

The playground and outdoor space is large here with good student access. With only one play structure, added playground equipment should be considered for this area.

Safety, Security and Code Compliance

The front entrance is not supervisable due to configuration and lines of sight, resulting in a poorly secured facility. Modifications should be considered at the Entrance to allow the primary entrance to be supervised. It should also be noted that the Maple Street Social Worker must be located close to the entrance as this position has become a community and parent asset with many visitors. Thought should also be given to creating an entrance which would allow community use of a room in the school without full access to the remainder of the facility.

This Facility is entirely non-accessible with stairs to enter the building, no elevator, and no accessible rest rooms.

Acoustics and Daylighting

Classroom acoustics and daylighting are excellent Poor acoustic separation was noted at the Main Office areas, which are configured with partial-height walls.

Programming / Space Needs

Overview of Space Needs

The Maple Street school continues to serve four classes or less, very few additional spaces are required. Some modifications to allow for improved acoustics, security, and accessibility should still be made.

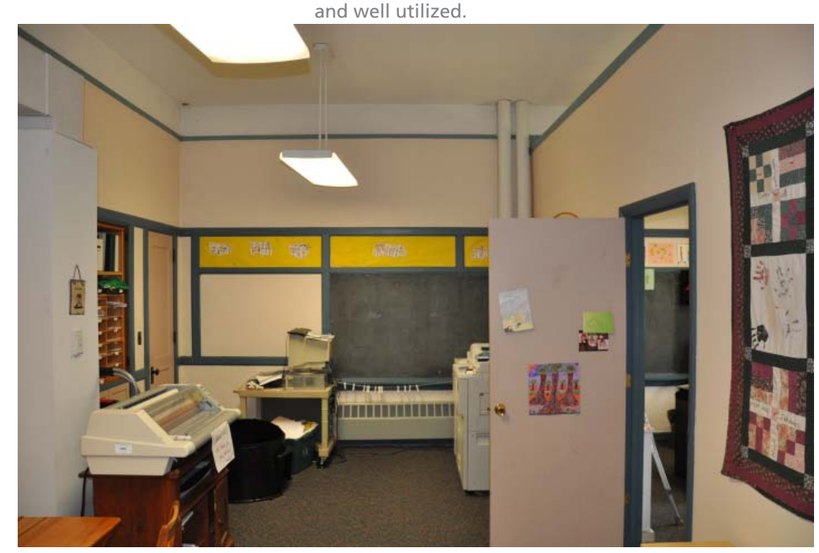
Should this school become a K-5 School (Magnet or otherwise), the following spaces would need to be added:

- Added storage
- Accessible Staff/Adult and Student Rest rooms
- One Specialty Classroom (to accommodate Art, Music, and Chorus) as a single Multi-purpose room cannot accommodate this many classes for this many uses.
- One Conference room
- Larger Guidance Office
- 4th Grade Classroom
- 5th Grade Classrooms
- Two Added Intervention Spaces (to accommodate new grades)
- Appropriately sized Kindergarten room (current room undersized and could be re-purposed to one or more of the spaces listed above)

Added storage should be considered as part of any renovation to avoid storing of items in improper locations.

Special Education and Intervention areas are adequate and well utilized.

Classrooms, although small, are well designed with high ceilings, lots of natural light, and built-in storage.



The Main Office area, including the Principal's Office do not achieve acoustic separation as the partitions do not extend all the way up, offering no privacy.

Maple Street School Program Based on Enrollment

Education Program Areas

Course/Subject	# Students	Max Students/ Teaching Space	Utilization (90%)	# of Sections	Offered	Required Teaching Spaces (adjusted)	Number of Appropriately sized spaces in existing building	Required additional spaces	Notes
Kindergarten	16	18	0.90	0.99	Full Day	**1**	1	0	
1st Grade	17	20	0.90	0.94	Full Day	**1**	1	0	
2nd Grade	17	22	0.90	0.86	Full Day	**1**	1	0	
3rd Grade	17	22	0.90	0.86	Full Day	**1**	1	0	
4th Grade	0	25	0.90	0.00	Full Day	**0**	0	0	
5th Grade	0	25	0.90	0.00	Full Day	**0**	0	0	
Total Enrollment	67					**4**			

Core Program Areas

Space	Student Access Per week (periods)	# of Students Served	# of Classes/wk	Calculated SF of Space (Per Standards)	Periods per week Offered***	# Spaces Required	Number of Appropriately sized spaces in existing building (or size of existing space)	Required additional spaces	Notes
Computer Lab	1	67	4		30	**1**	1	0	Located in the Library
Art	1	51	4		5	**1**	1	0	Held in Multi-purpose room
Music	1	51	3		5	**1**	1	0	Held in Multi-purpose room
Physical Education	1	51	4		5	**1**	1	0	Held in Multi-purpose room
Media Center	1	67	4	268	15	**1**	778	0	Net Square Feet
Cafeteria	5	67	5	251	5	**1**	1830	0	Net Square Feet
Special Education Student Areas*	5	20	50		30	**2**	2	0	Calculations assume 2 students/area
Intervention / Small Group Areas**	5	37	61		30	**3**	3	0	Calculations assume 3 students/area
Professional Areas								3	Need (1) private Conference room, (1) Special Education Quiet Room, and (1) storage room

* 30% of students identified to receive special services by District Special Education .

** 55% of students identified to receive Tier 2 or Tier 3 Intervention (Title 1) instruction

*** Standard 8 period day, allowing for no specials during first and last periods.

Dept of Ed allowable:	Age Group	Enrollment	SF/Pupil	Utilization	Total Building (NSF)	
For New Construction	Grade 1-2	51	144	0.90	8,160	
	Kindergarten - Trans	16	150	0.90	2,667	
					10,827	Total Allowable by NH DOE standards for new construction

Existing Analysis / Capacity

Current Enrollment					**63**	
Current Building Size (gsf)					14,465	
Estimated Building Capacity Based solely on size of building	Based on Average NH School Construction of 144sf/student for Grades 1-5 and 150sf/student in K @ 90% Utilization				89	
	# Classrooms*	Max Seats/ Classroom **	Utilization (90%)	Utilized Seats	Theoretical Student Capacity	
Education Areas Capacity	4	20	0.9	72	**72**	
Specialty Classrooms (Art.Music, Cpu, Etc)	2	20	0.9	36		
Current Utilization / Capacity					**87.50%**	

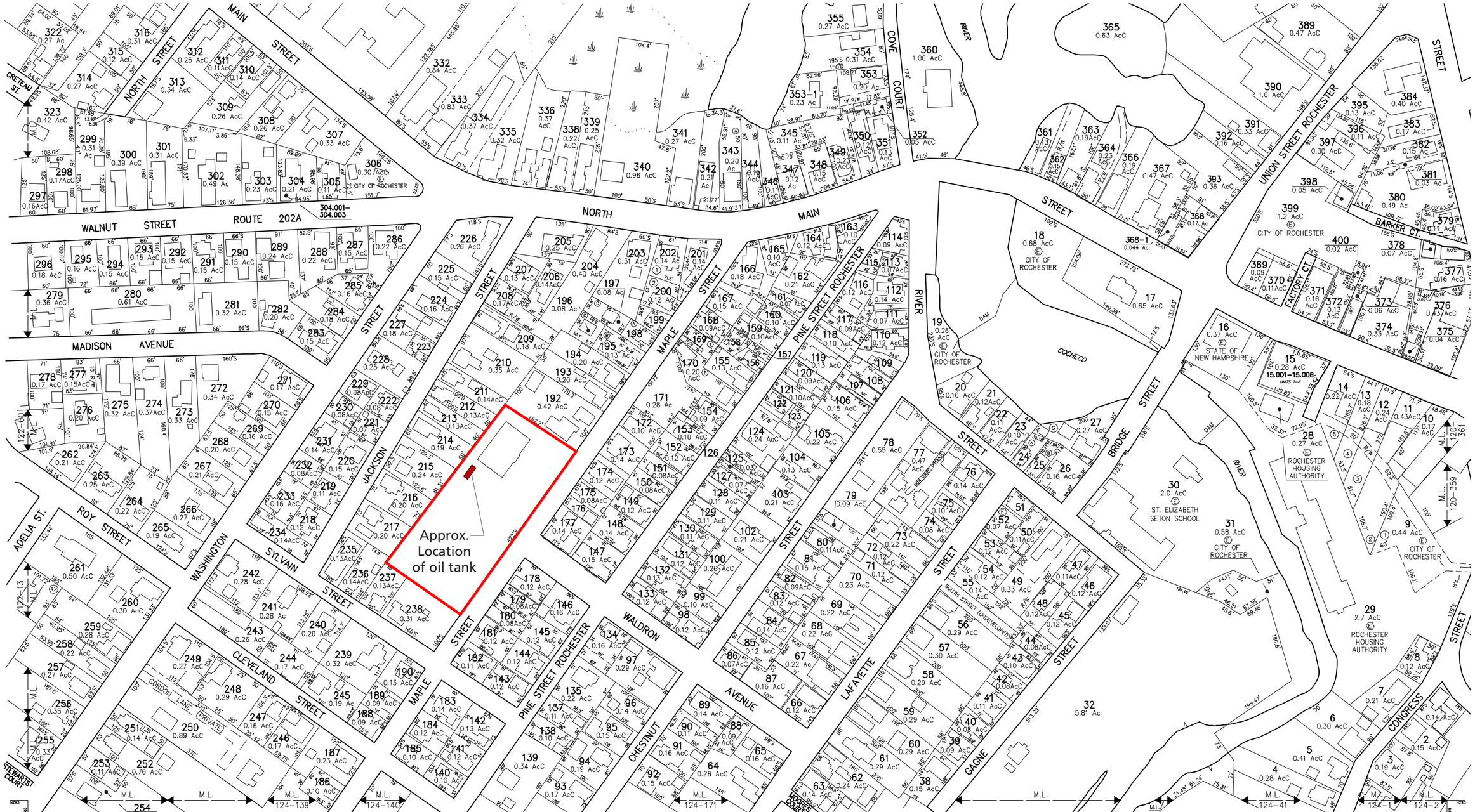
*Currently, there are 4 Homerooms.

** Averaging K-2 Class Sizes (16 for Kindergarten, 24 for Grades 1 and 2)

*** Standard 8 period day, allowing for no specials during first and last periods.

Core Capacity	Size of Area (sf)	Appropriately Sized?	Seats/persons	Utilization (90%)	Periods per week Offered***	Theoretical Student Capacity	
Art	1830	Y	22	0.9	5	99	If taught within Multi-purpose room
Music	1830	Y	22	0.9	5	99	If taught within Multi-purpose room
Media Center	778	Y	ed @ Students x .10 x 40 sf		15	195	
Gymnasium	1830	Y	44	0.9	5	198	If taught within Multi-purpose room
CPU Lab	778	Y	22	0.9	15	297	In Media Center
Cafeteria	1830	Y	102	0.9	5	91.5	Multi-purpose room

Existing Property Map



THIS MAP IS FOR ASSESSMENT PURPOSES. IT IS NOT VALID FOR LEGAL DESCRIPTION OR CONVEYANCE.

THE HORIZONTAL DATUM IS THE NEW HAMPSHIRE STATE PLANE COORDINATE SYSTEM.

PHOTOGRAPHY DATE: APRIL 28, 1990

COMPLETION DATE: JUNE 30, 1992

PRODUCED IN 1992 BY
CARTOGRAPHIC ASSOC. INC.
PROFESSIONAL CONSULTANTS
MUNICIPAL MAPPING – GIS – PUBLIC WORKS INFORMATION MANAGEMENT
11 PLEASANT STREET, LITTLETON, NEW HAMPSHIRE 03561
(603)444-6768 – 1(800)322-4540 – FAX (603)444-1366 – WWW.CAI-INFO.COM

LEGEND

AREA SURVEYED . . . . . Ac
AREA CALCULATED . . . . . AcC
RECORD DIMENSION . . . . . 100'
SCALED DIMENSION . . . . . 100'S
MATCH LINE . . . . . M.L.
WATER . . . . . –W–
EXEMPT PROPERTY . . . . . (E)
SUBDIVISION LOT NO. . . . . (2)
BUILDING . . . . . (B)
RIGHT OF WAY . . . . . R/W
COMMON OWNERSHIP . . . . . OR
WETLANDS . . . . . (W)

FEET 50 0 100 200 300
SCALE 1" = 100'
25 0 25 50 75 METERS

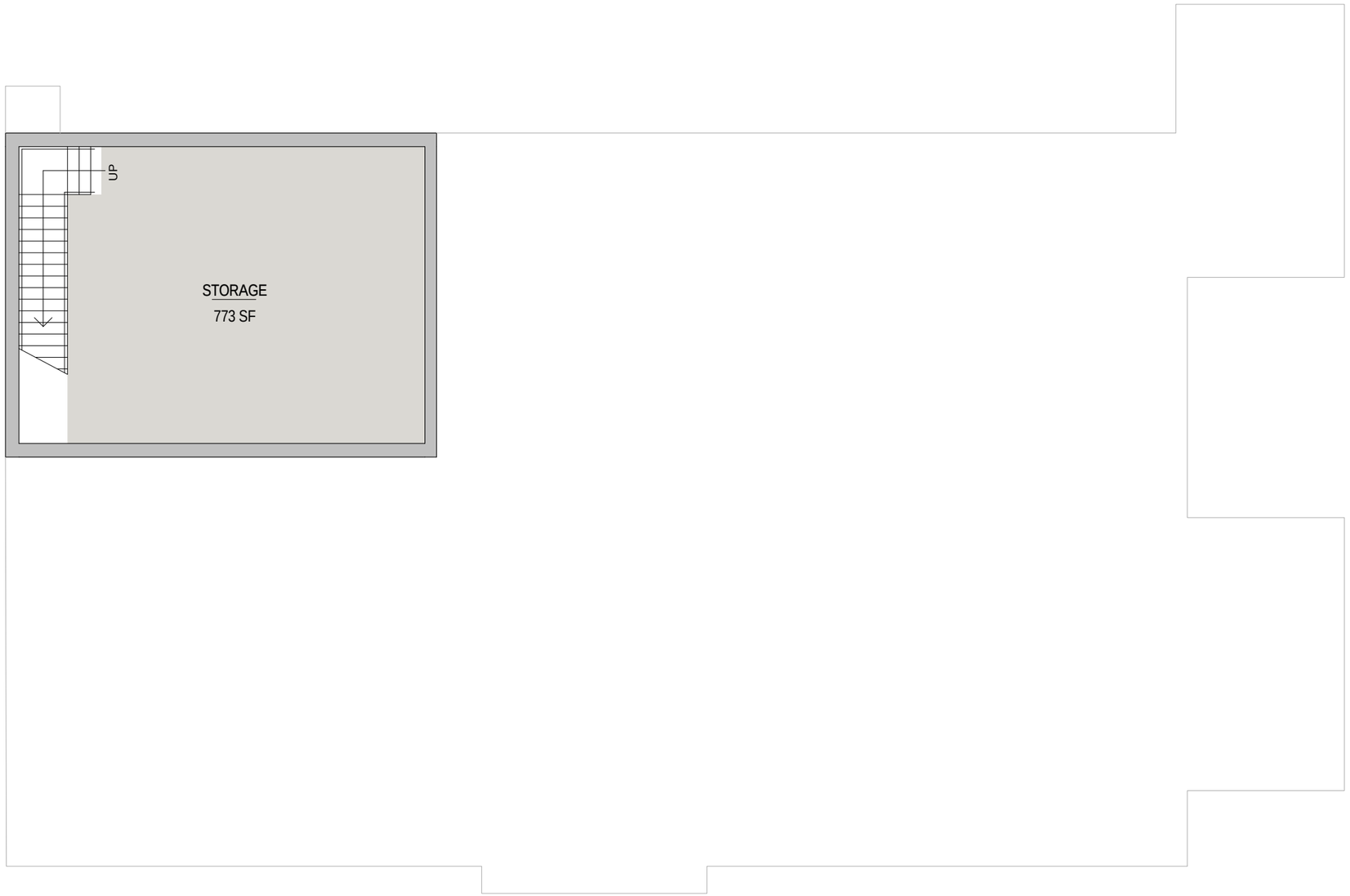
REVISED TO : APRIL 1, 2010

PROPERTY MAPS
ROCHESTER
NEW HAMPSHIRE

INDEX DIAGRAM
115 116 117
122 120
123 124 125
GN

MAP NO.
121

Existing Assessment - Basement

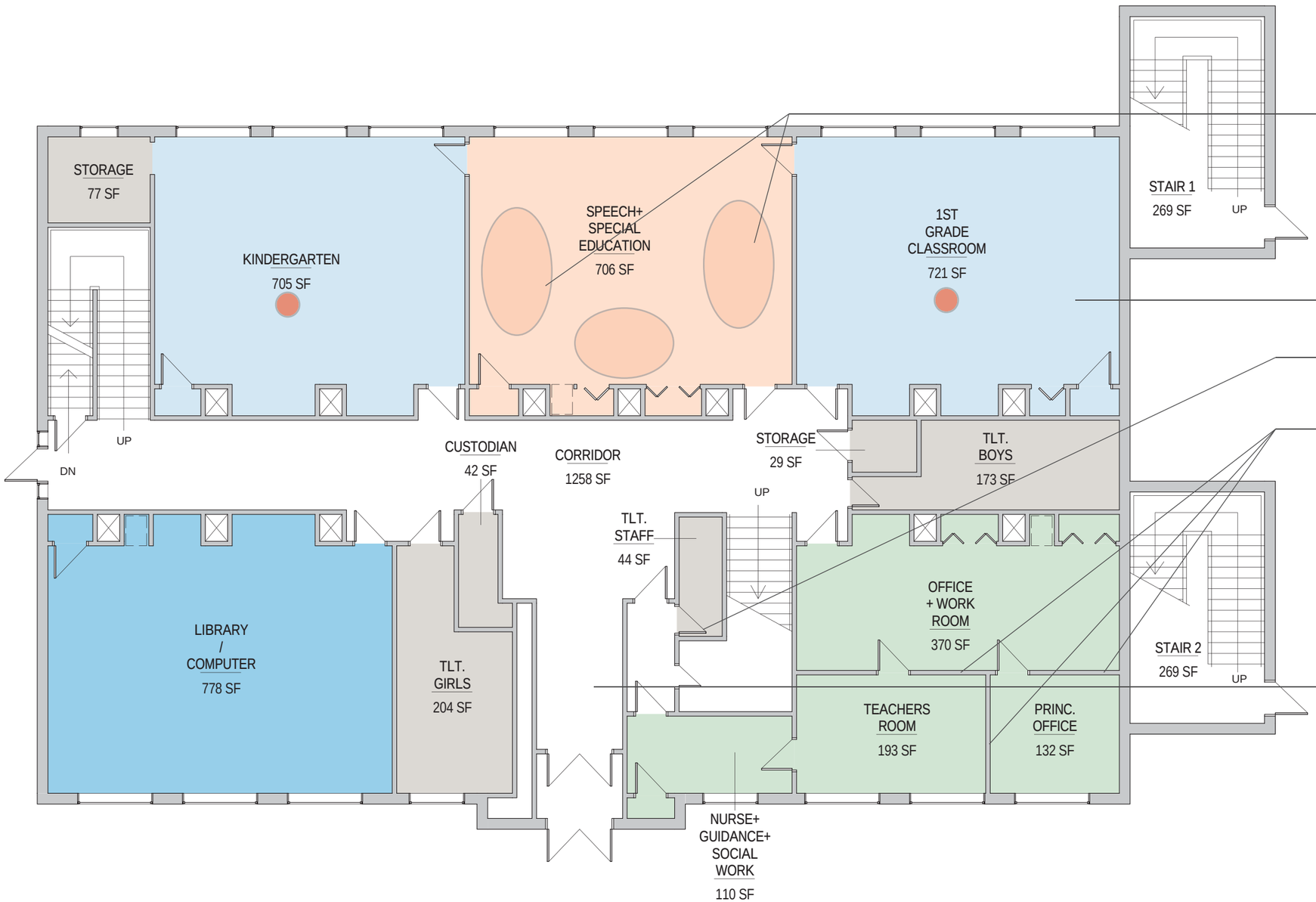


- CIRCULATION
- CLASSROOMS
- SPECIAL EDUCATION / INTERVENTION
- SPECIALTY CLASSROOMS
- STAFF / FACILITY
- SUPPORT

Existing Assessment - Main Level

Undersized Classroom

Note: These classrooms cannot feasibly be expanded to 900sf standards. To meet NH DOE standards of 36sf per student, each of these classrooms should be limited to 20 students (18 in Kindergarten)



Current Intervention, Reading, Speech, and Special Education Spaces

All classrooms lack enough electrical outlets

Door is only 2'x5'

These walls partial height, creating poor acoustics

Non-supervisable entrance from Administration areas

- CIRCULATION
- CLASSROOMS
- SPECIAL EDUCATION / INTERVENTION
- SPECIALTY CLASSROOMS
- STAFF / FACILITY
- SUPPORT

Existing Assessment - Level 2

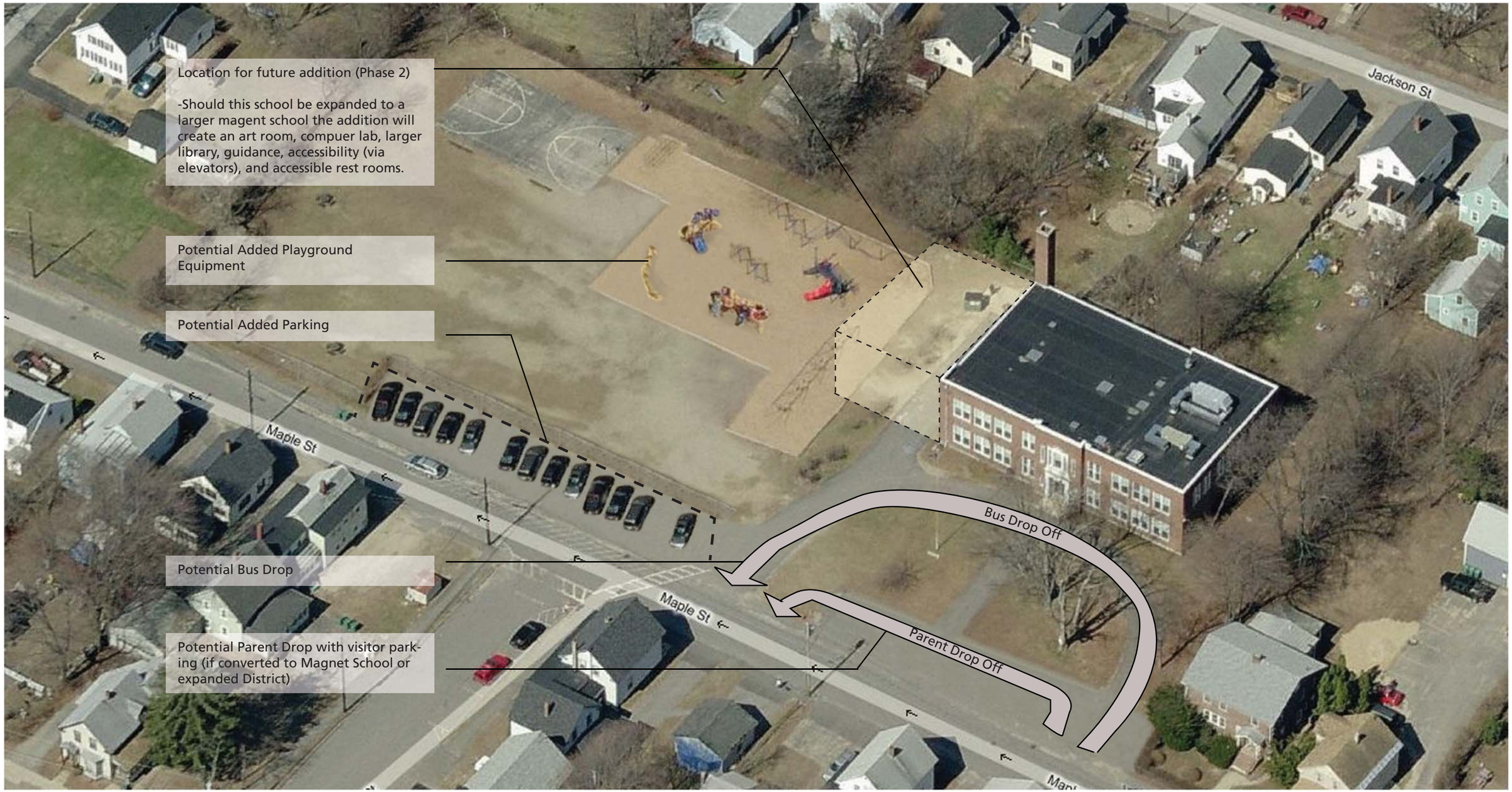
Undersized Classroom

Note: These classrooms cannot feasibly be expanded to 900sf standards. To meet NH DOE standards of 36sf per student, each of these classrooms should be limited to 19-20 students

Current Intervention, Reading, and Special Education Spaces

- CIRCULATION
- CLASSROOMS
- SPECIAL EDUCATION / INTERVENTION
- SPECIALTY CLASSROOMS
- STAFF / FACILITY
- SUPPORT

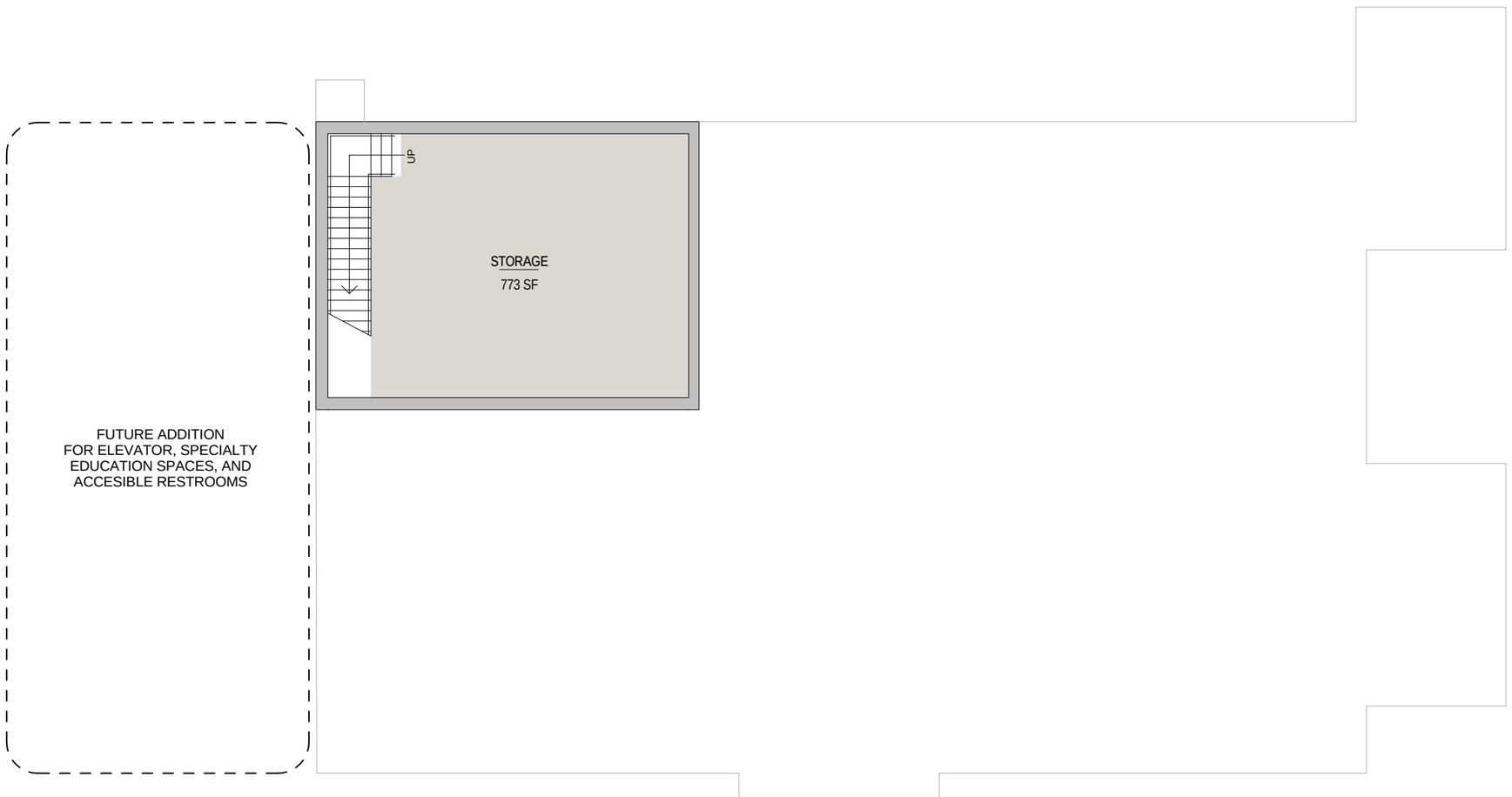
Recommended Improvements



Aerial Site - Courtesy of Bing Maps

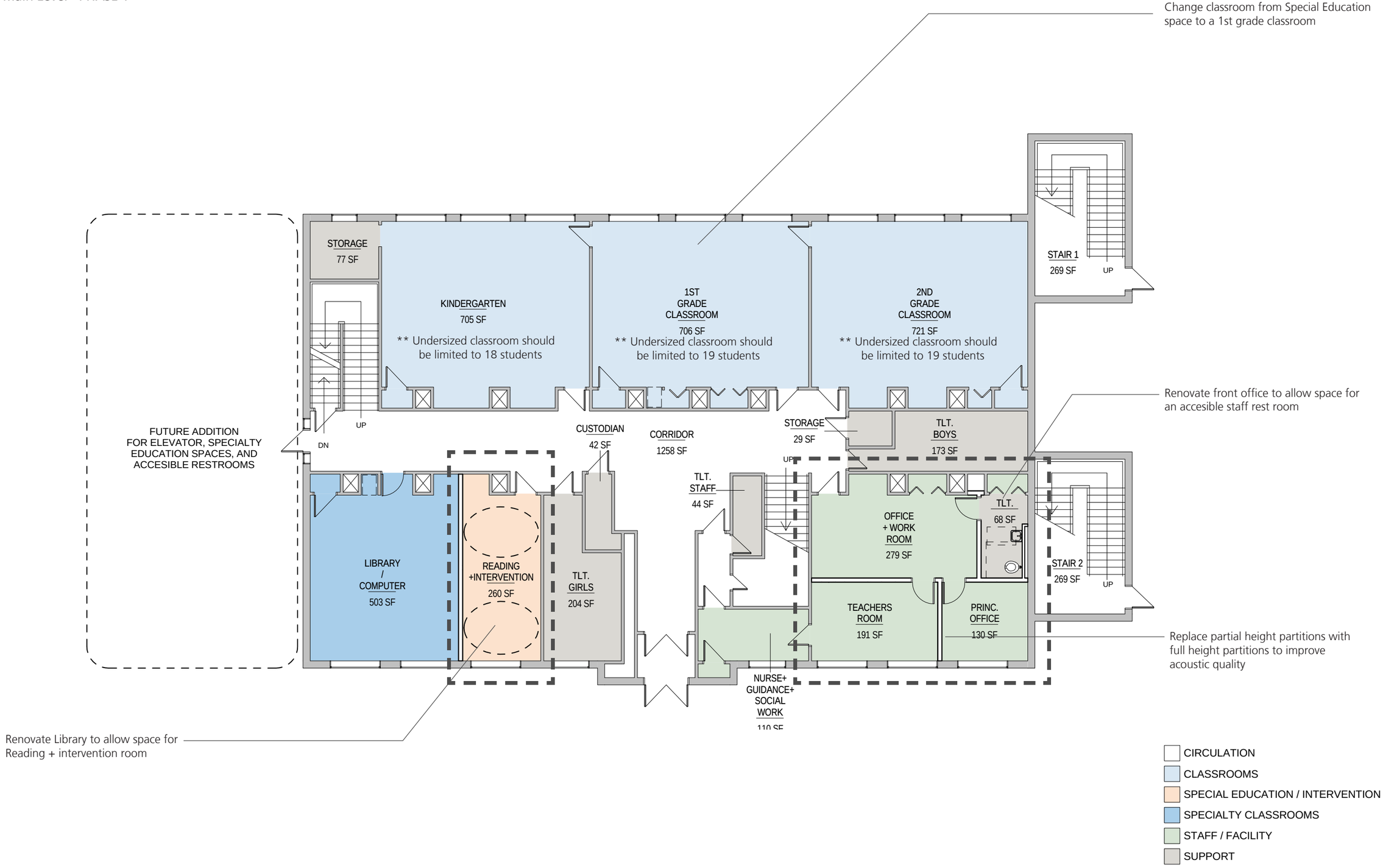
Proposed Plan - Basement - PHASE 1

**No changes to this level



- CIRCULATION
- CLASSROOMS
- SPECIAL EDUCATION / INTERVENTION
- SPECIALTY CLASSROOMS
- STAFF / FACILITY
- SUPPORT

Proposed Plan - Main Level - PHASE 1

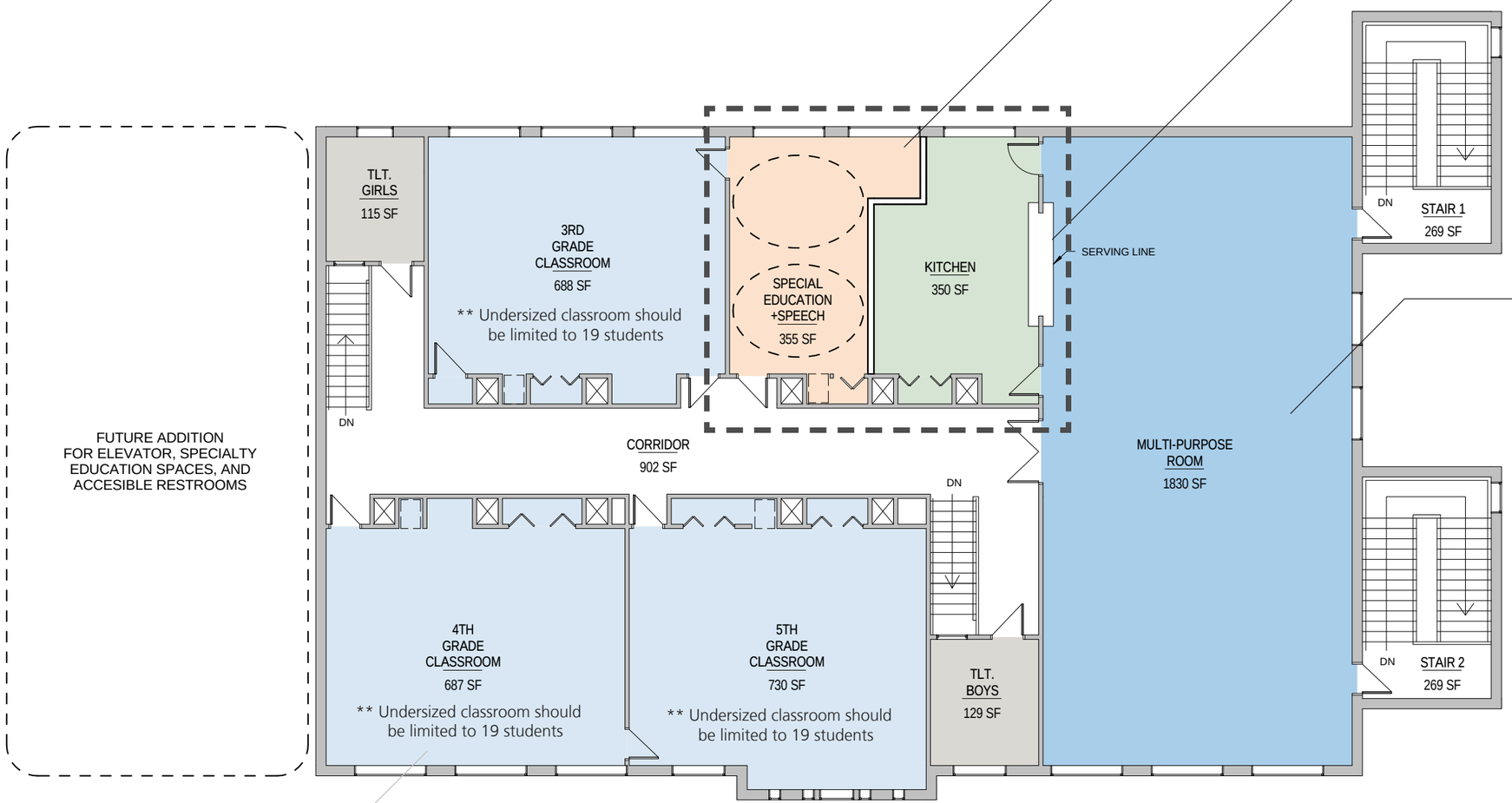


Proposed Plan - Level 2 - PHASE 1

Renovate kitchen to allow space for a Special Education classroom

Kitchen access restricted to staff only. Students will use service window accesed from multipurpose room.

Music + Art to be taught in Multi-Purpose room this phase.

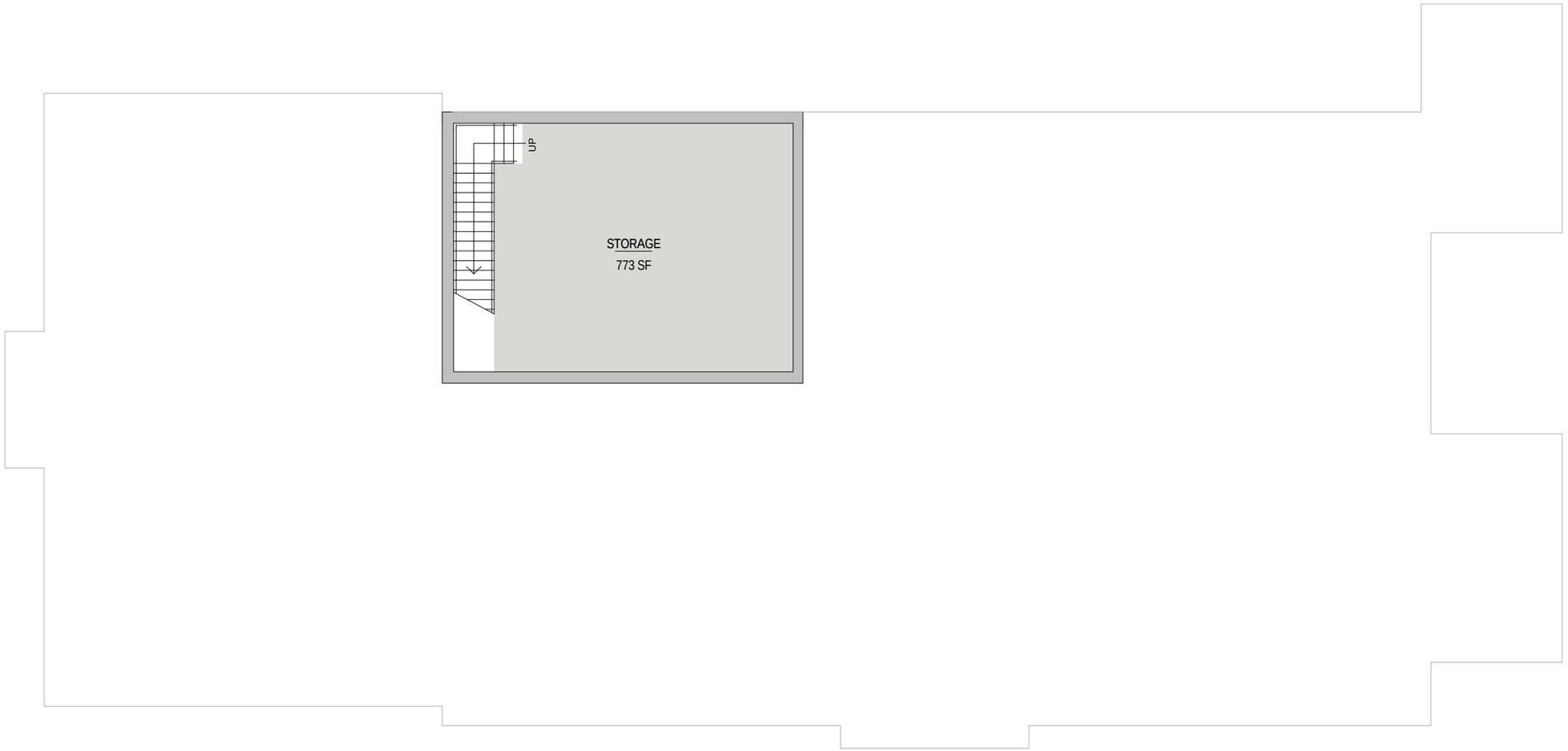


Repurpose room from a Reading + Intervention classroom to a 4th grade classroom

- CIRCULATION
- CLASSROOMS
- SPECIAL EDUCATION / INTERVENTION
- SPECIALTY CLASSROOMS
- STAFF / FACILITY
- SUPPORT

Proposed Plan - Basement - PHASE 2

**No changes to this level



- CIRCULATION
- CLASSROOMS
- SPECIAL EDUCATION / INTERVENTION
- SPECIALTY CLASSROOMS
- STAFF / FACILITY
- SUPPORT

Proposed Plan - Main Level - PHASE 2

Proposed Plan - Level 2 - PHASE 2

Existing Assessment

Existing Building Condition

The McClelland school is a 1957-1959 Building with additions erected in 1988. The exterior envelope is mixed brick and translucent panels with operable units. The exterior walls appear to be in excellent condition. Comfort issues were reported within the Special Education and Intervention areas currently located on the upper floor mezzanine, as well as within the main office. It should also be noted that rest rooms lack proper ventilation. Interior finishes are in generally good condition with the VCT flooring beginning to show it's age. Lighting fixtures throughout the classrooms are direct T8 fenced fluorescent (inefficient compared to today's standards) and should be scheduled for replacement.

Existing Site

Parking appears adequate for school hours, and drop-off areas for busses and parents work well. Visitor parking is fairly limited in front of the building, but overflow can utilize the main parking area without issue. Outdoor athletics and play space are large and appropriately located for student access.

Safety, Security and Code Compliance

School staff noted that they are able to maintain a secure facility as it is currently configured.

Acoustics and Daylighting

Several classroom suffer from poor acoustics as they have hard ceilings and no absorptive materials. Daylighting is adequate on all areas.

Programming / Space Needs

Overview of Space Needs

The McClelland school needs no major additions to serve it's current student population. Improvements in classroom technology, classroom acoustics, a second boiler, and improved ventilations systems should be considered

Classrooms would benefit from acoustic ceiling tile and updated technology (white boards or interactive white boards).

Lack of storage is apparent in classrooms but could be remedied with some added wardrobe cabinets or similar casework and some purging.

McClelland School Program Based on Enrollment

Education Program Areas

Course/Subject	# Students	Max Students/ Teaching Space	Utilization (90%)	# of Sections	Offered	Required Teaching Spaces (adjusted)	Number of Appropriately sized spaces in existing building	Required additional spaces	Notes
Kindergarten	50	18	0.90	3.09	Full Day	**3**	3	0	
1st Grade	56	20	0.90	3.11	Full Day	**3**	3	0	
2nd Grade	56	22	0.90	2.83	Full Day	**3**	3	0	
3rd Grade	67	22	0.90	3.38	Full Day	**4**	4	0	
4th Grade	67	25	0.90	2.98	Full Day	**3**	3	0	
5th Grade	75	25	0.90	3.33	Full Day	**3**	3	0	
Total Enrollment*	371					**19**			

Enrollment numbers were not verified by the Principal

Core Program Areas

Space	Student Access Per week (periods)	# of Students Served	# of Classes/wk	Calculated SF of Space (Per Standards)	Periods per week Offered***	# Spaces Required	Number of Appropriately sized spaces in existing building (or size of existing space)	Required additional spaces	Notes
Computer Lab	1	371	19		30	**1**	1	0	
Art	1	321	19		30	**1**	1	0	
Music	1	321	16		30	**1**	1	0	
Physical Education	1	321	19		20	**1**	1	0	
Media Center	1	371	19	1484	30	**1**	1185	0	Net Square Feet
Cafeteria	5	371	20	1391	10	**2**	5552	0	Net Square Feet
Special Education Student Areas*	5	85	213		30	**8**	8	0	Calculations assume 2 students/area
Intervention / Small Group Areas**	5	93	155		30	**6**	5	1	Calculations assume 3 students/area
Professional Areas								0	

* 23% of students identified to receive special services by District Special Education .

** 25% of students identified to receive Tier 2 or Tier 3 Intervention (Title 1) instruction

*** Standard 8 period day, allowing for no specials during first and last periods.

Dept of Ed allowable:

	Age Group	Enrollment	SF/Pupil	Utilization	Total Building (NSF)	
For New Construction	Grade 1-5	321	144	0.90	51,360	
	Kindergarten - Trans	50	150	0.90	8,333	
					59,693	Total Allowable by NH DOE standards for new construction

Existing Analysis / Capacity

Current Enrollment	**371**	
Current Building Size (gsf)	55,662	Excluding Portables
Estimated Building Capacity Based solely on size of building	Based on Average NH School Construction of 144sf/student for Grades 1-5 and 150sf/student in K @ 90% Utilization: 345	

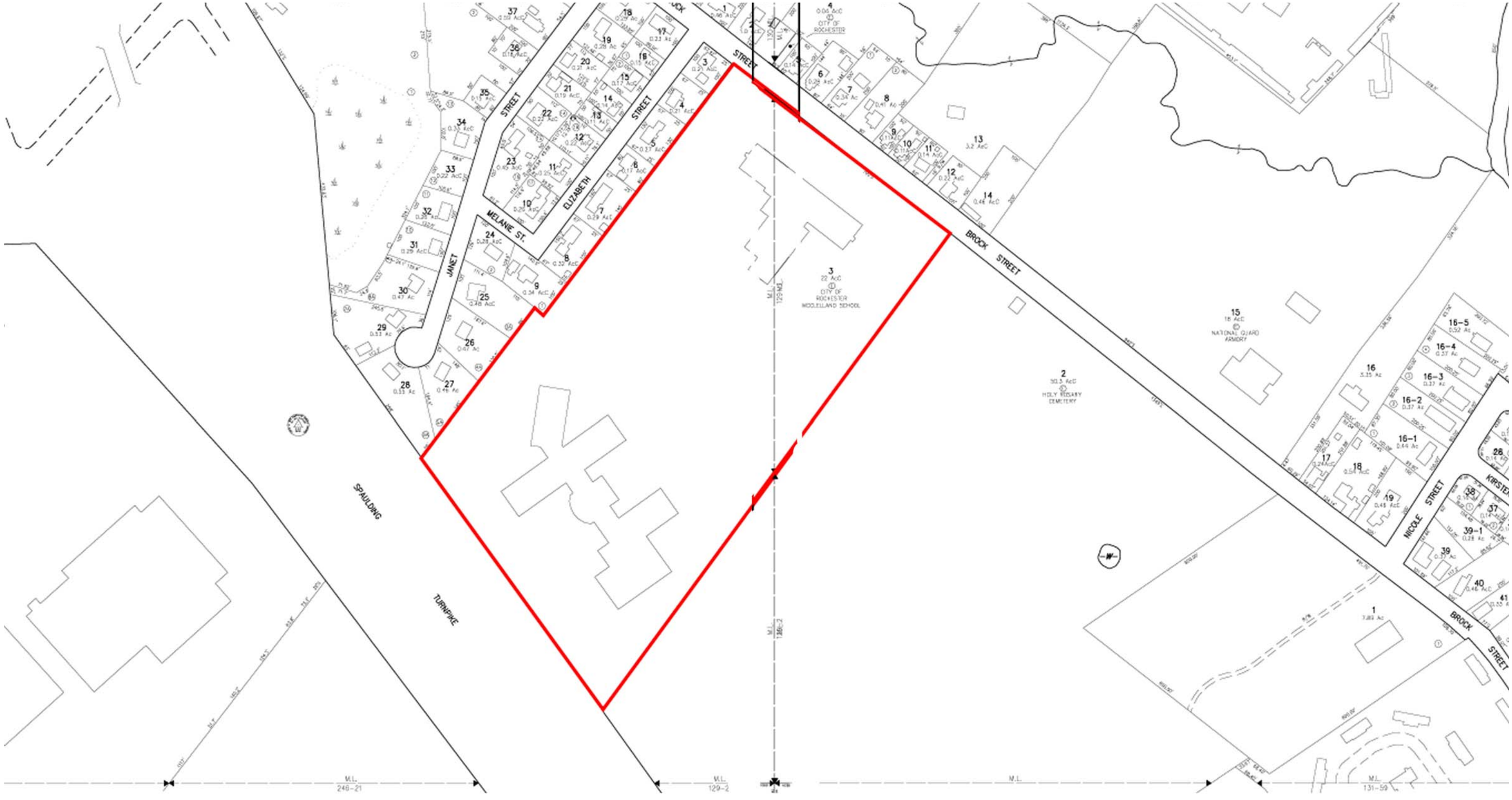
	# Classrooms*	Max Seats/ Classroom **	Utilization (90%)	Utilized Seats	Theoretical Student Capacity	
Education Areas Capacity	19	22	0.9	376.2	**376**	
Specialty Classrooms (Art.Music, Cpu, Etc)	3	22	0.9	59.4		
Current Utilization / Capacity					**98.62%**	

** Averaging K-5 Class Sizes

*** Standard 8 period day, allowing for no specials during first and last periods.

Core Capacity	Size of Area (sf)	Appropriately Sized?	Seats/persons	Utilization (90%)	Periods per week Offered***	Theoretical Student Capacity	
Art	855	Y	22	0.9	30	594	
Music	1027	Y	22	0.9	30	594	
Media Center	1185	Y	ed @ Students x .10 x 40 sf			296	Slightly undersized for current student poulation
Gymnasium	5552	Y	44	0.9	20	792	If Gym allows 2 classes/period
CPU Lab	900	Y	22	0.9	30	594	
Cafeteria	5552	Y	308	0.9	10	555.2	Shared Café-Gym

Existing Property Map



Existing Assessment - Main Level

Undersized Classroom

Note: some classrooms shown here are undersized by NH DOE standards of 900sf, however, do meet standards for requirement of 36sf per student.

Many classrooms still have a chalk-board rather than a white-board or an interactive white board.

Entrance is non-supervisable from Administration areas

Health Office does not have good privacy

These classrooms have poor acoustics due to hard ceiling.

These classrooms have poor acoustics due to hard ceiling.

- CIRCULATION
- CLASSROOMS
- SPECIAL EDUCATION / INTERVENTION
- SPECIALTY CLASSROOMS
- STAFF / FACILITY
- SUPPORT

Existing Assessment - Level 2

These areas suffer from poor ventilation.

- CIRCULATION
- CLASSROOMS
- SPECIAL EDUCATION / INTERVENTION
- SPECIALTY CLASSROOMS
- STAFF / FACILITY
- SUPPORT

Existing Site to Remain

Aerial Site - Courtesy of Bing Maps

Existing Assessment

Existing Building Condition

The School Street school is a 1911 School with very few modifications made over the past century. The exterior envelope is in good condition and provides for a comfortable interior environment. No comfort issues within classroom areas were reported by staff. Interior finishes on the upper two floors are vintage materials which in good condition. The basement would benefit from interior finish upgrades including wall surfaces, and acoustic ceilings. Lighting fixtures throughout the classrooms are direct T8 fluorescent (inefficient compared to today's standards) and should be scheduled for replacement.

Existing Site

With only 23 parking spaces on site, and an additional 8 available on the street (one being accessible), the school is short on parking; however, it should be noted that the staff currently manage with their available parking and had no complaints in this area. The playground and outdoor space is ample. Landscaping improvements have been made to the school including rain gardens and permeable paving.

Safety, Security and Code Compliance

The front entrance is not easily secured during the school day, but does have proper lines of site to provide a well supervised area. As a split-level design, entirety of the School Street School is non-accessible, with no elevator. Creating a fully accessible facility would require an additional entrance (as the main entrance does not lend itself to becoming an accessible entrance).

Acoustics and Daylighting

Classroom acoustics are adequate and daylighting is exceptional. While undersized, the classrooms have excellent proportions and built in storage.

Programming / Space Needs

Overview of Space Needs

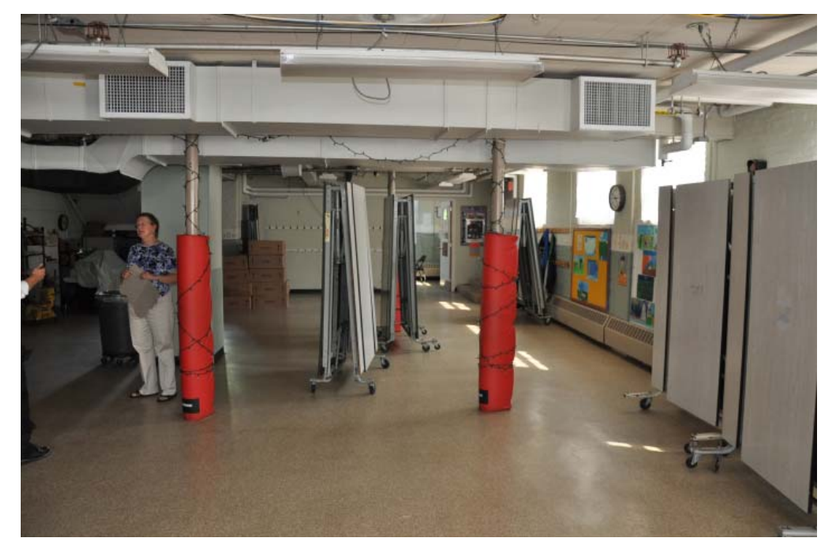
Administration noted they were very happy with the current school and the spaces available to them. However, in review of the specialty areas of School Street, it was noted that the Multi-purpose room is inadequate and unequal to offerings at other Rochester Schools.

The School Street school housed grades K-3 during the 2010-2011 school year and will be housing grades K-4 in the 2011-2012 school year. For the school to consider shifting it's enrollment to a K-5 school, it would need the following spaces:

- Appropriately sized Multi-purpose Room**
- Elevator**
- Accessible Rest rooms**
- Appropriately sized Health Office**
- Staff lunch/break room
- Staff work room
- 5th Grade Classroom
- Computer Lab**
- One more Special Education Area (preferably on upper floor)

** Even if the school remains K-4, these spaces should be considered.

The classrooms, although undersized, are nicely proportioned with vintage finishes and ample natural light.



The Multi-purpose room is essentially basement space without enough room for proper Physical Education classes.

Programming / Space Needs Calculations

School Street School Program Based on Enrollment

Education Program Areas

Course/Subject	# Students	Max Students/ Teaching Space	Utilization (90%)	# of Sections	Offered	Required Teaching Spaces (adjusted)	Number of Appropriately sized spaces in existing building	Required additional spaces	Notes
Kindergarten	20	18	0.90	1.23	Full Day	**1**	1	0	
1st Grade	20	20	0.90	1.11	Full Day	**1**	1	0	
2nd Grade	18	22	0.90	0.91	Full Day	**1**	1	0	
3rd Grade	16	22	0.90	0.81	Full Day	**1**	1	0	
4th Grade	14	25	0.90	0.62	Full Day	**1**	1	0	
5th Grade*	20	25	0.90	0.89	Full Day	**0**	0	0	
Total Enrollment	108					**5**			

If Added in the future (assumed enrollment)

Core Program Areas

Space	Student Access Per week (periods)	# of Students Served	# of Classes/wk	Calculated SF of Space (Per Standards)	Periods per week Offered***	# Spaces Required	Number of Appropriately sized spaces in existing building (or size of existing space)	Required additional spaces	Notes
Computer Lab	1	108	5		30	**1**	0	1	CPU lab located in Media Cetner - Currently undersized.
Art	1	88	5		15	**0.33**	0	0	Shared Art and Music Room could utilize existing MP room
Music	1	88	4		15	**0.27**	0	0	Shared Art and Music Room could utilize existing MP room
Physical Education	1	88	5		15	**1**	0	1	Undersized for PE
Media Center	1	108	5	432	30	**1**	478	0	Net Square Feet
Cafeteria	5	108	5	1944	15	**1**	1763	181	Net Square Feet
Special Education Student Areas*	5	21	51		30	**2**	1	1	Calculations assume 2 students/area
Intervention / Small Group Areas**	5	48	79		30	**3**	2	1	Calculations assume 3 students/area
Professional Areas								3	If converted to K-5, provide enlarged health/nurse, (1) staff lunch area, and (1) staff work room

* 19% of students identified to receive special services by District Special Education .
** 44% of students identified to receive Tier 2 or Tier 3 Intervention (Title 1) instruction
*** Standard 8 period day, allowing for no specials during first and last periods.

Dept of Ed allowable:	Age Group	Enrollment	SF/Pupil	Utilization	Total Building (NSF)	
For New Construction	Grade 1-5	88	144	0.90	14,080	
	Kindergarten - Trans	20	150	0.90	3,333	
					17,413	Total Allowable by NH DOE standards for new construction

Existing Analysis / Capacity

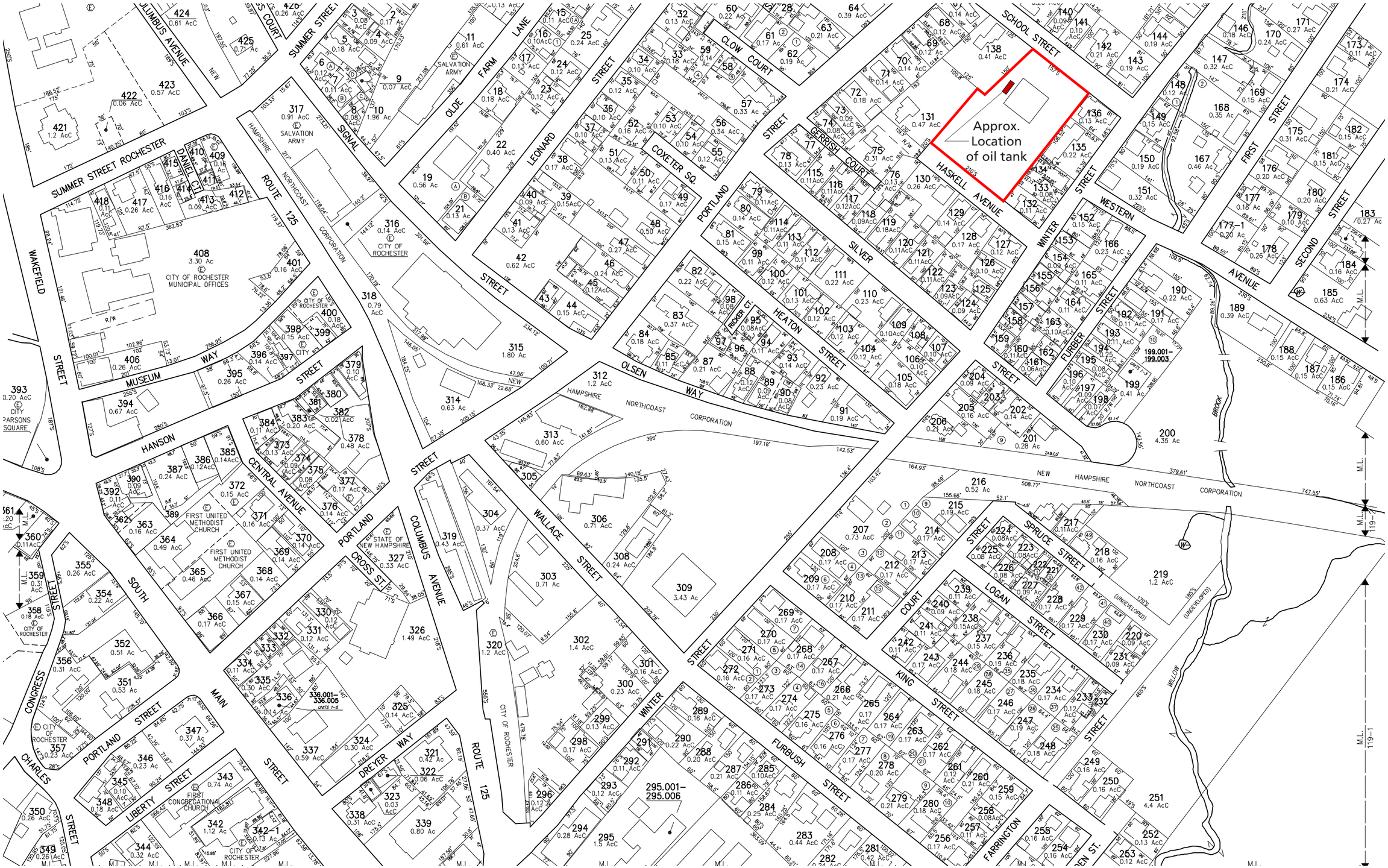
Current Enrollment	**88**	
Current Building Size (gsf)	13,259	excluding attic - 4,462 sf
Estimated Building Capacity Based solely on size of building	Based on Average NH School Construction of 144sf/student for Grades 1-5 and 150sf/student in K @ 90% Utilization: 82	

	# Classrooms*	Max Seats/ Classroom **	Utilization (90%)	Utilized Seats	Theoretical Student Capacity	
Education Areas Capacity	5	20	0.9	90	**90**	
Specialty Classrooms (Art.Music, Cpu, Etc)	1	20	0.9	18		See notes below
Current Utilization / Capacity					**97.78%**	

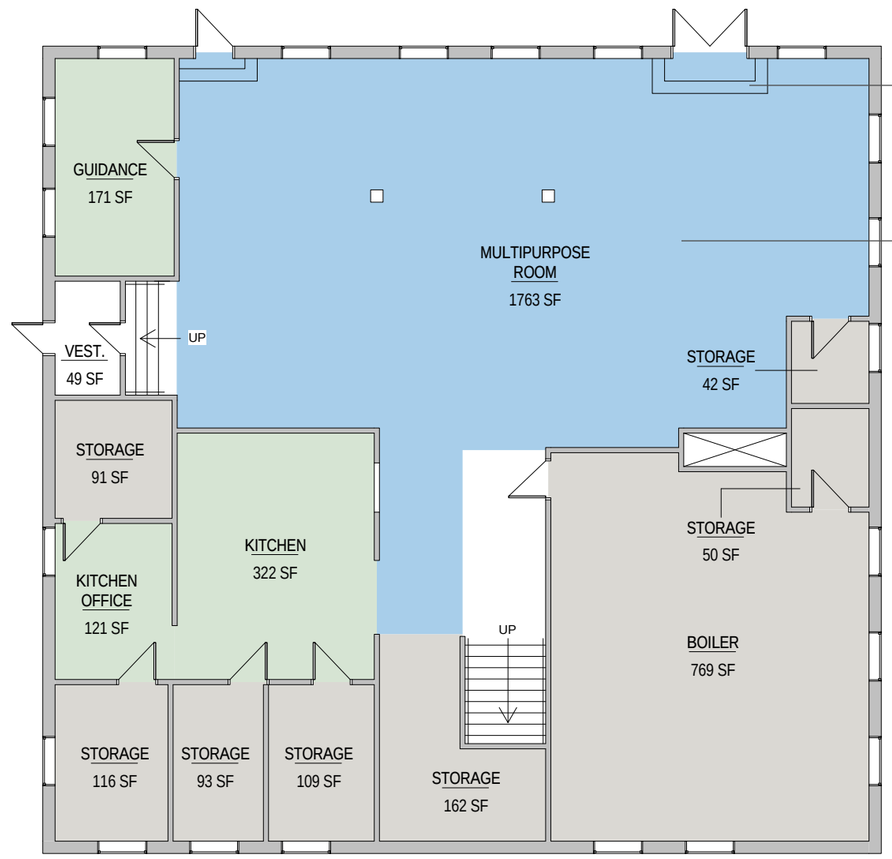
** Averaging K-2 Class Sizes (16 for Kindergarten, 24 for Grades 1 and 2)
*** Standard 8 period day, allowing for no specials during first and last periods.

Core Capacity	Size of Area (sf)	Appropriately Sized?	Seats/persons	Utilization (90%)	Periods per week Offered***	Theoretical Student Capacity	
Art	1763	Y	22	0.9	5	99	Taught in Multi-purpose Room
Music	1763	Y	22	0.9	5	99	Taught in Multi-purpose Room
Media Center	478	Y	ed @ Students x .10 x 40 sf			120	
Gymnasium	1763	N	44	0.9	5	198	
CPU Lab	478	N	22	0.9	5	99	Currently in Media Center - undersized as cannot fit entire class
Cafeteria	1763	Y	98	0.9	5	88.15	Slightly undersized for K-5

Existing Property Map



Existing Assessment - Basement



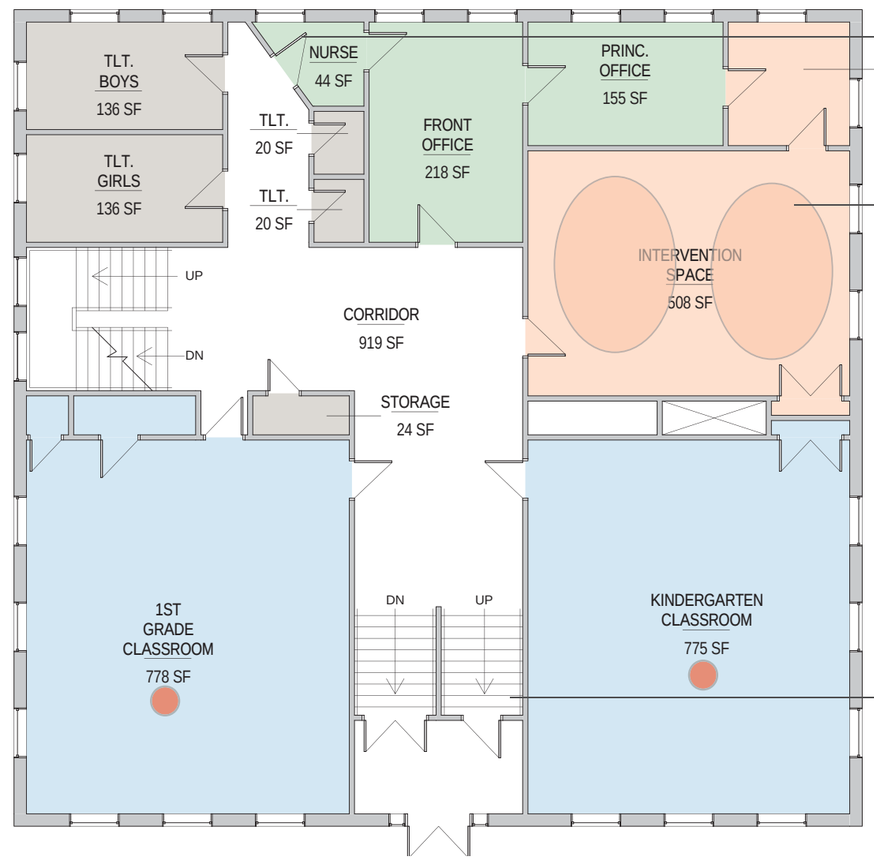
School is non-accessible throughout including each level and access to outdoor student areas

Undersized for PE (low ceiling height and lack of floor space)

- CIRCULATION
- CLASSROOMS
- SPECIAL EDUCATION / INTERVENTION
- SPECIALTY CLASSROOMS
- STAFF / FACILITY
- SUPPORT

Existing Assessment - Main Level

Undersized Classroom
Note: These classrooms cannot feasibly be expanded to 900sf standards. To meet NH DOE standards of 36sf per student, each of these classrooms should be limited to 21 students



Current Nurse/Health Office (undersized)

Current Intervention Spaces

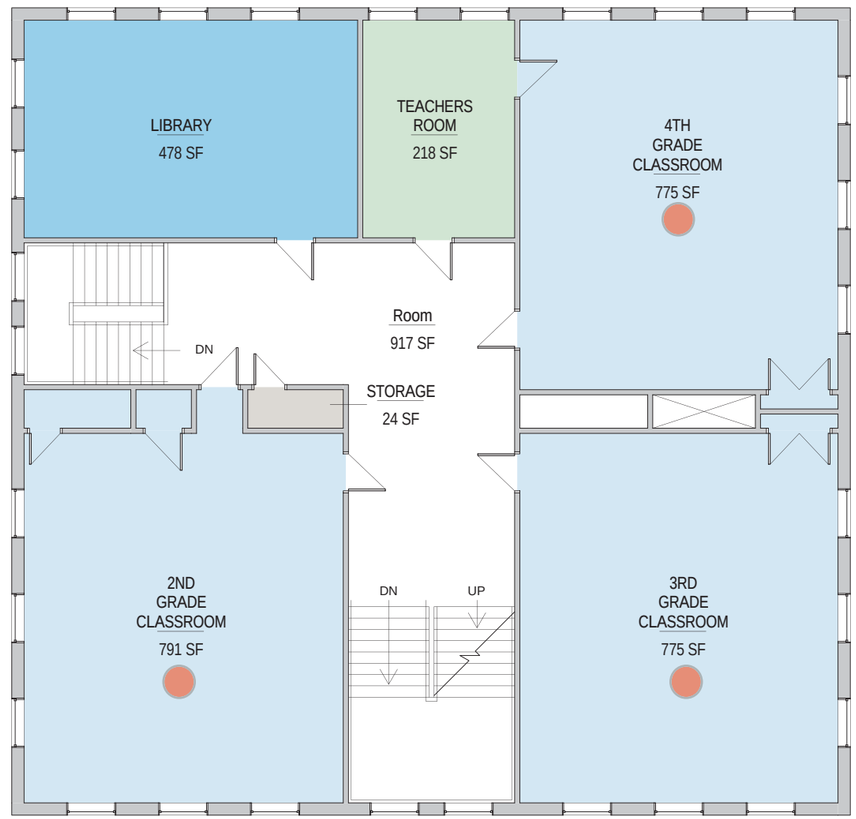
All levels of this school are non-accessible

- CIRCULATION
- CLASSROOMS
- SPECIAL EDUCATION / INTERVENTION
- SPECIALTY CLASSROOMS
- STAFF / FACILITY
- SUPPORT

Existing Assessment - Level 2

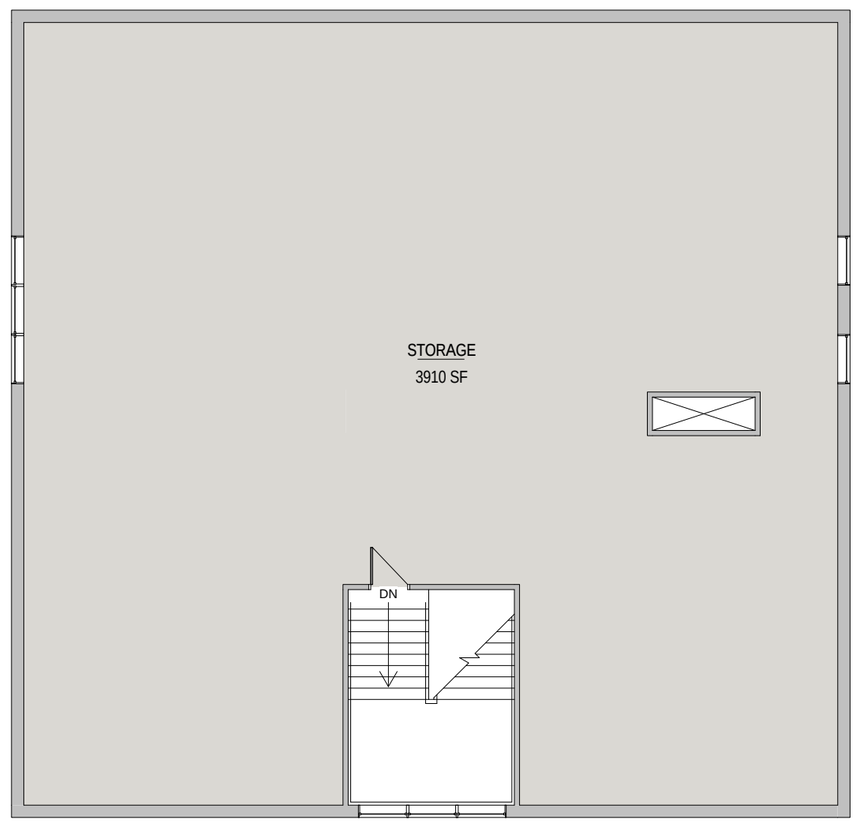
Undersized Classroom

Note: These classrooms cannot feasibly be expanded to 900sf standards. To meet NH DOE standards of 36sf per student, each of these classrooms should be limited to 21 students



- CIRCULATION
- CLASSROOMS
- SPECIAL EDUCATION / INTERVENTION
- SPECIALTY CLASSROOMS
- STAFF / FACILITY
- SUPPORT

Existing Assessment - Attic



- CIRCULATION
- CLASSROOMS
- SPECIAL EDUCATION / INTERVENTION
- SPECIALTY CLASSROOMS
- STAFF / FACILITY
- SUPPORT

Recommended Improvements

Aerial Site - Courtesy of Bing Maps

Proposed Plan - Basement

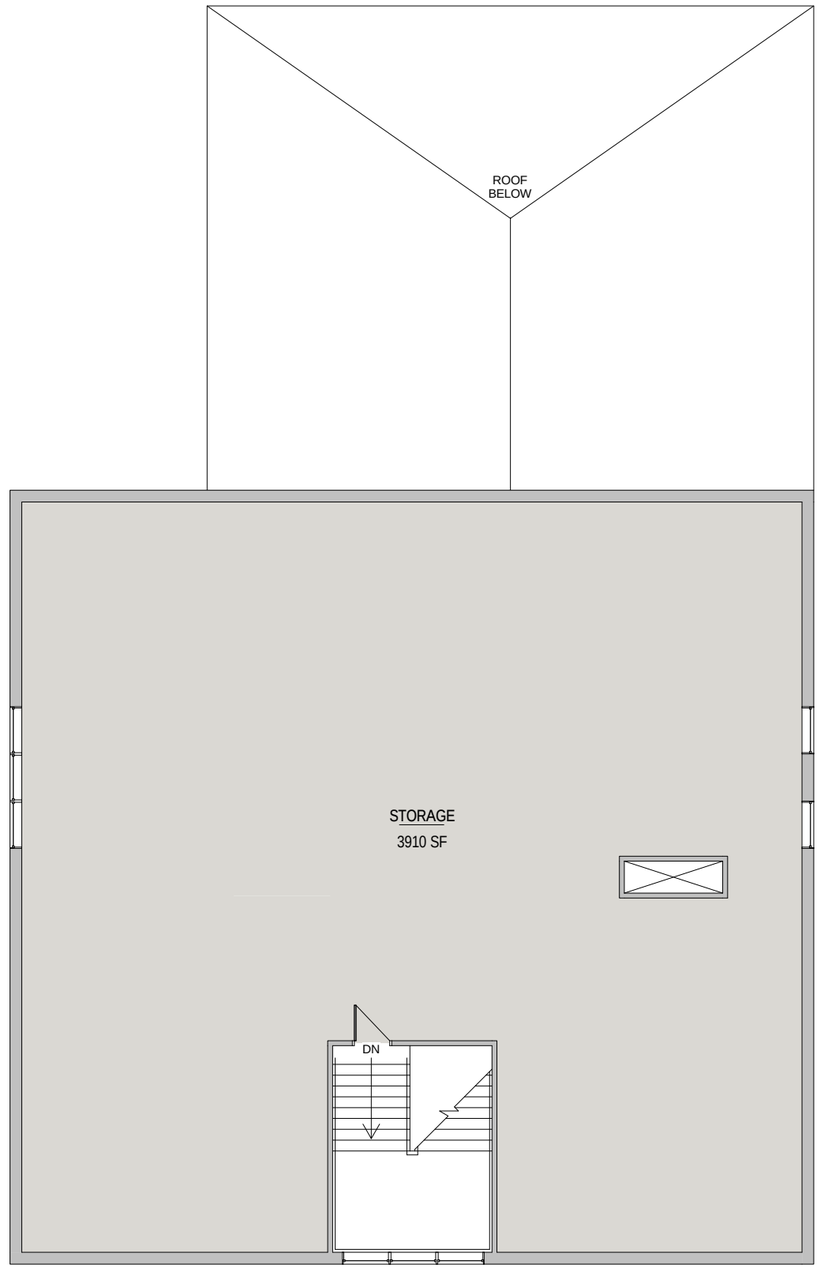
- CIRCULATION
- CLASSROOMS
- SPECIAL EDUCATION / INTERVENTION
- SPECIALTY CLASSROOMS
- STAFF / FACILITY
- SUPPORT

Proposed Plan - Main Level

Proposed Plan - Level 2

Proposed Plan - Attic

** No Changes on this level



- CIRCULATION
- CLASSROOMS
- SPECIAL EDUCATION / INTERVENTION
- SPECIALTY CLASSROOMS
- STAFF / FACILITY
- SUPPORT

Existing Assessment

Existing Building Condition

The East Rochester school is a 1968 open concept School with additions erected in 2000. The exterior envelope is in good condition. The interior layout, being an open concept design, does not work well and should be completely renovated. Comfort issues reported are the result of a single zone heating system, which should be fully replaced as part of a major renovation and interior fit-up at this school. Light fixtures should be replaced completely during this renovation (along with ceilings and all other interior finishes There are two portable structures on site, housing 3 preschool classrooms and 1 special education area. To help resolve space issues at East Rochester School, the pre-school program should be annexed from this building and built either on-site here or at another site. Note that the Special Education study encouraged the School District to consider collocating the Preschool and the ASD Programs with the Head Start program.

Existing Site

Parking is short and very condensed and should be increased by approximately 25 spaces for daytime use. Queuing for parent drop off and Busses was reported to be very problematic, creating traffic issues on Portland street. Outdoor athletics and play space are adequate and appropriately located This should be completely reorganized on site. The playground was noted to need new surfacing that would allow disabled students better access. It should also be noted that Pre-school students in the portables are a significant distance from the Pre-school playground.

Safety, Security and Code Compliance

The front entrance is easily supervisable and lacks a secure vestibule at the main entrance. This should be resolved as part for renovations at the East Rochester school. To further improve a secure environment during the school day, consideration should be given to removing the exterior doors directly from classrooms. Accessibility issues include no access to the stage and lack of accessible rest rooms for both staff and students. Code compliance for fire safety including separation of egress components will also be remedies as part of interior layout modifications. Air handling systems may also be brought up to current code at this time in terms of ventilation needs

.

Acoustics and Daylighting

Classroom acoustics are totally inadequate and fail to meet current standards (including the ANSI code) due to the open design. With very few windows in the existing building, daylighting is also poor at East Rochester school. A renovation of this building should include re-construction of portions of the exterior wall to allow operable windows in each classroom improving both daylighting and air quality.

Programming / Space Needs

Overview of Space Needs

The East Rochester school is lacking specialty education areas as well as some select professional areas. The Pre-school is severely undersized, as is evident by the use of portable structures. In general, the following spaces should be added:

- New pre-school structure (including 12 education areas and support spaces)
- New ASD area
- (1) appropriately sized Kindergarten room (potentially re-purposed from the pre-school area)
- Appropriately sized Music Classroom
- Appropriately sized Art Classroom
- Computer Lab (to allow for appropriately sized Media Center)
- Conference room
- Storage Space
- Staff Break Room
- Professional Development Space

Classrooms are essentially open to one-another, separated by only partial height partitions or storage units as shown here. No acoustic separation and little natural light make for poor interior learning environments.

East Rochester School Program Based on Enrollment

Education Program Areas

Course/Subject	# Students	Max Students/ Teaching Space	Utilization (90%)	# of Sections	Offered	Required Teaching Spaces (adjusted)	Number of Appropriately sized spaces in existing building	Required additional spaces	Notes
Preschool	258	12	0.90	23.89	Students attend 2.5 days/week	**12**	1	11	95 students are in Pre-school now- plus an additional 34 recomened by Special Educaiton Report. Population cinrease 100% to acheive 50% integration.
ASD Program	12	12	0.90	1.11	Full Day	**1**	1	0	
Kindergarten	41	18	0.90	2.53	Full Day	**3**	1	2	One Classroom undersized
1st Grade	33	20	0.90	1.83	Full Day	**2**	2	0	
2nd Grade	44	22	0.90	2.22	Full Day	**2**	2	0	Very close to needing a 3rd classroom (44 kids max capacity)
3rd Grade	49	22	0.90	2.47	Full Day	**3**	2	1	Note: Should Nancy Loud get a 5th grade, 2 classrooms would be adequate
4th Grade	60	25	0.90	2.67	Full Day	**3**	3	0	Note: Should Nancy Loud get a 4th grade, 2 classrooms would be adequate
5th Grade	51	25	0.90	2.27	Full Day	**3**	3	0	
Total Enrollment	548					**29**			

Core Program Areas

Space	Student Access Per week (periods)	# of Students Served	# of Classes/wk	Calculated SF of Space (Per Standards)	Periods per week Offered***	# Spaces Required	Number of Appropriately sized spaces in existing building (or size of existing space)	Required additional spaces	Notes
Computer Lab	1	278	29		30	**1**	1	0	Could be relocated to allow for adequate sized Media Center
Art	1	237	29		30	**1**	0	1	
Music	1	237	13		30	**1**	0	1	Stage not counted since it is not acoustically sealed for Instruction
Physical Education	1	237	29		15	**2**	2952	0	Could be satisfied through dividing curtain
Media Center	1	278	29	1112	30	**1**	750	362	Net Square Feet - could be restored to adequate size if CPU lab is relocated
Cafeteria	5	278	20	1043	15	**2**	2952	0	Net Square Feet
Special Education Student Areas*	5	64	160		30	**6**	6	0	Calculations assume 2 students/area
Intervention / Small Group Areas**	5	70	116		30	**4**	4	0	Calculations assume 3 students/area
Professional Areas								4	(1) Conference Room for 12 , (1) staff break room, (1) Professional Development / Staff room, (1) building sotrage area

* 23% of students identified to receive special services by District Special Education .

** 25% of students identified to receive Tier 2 or Tier 3 Intervention (Title 1) instruction

*** Standard 8 period day, allowing for no specials during first and last periods.

Dept of Ed allowable:	Age Group	Enrollment	SF/Pupil	Utilization	Total Building (NSF)	
For New Construction	Grade 1-5	237	120	0.90	31,600	
Does not include Preschool and ASD programs	Kindergarten - Trans	41	150	0.90	6,833	
					38,433	Total Allowable by NH DOE standards for new construction

Existing Analysis / Capacity

Current Enrollment					**373**	
Current Building Size (gsf)					34,412	Excluding Portables
Estimated Building Capacity Based solely on size of building	Based on Average NH School Construction of 120sf/student for Grades 1-5 and 150sf/student in K @ 90% Utilization				248	
	# Classrooms*	Max Seats/ Classroom **	Utilization (90%)	Utilized Seats	Theoretical Student Capacity	
Education Areas Capacity	12	22	0.9	237.6	**238**	
Specialty Classrooms (Art.Music, Cpu, Etc)	3	20	0.9	54		See notes below
Current Utilization / Capacity					**156.99%**	

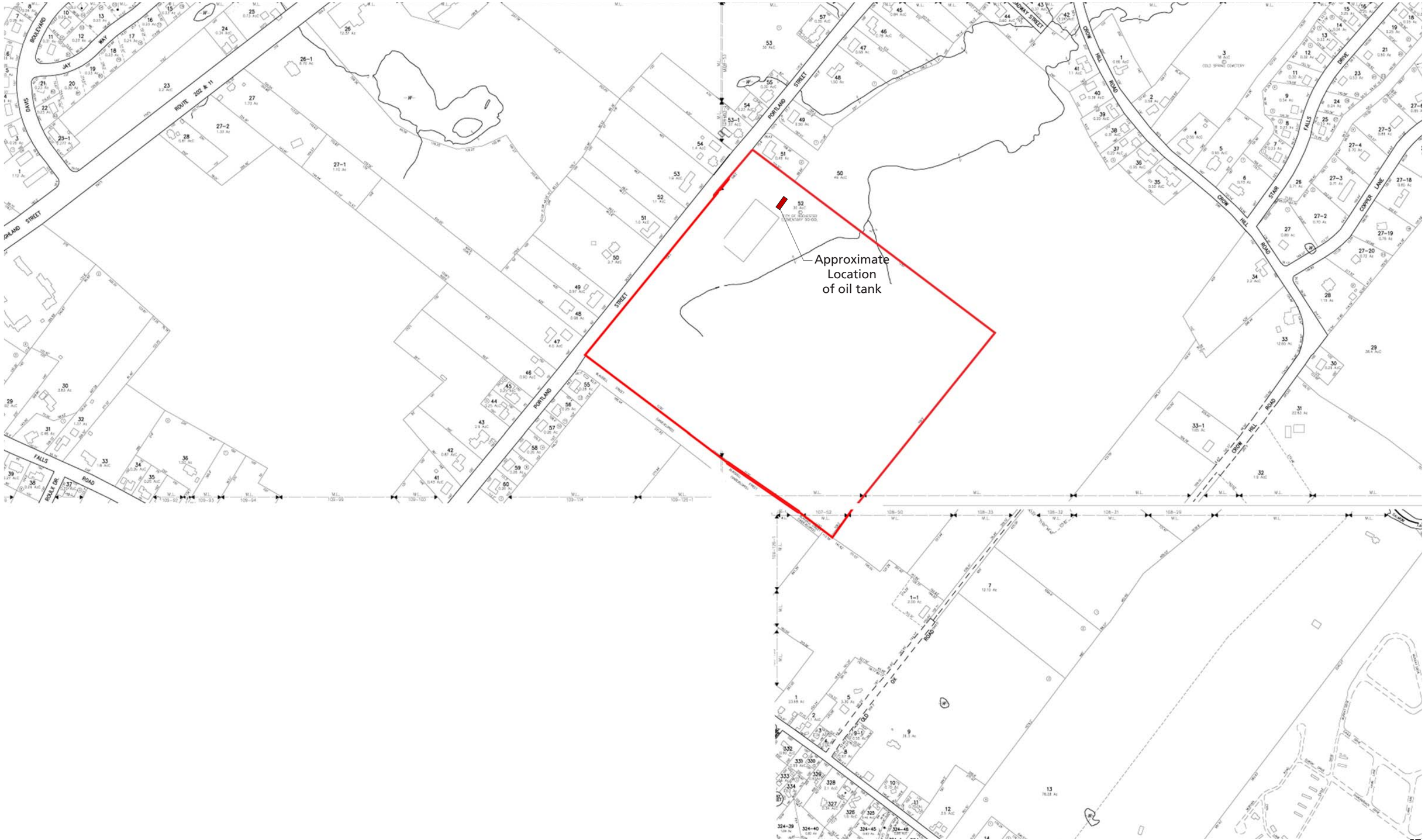
*Currently, there are 15 Homerooms. Deduct one each for the following: Art, Music, Media Center

** Averaging K-2 Class Sizes (16 for Kindergarten, 24 for Grades 1 and 2)

*** Standard 8 period day, allowing for no specials during first and last periods.

Core Capacity	Size of Area (sf)	Appropriately Sized?	Seats/persons	Utilization (90%)	Periods per week Offered***	Theoretical Student Capacity	
Art	390	N	22	0.9	30	594	Severly undersized room to fit 22 students
Music	366	N	22	0.9	30	594	Severly undersized room to fit 22 students
Media Center	750	N	ed @ Students x .10 x 40 sf			188	
Gymnasium	2952	Y	44	0.9	15	594	If Gym allows 2 classes/period
CPU Lab	750	Y	22	0.9	30	594	
Cafeteria	2952	Y	164	0.9	15	442.8	Shared Café-Gym

Existing Property Map



Existing Assessment

Undersized Music classroom

None of these walls extend to the ceiling therefore do not acoustically separate rooms

Undersized Art classroom

No natural light at these classrooms

Undersized Kindergarten classroom

School lacks fire/smoke separation at egress corridors

Direct doors from classrooms reduce school security

Poor amounts of natural lighting throughout classroom areas

No accessible access to stage

- CIRCULATION
- CLASSROOMS
- SPECIAL EDUCATION / INTERVENTION
- SPECIALTY CLASSROOMS
- STAFF / FACILITY
- SUPPORT

Recommended Improvements

Aerial Site - Courtesy of Bing Maps

Proposed Plan

New vestibule area

Repurpose Music room for a Reading + Intervention classroom

Demolish and renovate 16,800 GSF in order to remove all partial height partitions and replace with full height partitions to provide better acoustic quality and fire and smoke protection in egress corridors. Renovation will also provide appropriately sized Library, Computer Lab, Music + Art room, and accessible restrooms.

** Note: A waiver on class sizes from the DOE will be required. Recent conversations with them indicate that variance could be given if class sizes were limited not to exceed 36 square feet per student, consistent with ED321

Exterior envelope modifications

Renovate entrance to create a secure entrance vestibule

- CIRCULATION
- CLASSROOMS
- SPECIAL EDUCATION / INTERVENTION
- SPECIALTY CLASSROOMS
- STAFF / FACILITY
- SUPPORT

Existing Assessment

Existing Building Condition

The William Allen school is a 1964 School with a 1973 addition and Kindergarten additions erected in 2000. The exterior envelope is in good condition and appears to have high efficiency window retrofits (Kalwall type frames). Comfort issues were reported in south facing classrooms and the main office areas (also south facing). Increased ventilation or air conditioning could remedy these issues. Interior finishes are in need of repair in select areas (such as rest rooms) and ceilings should be scheduled for replacement. Lighting fixtures throughout the classrooms are direct T8 fluorescent (inefficient compared to today's standards) and should be scheduled for replacement at the time suspended ceiling tile are replaced.. There are two portable structures on site, housing two classrooms and one special education space. It was noted that the portable classroom units are at the end of their life.

Existing Site

Parking appears is short for staff and visitors by approximately 25 spaces. The drop-off area for busses is undersized, and parents use the street for drop off, both of which should be remedied. Outdoor athletics and play space are excellent, however access to these areas is challenging. Currently students traverse a sizable hill to access these. Serious grading or a complete relocation would be required to resolve this issue. It should be noted that modifications to this site are extremely challenging given the tight property lines, limited access points, and steep grades bounding the usable area.

Safety, Security and Code Compliance

The front entrance is not supervisable due to configuration and lines of sight, resulting in a poorly secured facility. Without an elevator, the lower floor of this school is non-accessible. To make this building an accessible facility, accessible rest rooms would also need to be added. Fire safety and Egress components appear to be in good standing.

Acoustics and Daylighting

Acoustic issues can be found throughout the facility, as many partitions which have been added in recent years do not extend to the ceiling. These areas include, three classrooms, special education areas, administrative areas, and intervention areas. Daylighting is adequate throughout the classrooms.

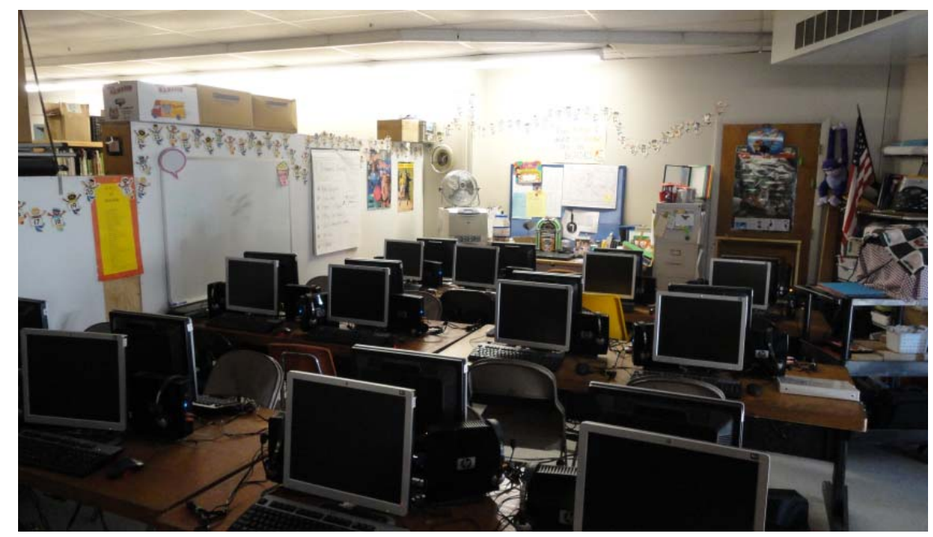
Programming / Space Needs

Overview of Space Needs

The William Allen school is lacking education areas, as is evident by the use of Portable Structures. Reconfiguration of the school could solve many issues with core areas. The school is currently lacking the following spaces:

- Accessible Student Rest rooms
- Staff/Adult Rest rooms
- Art Classroom (currently provide art-on-a-cart)
- Music Classroom (currently offered on stage which has no acoustic separation from MP room making music instruction difficult)
- Conference rooms
- Computer Lab (Current CPU lab is undersized)
- 2 4th Grade Classrooms (Currently in Portable)
- 1 1st grade Classroom (currently using spaces that are not adequately sized)
- 2 Kindergarten Classrooms (one undersized, one missing)
- Special Education Space (One currently in Portable)

Partial height walls dividing the main office from student intervention areas provide for no acoustic separation. Similar conditions existing in many areas of the school.



Lack of space in the Media Center and the Computer Lab is compounded by poor acoustic separation to render these areas inadequate for educational needs. Reconfiguration and renovation could remedy these issues.

Programming / Space Needs Calculations

William Allen School Program Based on Enrollment

Education Program Areas

Course/Subject	# Students	Max Students/ Teaching Space	Utilization (90%)	# of Sections	Offered	Required Teaching Spaces (adjusted)	Number of Appropriately sized spaces in existing building	Required additional spaces	Notes
Kindergarten	58	18	0.90	3.58	Full Day	**4**	2	2	1 K Classroom undersized
1st Grade	46	20	0.90	2.56	Full Day	**3**	2	1	1 Classroom is severly undersized
2nd Grade	44	22	0.90	2.22	Full Day	**3**	3	0	Might be able to use 2 classrooms only with only 44 students (100% full)
3rd Grade	49	22	0.90	2.47	Full Day	**3**	3	0	Need improved aceess to one of these classrooms if it remains
4th Grade	58	25	0.90	2.58	Full Day	**3**	1	2	Excludes Portables
5th Grade	62	25	0.90	2.76	Full Day	**3**	3	0	
Total Enrollment	317					**19**			

Core Program Areas

Space	Student Access Per week (periods)	# of Students Served	# of Classes/wk	Calculated SF of Space (Per Standards)	Periods per week Offered***	# Spaces Required	Number of Appropriately sized spaces in existing building (or size of existing space)	Required additional spaces	Notes
Computer Lab	1	317	19		30	**1**	0	1	Computer lab is undersized and becomes very tight when capacity is over 10.
Art	1	259	19		30	**1**	0	1	Art teacher travels from room to room, there is no room dedicated to art.
Music	1	259	15		30	**1**	0	1	Stage not counted as is not acoustically separated
Physical Education	1	259	19		15	**2**	1	1	
Media Center	1	317	19	1268	30	**1**	1124	144	
Cafeteria	5	317	20	1189	15	**2**	4281	0	Net Square Feet
Special Education Student Areas*	5	60	151		30	**6**	6	0	
Intervention / Small Group Areas**	5	63	106		25	**5**	4	1	
Professional Areas								4	1 calming room (special educaiton), 1 confernece room for 12, and one space for professional development, 1 special education staff area

* 19% of students identified to receive special services by District Special Education .

** 20% of students identified to receive Tier 2 or Tier 3 Intervention (Title 1) instruction

*** Standard 8 period day, allowing for no specials during first and last periods.

Dept of Ed allowable:	Age Group	Enrollment	SF/Pupil	Utilization	Total Building (NSF)	
For New Construction	Grade 1-5	259	144	0.90	41,440	
	Kindergarten - Trans	58	150	0.90	9,667	
					51,107	Total Allowable by NH DOE standards for new construction

Existing Analysis / Capacity

Current Enrollment					**317**	
Current Building Size (gsf)					38,283	Excluding Portables
Estimated Building Capacity Based solely on size of building	Based on Average NH School Construction of 144sf/student for Grades 1-5 and 150sf/student in K @ 90% Utilization				238	
	# Classrooms*	Max Seats/ Classroom **	Utilization (90%)	Utilized Seats	Theoretical Student Capacity	
Education Areas Capacity	13	22	0.9	257.4	**257**	
Specialty Classrooms (Art, Music, Cpu, Etc)	3	20	0.9	54		See notes below
Current Utilization / Capacity					**123.15%**	

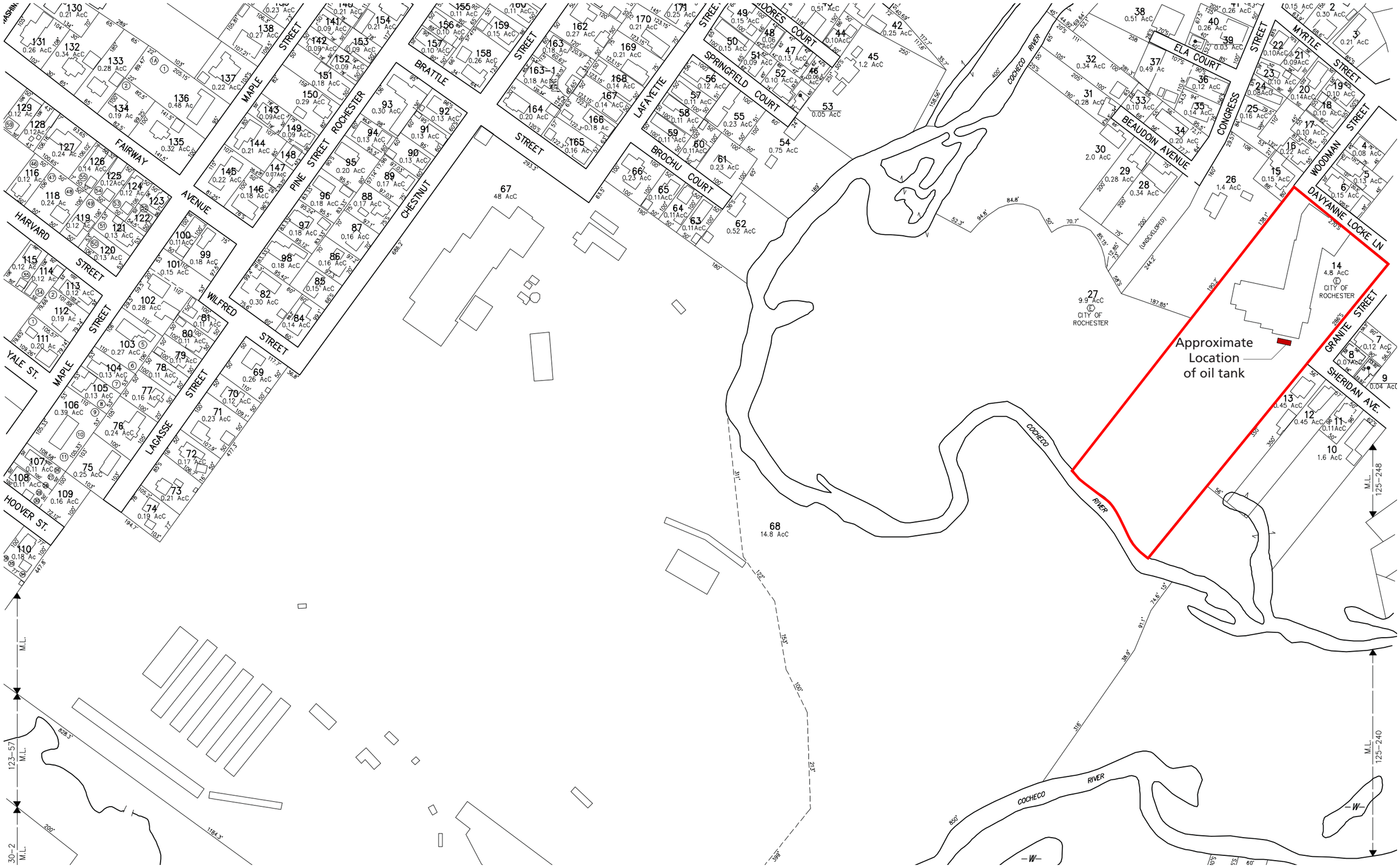
*Currently, there are 16 Homerooms. One is severly undersized and another has no access. Deduct one each for Art

** Averaging K-5 Class Sizes (16 for Kindergarten, 24 for Grades 1 and 2)

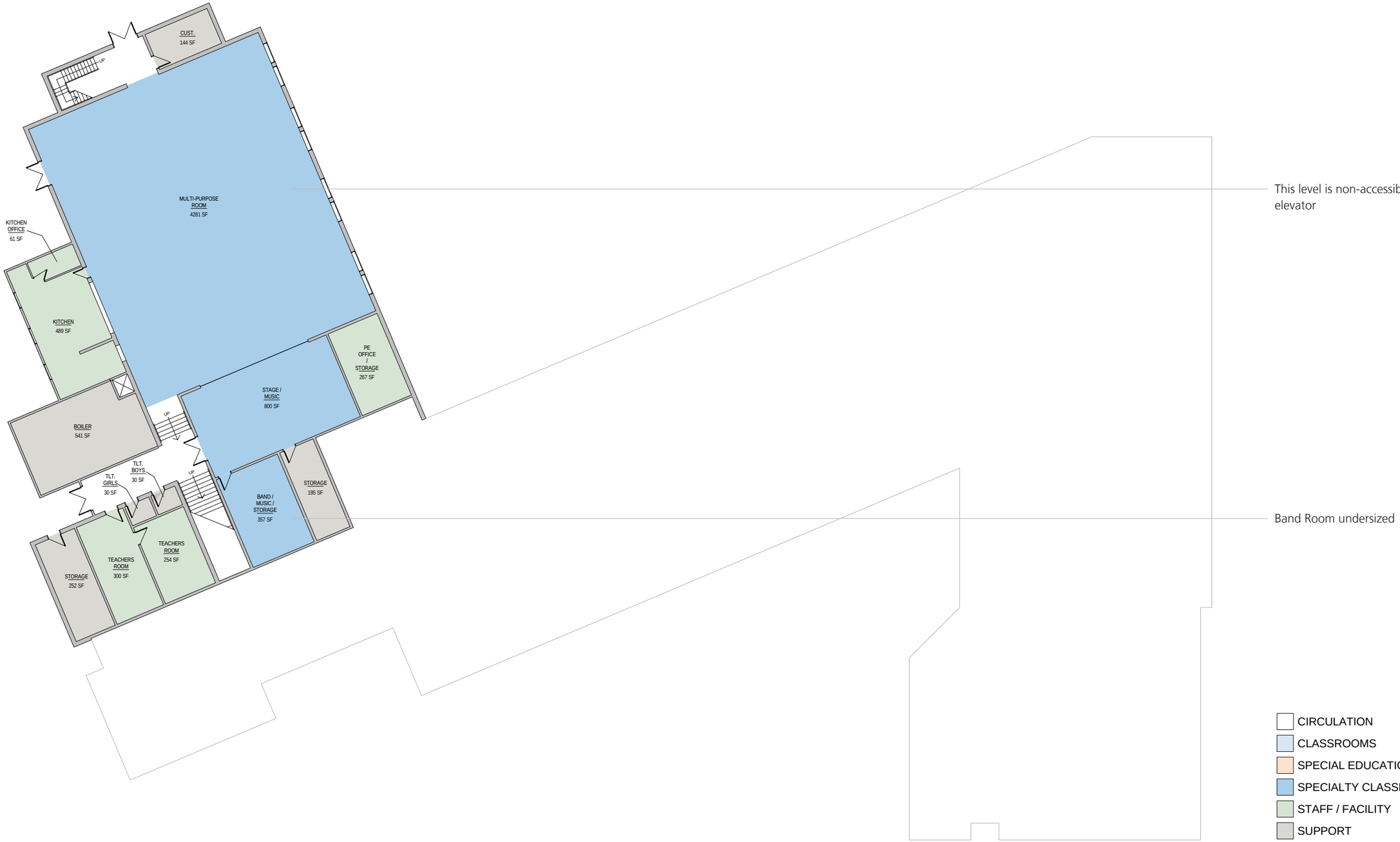
*** Standard 8 period day, allowing for no specials during first and last periods.

Core Capacity	Size of Area (sf)	Appropriately Sized?	Seats/persons	Utilization (90%)	Periods per week Offered***	Theoretical Student Capacity	
Art	900	Y	22	0.9	30	594	Slightly Undersized Area - If restored from a classroom
Music	800	N	22	0.9	30	594	If stage is used, Needs separation from MP room (folding partition or other)
Media Center	1124	N	Calculated @ Students x .10 x 40 sf			281	Should expand back into adjacent classroom
Gymnasium	4281	Y	44	0.9	15	594	If Gym allows 2 classes/period
CPU Lab	375	N	22	0.9	30	594	Would need to be enlarged
Cafeteria	4281	Y	238	0.9	15	642	Shared Café-Gym

Existing Property Map



Existing Assessment - Basement



Existing Assessment - Main Level

Undersized Classroom

Note: some classrooms shown here are undersized by NH DOE standards of 900sf, however, do meet standards for requirement of 36sf per student.

Reported comfort issues in these rooms

Current Intervention Space poorly located

No acoustic separation in these spaces

No acoustic separation in these spaces

Non-supervisable entrance from Administration areas

No acoustic separation in these spaces

- CIRCULATION
- CLASSROOMS
- SPECIAL EDUCATION / INTERVENTION
- SPECIALTY CLASSROOMS
- STAFF / FACILITY
- SUPPORT

Recommended Improvements

Aerial Site - Courtesy of Bing Maps

Proposed Plan - Lower Level

- CIRCULATION
- CLASSROOMS
- SPECIAL EDUCATION / INTERVENTION
- SPECIALTY CLASSROOMS
- STAFF / FACILITY
- SUPPORT

Proposed Plan - Main Level

Existing Assessment

Existing Building Condition

The Rochester Middle School was built in 1992 with additions completed in 2002. The exterior envelope is in good condition and provides for a comfortable interior environment. Comfort issues were reported in only a few rooms, which could likely be resolved through HVAC control management, Interior finishes are in generally good condition and appear to be well maintained. Although subjective, it could be noted that the exterior and interior finishes are bland an lack life with the exception of the student implemented wall murals. The wall murals should be preserved and expanded upon to give the facility an improved ambiance appropriate of a Middle School.

Existing Site

Parking appears adequate for staff but short for visitors. It was noted by the Principal that as many as 17 spaces could be added at various areas around the building (at very little costs). The drop-off area for busses and parents works well. Athletic Field Access, although crossing a vehicular lane, is appropriate for students of this age given the small amount of daytime traffic here.
The outdoor student area adjacent to the cafeteria would benefit from landscaping improvements including hardscape and high traffic natural space such as synthetic turf and natural plantings. This area is currently dirt / mud due to it's high use.

Safety, Security and Code Compliance

The building, being a newer facility, is in good standing with fire safety and security standards. The school appears to be fully accessible. As always furnishings within each education area must observe proper clearances as required to maintain this accessibility throughout the school day.

Acoustics and Daylighting

Classroom acoustics are good (with the exception of one room which was reported to have acoustic issues). Daylighting, while being minimal, is adequate throughout most areas. Increase daylighting could be realized in many areas such as the gymnasium and the music rooms through the use of skylights.

Programming / Space Needs

Overview of Space Needs

The Rochester Middle School is appropriately sized for it's current student population. While programming calculations point out that the Cafeteria is slightly under the recommended area, it should be noted that the school operates well with the space it has in this room. Programming calculations also note that the Rochester Middle School is short on World language classrooms, however, this shortage is easily addressed by allowing use of the general classrooms for World Languages. It should also be noted that, based on current populations, one sixth grade classroom and two eight grade classrooms could be re-purposed to meet World Language needs. Programming also notes that the school should provide 2 more areas for Intervention, which could be created within one of the Computer Labs, as it appears that two would be adequate to handle the current curriculum.

Student created wall murals give life the Rochester Middle School. This effort should be embraced.

Some areas, like the gymnasium, lack natural light. To remedy this, diffuse lensed skylights could be provided, along with daylight harvesting sensors, to both improve lighting and provide energy savings. Cost effective solutions include packaged round skylight units (such as Solar-tubes), small rectangular packaged units, or pyramidal skylight units.

Programming / Space Needs Calculations

Rochester Middle School Program Based on Enrollment

Education Program Areas

Course/Subject	# Students	Max Students/ Teaching Space	Utilization (90%)	# of Sections	Offered	Required Teaching Spaces (adjusted)	Number of Appropriately sized spaces in existing building	Required additional spaces	Notes
6th Grade	308	25	0.90	13.69	Full Day	**14**	15	-1	15 current rooms could accommodate 337 kids at 90% utilization
7th Grade	341	25	0.90	15.16	Full Day	**16**	16	0	16 current rooms could accommodate 360 kids at 90% utilization
8th Grade	311	25	0.90	13.82	Full Day	**14**	16	-2	15 current rooms could accommodate 360 kids at 90% utilization
Total Enrollment	960					**44**			

Core Program Areas

Space	Student Access Per week (periods)	# of Students Served	# of Classes/wk	Calculated SF of Space (Per Standards)	Periods per week Offered***	# Spaces Required	Number of Appropriately sized spaces in existing building (or size of existing space)	Required additional spaces	Notes
Computer Lab	5	240	55		40	**2**	3	-1	
Art	5	240	55		40	**2**	2	0	
Music/Band	5	240	55		40	**2**	2	0	Note: one classroom is undersized (suited for 12 students or less)
Tech Ed (Industrial Arts)	3	240	23		40	**1**	1	0	
FACS	3	240	23		40	**1**	1	0	Note: one classroom is undersized (suited for 12 students or less)
World Language	5	240	150		40	**4**	2	2	
Health/Wellness	5	240	55		40	**2**	1	1	
Physical Education	5	240	55		40	**2**	2	0	Assuming two stations in gym per preiod
Media Center	1	960	44	3840	40		3516	324	Net Square Feet
Cafeteria	5	960		4800	15		4000	800	Net Square Feet
Excel Program	5	96	96		40	**3**			Calculations assume 5 students/section
Special Education Student Areas*	5	240	600		40	**15**	15	0	Calculations assume 2 students/section, and 2 sections per area in existing plan
Intervention / Small Group Areas**	5	240	400		40	**10**	8	2	Calculations assume 2 students/section, and 2 sections per area in existing plan
Professional Areas								0	

* 25% of students identified to receive special services by District Special Education .
** 25% of students identified to receive Tier 2 or Tier 3 Intervention (Title 1) instruction
*** 10% of all kids working within excel prorgam
Standard 8 period day used for calculations
Numbers based on student access for UA classes as listed below

CPU Lab: 25% of all students at 5 days per week
Art: 25% of all students at 5 days per week
Music: All Students at 3 days per week
FACS: 25% of 7-8 graders at 3 days per week
Reading: taught in home classrooms
World Languages: All 7-8 Graders at 5 days per week
Health/Wellness: 25% of all students at 5 days per week
Tech Ed: 25% of 7/8 Graders at 3 days per week
PE: 25% of all students enrolled at 5 days per week
Media Center: All Students 1 day per week.

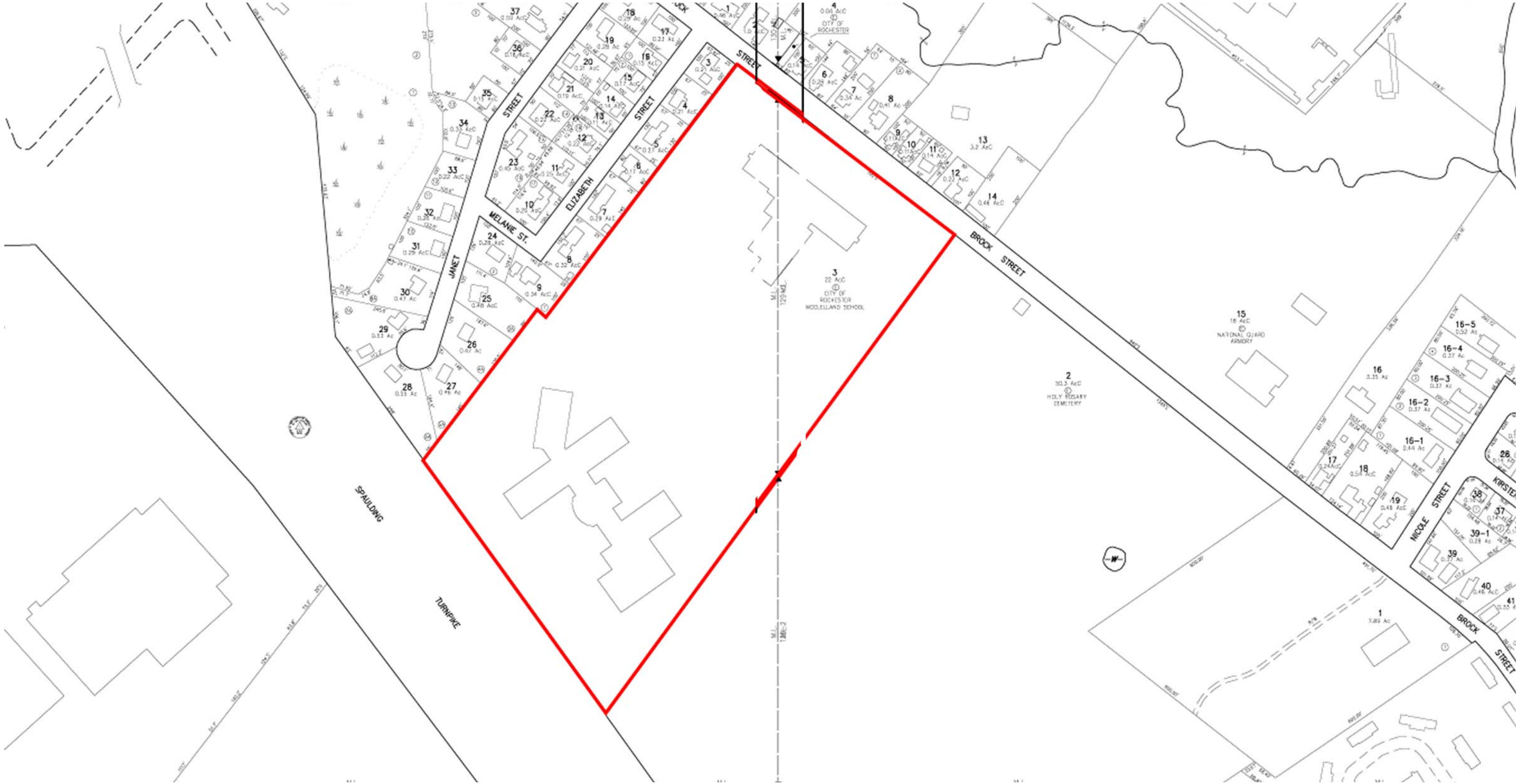
Dept of Ed allowable:	Age Group	Enrollment	SF/Pupil	Utilization	Total Building (NSF)	
For New Construction	Grade 6-8	960	140	0.90	149,333	Total Allowable by NH DOE standards for new construction

Existing Analysis / Capacity

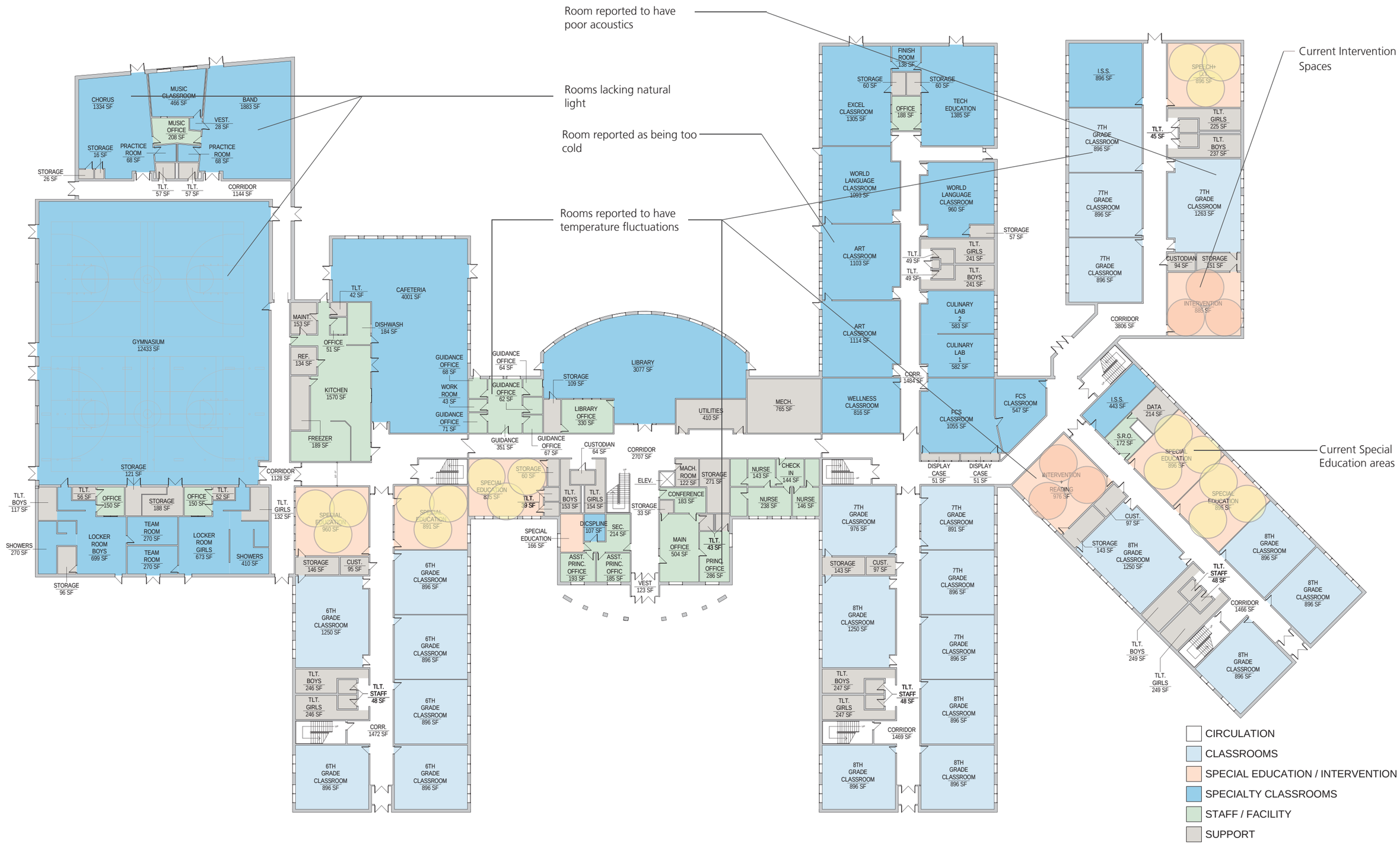
Current Enrollment					**960**	
Current Building Size (gsf)					155,536	Excluding Portables
Estimated Building Capacity Based solely on size of building	Based on Average NH School Construction of 140sf/student				1,000	
	# Classrooms	Max Seats/ Classroom **	Utilization (90%)	Utilized Seats	Theoretical Student Capacity	
Education Areas Capacity	47	25	0.9	1057.5	**1058**	
Specialty Classrooms (Art.Music, Cpu, Etc)	12	25	0.9	270		
Current Utilization / Capacity					**90.78%**	

Core Capacity	Number of Areas (or s	Appropriately Sized?	Seats/persons	Utilization (90%)	Periods per week Offered***	Theoretical Student Capacity	
Art	2	Y	25	0.9	40	1800	
Music	3	Y	25	0.9	40	2700	
Media Center	3516	N	Calculated @ Students x .10 x 40 sf			879	
Gymnasium	12433	Y	50	0.9	40	1800	If Gym allows 2 classes/period
CPU Lab	3	N	25	0.9	40	2700	
Cafeteria	4000	Y	267	0.9	15	720	Allowing for 15sf/student @ 3 periods per day

Existing Property Map



Existing Assessment - Main Level



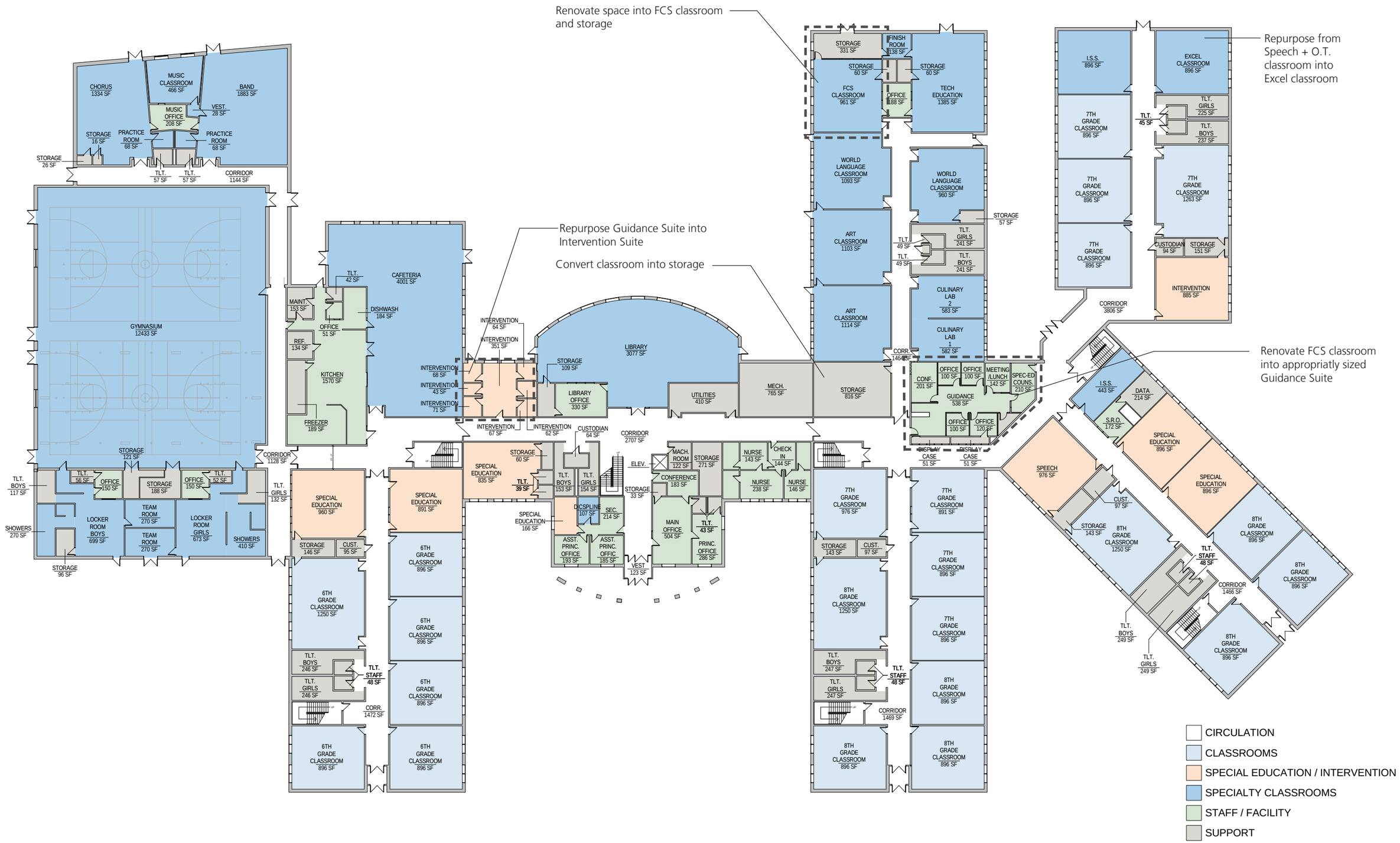
Existing Assessment - Level 2

Recommended Improvements

Aerial Site - Courtesy of Bing Maps

Rochester Middle School

Proposed Plan - Main Level



Proposed Plan - Level 2

** No Changes on this level

Order of Magnitude Costs

Construction Estimates

These Order of Magnitude costs are based on preliminary construction estimates and include hard construction costs for the building and site. Hard construction costs for the building can be defined as the cost of the physical building from the foundation upwards including all permanent building systems. "Soft Costs" can also have significant effects on the total amount of a project's cost. Soft costs include a wide array of items which all contribute to a total school bond required to construct or renovate a building. These costs include (but are not limited to): engineering and design fees, legal and administrative fees, furnishing and equipment not part of the building systems, utility connection charges, and permitting fees. Soft costs can vary greatly from school to school depending on local requirements and also on the amount of furnishings and equipment suitable for re-use in a new or rehabilitated school. In general, these costs can range from 20-30% of construction costs. Also note that these Construction Costs are based on current year (2011) values. Given the relatively volatile market, we cannot forecast the construction inflation for the coming years with any degree of certainty. We hope that these very preliminary construction costs help you understand an order of magnitude budget and potential tax impacts as you consider options for phasing and implementation of your Middle School and Elementary School facility upgrades. As stated above, these costs are preliminary construction values. As the solutions for each phase of the master plan are further defined and developed, we will re-visit these construction values and develop a more detailed estimate relating to the scope and size of your selected capital improvements.

School		Category	Proposed Improvement	Priority	Estimated Construction Costs	Fiscal Year(s) Proposed	Capital Project or Annual Budget	
Chamberlain School		Steve LeClair – School Principal	• Bob Libby – Head Custodian					
		Site	Increased Parking and drop off	A	$20,000	2014	CP	Safer more maintainable route from Bu Drop to School
		Capacity/Space Needs	7300gsf Addition - Education Space	A	$1,480,000	2014	CP	Would eliminate portable classrooms and provide accessible restrooms
		Capacity/Space Needs / Safety	615gsf Addition - Entry	A	$20,000	2014	CP	Would create a more secure and supervisable entrance
		Professional Needs / Safety	1300gsf Renovation - Administrative Areas	A	$130,000	2014	CP	Would create a more secure and supervisable entrance and accessible staff restrooms
		Energy	Replace existing light fixtures with newer generation	C	$44,000	2014	AB	Replace 195 fixtures with RT5 or Super T8 fixtures. Assuming 1-1 replacement Estimated 33% savings on electricity fo lighting.
		Daylighting/Acoustics/Air Quality	New Acoustic Ceilings Throughout	C	$56,000	2014	CP	Improve acoustics - should be done at same time as lighting upgrade
		Security/ Safety	Electronic Latch Retraction for Main Entrance Doors	B	$4000/door	2014	AB	Allows for secure building entrance with ability to remotely unlock door from main office (assumes exit device with ELR, power supply, limited conduit, and single switch)
Built/Renovated	1961/2000	Facilites/Maintenance/Repair	Removal of Oil tanks	B	$13,000	2014	AB	Based on current regulations, the underground oil tanks are due for replacement or removal. Based on costs, we have recommended removal and carried an allowance to convert any oil fired equipment to Natural Gas. Estimate includes $10,000 allowance for tank removal and $3,000 allowance for analytical testing. Does not include abatement of contaminated soils.
Gross Square Feet	48,800							
Educational Capacity	238							
Core Capacity	594	Safety	Asbestos Abatement	B	$15,000	2015	AB	Allowance Only. Further study required to assess scope of Hazardous Material
Current Enrollment	368	Facilities/Maintenance/Repair	Miscellaneous Repairs and Improvements	B		Annual		
					$1,782,000	Total Proposed Improvements		

Order of Magnitude Costs

Construction Estimates

These Order of Magnitude costs are based on preliminary construction estimates and include hard construction costs for the building and site. Hard construction costs for the building can be defined as the cost of the physical building from the foundation upwards including all permanent building systems. "Soft Costs" can also have significant effects on the total amount of a project's cost. Soft costs include a wide array of items which all contribute to a total school bond required to construct or renovate a building. These costs include (but are not limited to): engineering and design fees, legal and administrative fees, furnishing and equipment not part of the building systems, utility connection charges, and permitting fees. Soft costs can vary greatly from school to school depending on local requirements and also on the amount of furnishings and equipment suitable for re-use in a new or rehabilitated school. In general, these costs can range from 20-30% of construction costs. Also note that these Construction Costs are based on current year (2011) values. Given the relatively volatile market, we cannot forecast the construction inflation for the coming years with any degree of certainty. We hope that these very preliminary construction costs help you understand an order of magnitude budget and potential tax impacts as you consider options for phasing and implementation of your Middle School and Elementary School facility upgrades. As stated above, these costs are preliminary construction values. As the solutions for each phase of the master plan are further defined and developed, we will re-visit these construction values and develop a more detailed estimate relating to the scope and size of your selected capital improvements.

School		Category	Proposed Improvement	Priority	Estimated Construction Costs	Fiscal Year(s) Proposed	Capital Project or Annual Budget	
Nancy Loud School (Annex)		Maureen Oakman – School Principal	• Bruce Tibbetts – Head Custodian					
		Site	Fencing and Bus-school route improvements	A	$46,000	2013	AB	Safer more maintainable route from Bu Drop to School
		Site	Playground Surfacing	B	$30,000	2013	AB	Replace surface (recycled rubber or similar) and remove timbers to improve accessibility
		Accessibility	2 stop Elevator and Enclosure	C	$52,000	2016	CP	Based on LULA type 2 stop elevator ($35,000 unit plus enclosure). Should AHJs require full elevator (sized for stretcher), cost would increase by an estimated $25,000.
		Energy	Replace existing light fixtures with newer generation	C	$22,500	2016	AB	Replace 100 fixtures with RT5 or Super T8 fixtures. Assuming 1-1 replacement Estimated 33% savings on electricity fo lighting.
		Safety	Handrail Extensions	C	$40,000	2016	AB	Add Extended handrails on stairs to meet current guardrail / fall requirements
		Capacity/Space Needs / Safety	1200 gsf Renovation including new restrooms	C	$45,000	2016	CP	Creates more secure entrance, added special education, speech, and intervention areas.
		Security/ Safety	Electronic Latch Retraction for Main Entrance Doors	B	$4000/door	2016	AB	Allows for secure building entrance with ability to remotely unlock door from main office (assumes exit device with ELR, power supply, limited conduit, and single switch)
Built/Renovated	1880	Facilites/Maintenance/Repair	Removal of Oil tanks	B	$15,000	2016	AB	Based on current regulations, the underground oil tanks are due for replacement or removal. Based on costs, we have recommended removal and carried an allowance to convert any oil fired equipment to Natural Gas. Estimate includes $10,000 allowance for tank removal and $3,000 allowance for analytical testing. Does not include abatement of contaminated soils.
Gross Square Feet	16,000							
Educational Capacity	99							
Core Capacity	99	Facilities/Maintenance/Repair	Provide Second Boiler	D	$40,000	$2,016	AB	Create redundancy with a second boiler. Will also increase longevity of existing boiler with proper cycling use and ease maintenance issues.
Current Enrollment	95	Facilities/Maintenance/Repair	Miscellaneous Repairs and Improvements	B		Annual		
					$294,500	Total Proposed Improvements		

Order of Magnitude Costs

Construction Estimates

These Order of Magnitude costs are based on preliminary construction estimates and include hard construction costs for the building and site. Hard construction costs for the building can be defined as the cost of the physical building from the foundation upwards including all permanent building systems. "Soft Costs" can also have significant effects on the total amount of a project's cost. Soft costs include a wide array of items which all contribute to a total school bond required to construct or renovate a building. These costs include (but are not limited to): engineering and design fees, legal and administrative fees, furnishing and equipment not part of the building systems, utility connection charges, and permitting fees. Soft costs can vary greatly from school to school depending on local requirements and also on the amount of furnishings and equipment suitable for re-use in a new or rehabilitated school. In general, these costs can range from 20-30% of construction costs. Also note that these Construction Costs are based on current year (2011) values. Given the relatively volatile market, we cannot forecast the construction inflation for the coming years with any degree of certainty. We hope that these very preliminary construction costs help you understand an order of magnitude budget and potential tax impacts as you consider options for phasing and implementation of your Middle School and Elementary School facility upgrades. As stated above, these costs are preliminary construction values. As the solutions for each phase of the master plan are further defined and developed, we will re-visit these construction values and develop a more detailed estimate relating to the scope and size of your selected capital improvements.

School		Category	Proposed Improvement	Priority	Estimated Construction Costs	Fiscal Year(s) Proposed	Capital Project or Annual Budget	
Gonic School		Gwen Rhodes – School Principal	• Ron Levesque until 5/20 then Dave McKenny as fill in – Head Custodian					
		Educational / Professional Needs	(2) Student Restrooms at MP Room	C	$40,000	2018	AB	Satisfy lack of student and staff restrooms.
		Site	Reorganize site to alleviate traffic and parking issues	B	$75,000	2013	AB	Widen access drive on left and expand parking. Add landscaping at areas of snow fall.
		Educational / Professional Needs	Create added storage and Teachers Room in MP Room	C	$75,000	2018	AB	This will replace storage and teachers space lost during the creation of restrooms
		Daylighting/Acoustics/Air Quality	Added Ventilation	D	$45,000	2018	AB	Add unit ventilators or RTUs to create increased air flow at storage areas re-purposed to student areas.
		Safety	Replace Door Hardware	B	$9,000	2012	AB	New door hardware throughout all student rooms (25 sets) to give administration ability to secure the building (lock-down).
		Safety	Asbestos Abatement	B	$15,000	2018	AB	Allowance Only. Further study requirec to assess scope of Hazardous Materia
		Security/ Safety	Electronic Latch Retraction for Main Entrance Doors	B	$4000/door	2018	AB	Allows for secure building entrance wit ability to remotely unlock door from main office (assumes exit device with ELR, power supply, limited conduit, an single switch)
Built/Renovated	1897/1987/2000	Facilites/Maintenance/Repair	Removal of Oil tanks	B	$15,000	2013	AB	Based on current regulations, the underground oil tanks are due for replacement or removal. Based on costs, we have recommended removal and carried an allowance to convert an oil fired equipment to Natural Gas. Estimate includes $10,000 allowance for tank removal and $3,000 allowance for analytical testing. Does not include abatement of contaminated soils.
Gross Square Feet	51,400							
Educational Capacity	198	Daylighting/Acoustics/Air Quality	New Acoustic Ceilings Throughout Classrooms	C	$40,000	2018	CP	Listed in current District CIP
Core Capacity	297	Facilities/Maintenance/Repair	Renovate oldest restrooms	C	$20,000	2018	AB	Listed in current District CIP
Current Enrollment	256	Facilities/Maintenance/Repair	Miscellaneous Repairs and Improvements	B		Annual		
					$338,000	Total Proposed Improvements		

Order of Magnitude Costs

Construction Estimates

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School: Maple Street School

Robin Brown – School Principal

- Diane Dever – Head Custodian

		Category	Proposed Improvement	Priority	Estimated Construction Costs	Fiscal Year(s) Proposed	Capital Project or Annual Budget	
		Educational Needs	Phase 1: Interior Modifications	A	$50,000	2013	AB	Minor Interior modifications to create a K-5 Magnet School. Includes partitions, ceilings, lighting, and HVAC extensions.
		Capacity/Space Needs	Phase 2: 5400 gsf addition	C	$1,308,000	2017	CP	Added Education and administration space to support educational goals and professional needs of K-5 Magnet School. Increases accessibility with elevator and restrooms.
		Energy	Phase 2: Replace existing light fixtures with newer generation	C	$30,000	2017	CP	Replace 83 fixtures with RT5 or Super T8 fixtures. Assuming 1-1 replacement Estimated 33% savings on electricity for lighting.
		Daylighting/Acoustics/Air Quality	Added Ventilation	C	$45,000	2017	CP	Add RTUs as part of new addition to create increased air flow at existing classrooms.
		Safety	Provide Sprinkler System	C	$68,000	2017	CP	Add sprinkler system throughout entire building when creating new addition (pump and cistern included)
		Facilites/Maintenance/Repair	Removal of Oil tanks	B	$13,000	2013	AB	Based on current regulations, the underground oil tanks are due for replacement or removal. Based on costs, we have recommended removal and carried an allowance to convert any oil fired equipment to Natural Gas. Estimate includes $10,000 allowance for tank removal and $3,000 allowance for analytical testing. Does not include abatement of contaminated soils.
		Security/ Safety	Electronic Latch Retraction for Main Entrance Doors	B	$4000/door	2013	AB	Allows for secure building entrance with ability to remotely unlock door from main office (assumes exit device with ELR, power supply, limited conduit, and single switch)
Built/Renovated	1928	Facilities/Maintenance/Repair	Masonry, Lintel, Chimney Repairs	B	$27,000	2013	AB	Listed in current District CIP
Gross Square Feet	16,000	Energy	Provide Exterior LED lamps	D	$10,000	2013	AB	Listed in current District CIP
Educational Capacity	72	Facilities/Maintenance/Repair	Liner At Chimney	B	$25,000	Hold	AB	Listed in current District CIP for 2012 or 2013. This item to be placed on hold pending decision to convert to Natural Gas. May be unnecessary.
Core Capacity	99	Facilities/Maintenance/Repair	Provide Second Boiler	C	$40,000	2017	AB	Create redundancy with a second boiler. Will also increase longevity of existing boiler with proper cycling use and ease maintenance issues.
Current Enrollment	63	Facilities/Maintenance/Repair	Miscellaneous Repairs and Improvements	B		Annual		
					$1,620,000	Total Proposed Improvements		

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School		Category	Proposed Improvement	Priority	Estimated Construction Costs	Fiscal Year(s) Proposed	Capital Project or Annual Budget	
McClelland School		Arlene Walker – School Principal	• Merlin Clickman – Head Custodian					
		Daylighting/Acoustics/Air Quality	Rooftop Packaged Air Conditioning Unit	B	$30,000	2013	AB	Increased ventilation and AC for Mezzanine areas to accommodate comfort issues.
		Energy	Replace existing light fixtures with newer generation	D	$73,000	2018	CP	Replace 324 fixtures with RT5 or Super T8 fixtures. Assuming 1-1 replacement Estimated 33% savings on electricity for lighting.
		Daylighting/Acoustics/Air Quality	New Acoustic Ceilings Throughout	D	$196,000	2018	CP	Improve acoustics - should be done at same time as lighting upgrade
		Security/ Safety	Electronic Latch Retraction for Main Entrance Doors	B	$4000/door	2018	AB	Allows for secure building entrance with ability to remotely unlock door from main office (assumes exit device with ELR, power supply, limited conduit, and single switch)
Built/Renovated	1957/1959/1988							
Gross Square Feet	83,800							
Educational Capacity	376							
Core Capacity	594	Facilities/Maintenance/Repair	Provide Second Boiler	D	$60,000	2013	AB	Create redundancy with a second boiler. Will also increase longevity of existing boiler with proper cycling use and ease maintenance issues.
Current Enrollment	371	Facilities/Maintenance/Repair	Miscellaneous Repairs and Improvements	B		Annual		
					$363,000	Total Proposed Improvements		

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School		Category	Proposed Improvement	Priority	Estimated Construction Costs	Fiscal Year(s) Proposed	Capital Project or Annual Budget	
School Street School		Nancy Booth – School Principal	• John Marts – Head Custodian					
		Site	Increased Parking	C	$30,000	2016	CP	Would create added parking and would prepare site for addition with accessible entrance
		Capacity/Space Needs	4880gsf Addition - Education Space	C	$1,093,600	2016	CP	Would create accessible entrance, Mult purpose room, accessible restrooms, and Admin Space
		Accessibility	2 stop Elevator	C	$35,000	2016	CP	Based on LULA type 2 stop elevator ($35,000 unit plus enclosure). Should AHJs require full elevator (sized for stretcher), cost would increase by an estimated $25,000.
	$1,165,600	Energy	Replace existing light fixtures with newer generation	D	$18,000	2016	CP	Replace 80fixtures with RT5 or Super T8 fixtures. Assuming 1-1 replacement Estimated 33% savings on electricity for lighting.
Built/Renovated	1911	Facilites/Maintenance/Repair	Removal of Oil tanks	B	$15,000	2016	AB	Based on current regulations, the underground oil tanks are due for replacement or removal. Based on costs, we have recommended removal and carried an allowance to convert any oil fired equipment to Natural Gas. Estimate includes $10,000 allowance for tank removal and $3,000 allowance for analytical testing. Does not include abatement of contaminated soils.
		Safety	Asbestos Abatement	B	$15,000	2016	AB	Allowance Only. Further study required to assess scope of Hazardous Materials
Gross Square Feet	16,000	Security/ Safety	Electronic Latch Retraction for Main Entrance Doors	B	$4000/door	2016	AB	Allows for secure building entrance with ability to remotely unlock door from main office (assumes exit device with ELR, power supply, limited conduit, and single switch)
Educational Capacity	90	Facilities/Maintenance/Repair	Liner At Chimney	B	$23,000	Hold	AB	Listed in current District CIP for 2012 or 2013. This item to be placed on hold pending decision to convert to Natural Gas. May be unnecessary.
Core Capacity	99	Facilities/Maintenance/Repair	Provide Second Boiler	D	$40,000	2016	AB	Create redundancy with a second boiler. Will also increase longevity of existing boiler with proper cycling use and ease maintenance issues.
Current Enrollment	88	Facilities/Maintenance/Repair	Miscellaneous Repairs and Improvements	B		Annual		
					$1,273,600	Total Proposed Improvements		

Order of Magnitude Costs

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School		Category	Proposed Improvement	Priority	Estimated Construction Costs	Fiscal Year(s) Proposed	Capital Project or Annual Budget	
East Rochester School		Colby Troidl – School Principal	• Louise Wheeler – Head Custodian					
		Capacity/Space Needs / Acoustics	16,800gsf Renovation - Education Space	A	$2,940,000	2013	CP	Complete gut renovation would eliminate portable classrooms, improve acoustics, air quality, accessibility, and satisfy educational needs
		Educational Needs / Daylighting	Exterior wall Modifications	A	$180,000	2013	CP	Rebuild portions of exterior walls to giv all classrooms windows and limit doors Would improve air quality, daylighting, security, and efficiency
		Site	Reorganize site to alleviate traffic issues	C	$300,000	2020	CP	Create new access drive to improve drop-off and parking. Avoids wetlands.
		Security/ Safety	Electronic Latch Retraction for Main Entrance Doors	B	$4000/door	2013	AB	Allows for secure building entrance witl ability to remotely unlock door from main office (assumes exit device with ELR, power supply, limited conduit, anc single switch)
Built/Renovated	1968/2000	Facilites/Maintenance/Repair	Removal of Oil tanks	B	$15,000	2013	AB	Based on current regulations, the underground oil tanks are due for replacement or removal. Based on costs, we have recommended remova and carried an allowance to convert an oil fired equipment to Natural Gas. Estimate includes $10,000 allowance for tank removal and $3,000 allowance for analytical testing. Does not include abatement of contaminated soils.
Gross Square Feet	51,400							
Educational Capacity	238							
Core Capacity	594	Safety	Asbestos Abatement	B	$15,000	2015	AB	Allowance Only. Further study required to assess scope of Hazardous Material
Current Enrollment	373	Facilities/Maintenance/Repair	Miscellaneous Repairs and Improvements	B		Annual		
					$3,454,000	Total Proposed Improvements		

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School		Category	Proposed Improvement	Priority	Estimated Construction Costs	Fiscal Year(s) Proposed	Capital Project or Annual Budget	
William Allen School		Chris Foley – School Principal	• Bob Plaisted – Head Custodian					
		Site	Acquisition of 2 neighboring properties	A	$350,000	2013	CP	Town Valuation of property set here - subject to negotiation
		Site	Traffic, Parking, and buildable space improvements	A	$250,000	2015	CP	
		Capacity/Space Needs	5280gsf Addition - Education Space	A	$1,100,000	2015	CP	Would eliminate portable classrooms
		Capacity/Space Needs	6450 gsf Renovation including new restrooms	A	$97,000	2015	CP	Part of Addition and site change to eliminate portable and solve sited issues
		Daylighting/Acoustics/Air Quality	Rooftop Ventilation Unit	D	$30,000	2021	AB	Increased ventilation at South Facing Classrooms for improved comfort
		Accessibility	2 stop Elevator, landing and Enclosure	A	$60,000	2015	CP	Based on LULA type 2 stop elevator ($35,000 unit plus enclosure). Should AHJs require full elevator (sized for stretcher), cost would increase by an estimated $25,000.
		Energy	Replace existing light fixtures with newer generation	C	$56,000	2015	AB	Replace 250 fixtures with RT5 or Super T8 fixtures. Assuming 1-1 replacement Estimated 33% savings on electricity for lighting.
		Daylighting/Acoustics/Air Quality	New Acoustic Ceilings Throughout	C	$97,000	2015	CP	Improve acoustics - should be done at same time as lighting upgrade
		Accessibility	Retrofit Restrooms	C	$75,000	2015	CP	Improved accessibility, upgrade fixtures and finishes
		Safety	Classroom Door Hardware	B	$6,000	2015	AB	Listed in current District CIP
		Security/ Safety	Electronic Latch Retraction for Main Entrance Doors	B	$4000/door	2015	AB	Allows for secure building entrance with ability to remotely unlock door from main office (assumes exit device with ELR, power supply, limited conduit, and single switch)
Built/Renovated	1964/1973/2000	Safety	Asbestos Abatement	B	$15,000	2015	AB	Allowance Only. Further study required to assess scope of Hazardous Materials
Gross Square Feet	57,000	Facilites/Maintenance/Repair	Removal of Oil tanks	B	$15,000	$2,015	AB	Based on current regulations, the underground oil tanks are due for replacement or removal. Based on costs, we have recommended removal and carried an allowance to convert any oil fired equipment to Natural Gas. Estimate includes $10,000 allowance for tank removal and $3,000 allowance for analytical testing. Does not include abatement of contaminated soils.
Educational Capacity	257							
Core Capacity	594							
Current Enrollment	317	Facilities/Maintenance/Repair	Miscellaneous Repairs and Improvements	B		Annual	AB	
					$2,155,000	Total Proposed Improvements		

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School		Category	Proposed Improvement	Priority	Estimated Construction Costs	Fiscal Year(s) Proposed	Capital Project or Annual Budget	
Rochester Middle School		Vallerie McKenny – School Principal	• Walter Gadbois – Head Custodian					
		Professional Needs	Reconfigure Guidance Area	B	$50,000	2013	AB	Proposed by Staff
		Professional Needs	FCS Classroom relocation	B	$10,000	2013	AB	Part of Guidance Relocation
		Professional Needs	FCS Classroom Casework and Equipment	B	$75,000	2013	AB	Would outfit FCS classroom to culinary/FCS lab
		Facilities/Maintenance/Repair & Safety	Engineering allowance to reconfigure generator to improve use of facility as an emergency shelter	B	$10,000	2012	AB	Listed in current District CIP. Assigned cost is a not-to-exceed engineering allowance to interpret circuiting and solve issues with current generator configuration.
		Facilities/Maintenance/Repair & Energy	Replace Boilers	B	$100,000	2016	CP	Listed in current District CIP
		Site	Site Modifications - 10,000sf Synthetic Turf, 10,000sf Hardscape, 20,000sf sand/drainage layer	A	$200,000	2018	CP	Improvements for break/recess area used daily by students.
		Site	Added Parking	B	$2000/space	2018	AB	Could be accomplished in phases
Built/Renovated	1992/2002	Security/ Safety	Electronic Latch Retraction for Main Entrance Doors	B	$4000/door	2013	AB	Allows for secure building entrance wit ability to remotely unlock door from main office (assumes exit device with ELR, power supply, limited conduit, an single switch)
Gross Square Feet	168,736	Facilities/Maintenance/Repair & Energy	Replace 4 failing Mech Units	B	$95,000	2013	CP	Inlcudes replacement of two 400K BTU gas fired Roof Top Units, one 300K BTU gas fired Roof Top Unit, and one Rooftop Ventialtion Unit
Educational Capacity	1058							
Core Capacity	1800							
Current Enrollment	960	Facilities/Maintenance/Repair	Miscellaneous Repairs and Improvements	B		Annual	AB	
					$544,000	Total Proposed Improvements		

Note: Costs shown here reflect 2011 hard construction costs only. Total Project costs anticipated to be approximately 20-30% higher including soft costs.

Facility	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D
Maple Street School		Interior Reno - $50,000 Upgrades/Repairs - $31,000 Site Lights / Oil Tanks - $25,000				Reno / Upgrades - $183,000 Addition - $1,308,000			LED Lighting - $10,000	
Planning & Design										
Construction										
East Rochester School		Phased Renovation - $3,135,000 Oil Tanks - $15,000							Site Improvements - $300,000	
Planning & Design										
Construction										
Chamberlain Street School			Capacity Additions / Reno - $1,649,000 Site/Oil Tanks - $35,000 Ceiling and Lighting Reno - $100,000							
Planning & Design										
Construction										
School Street School					Addition / Reno - $1,165,000 Site / Oil Tanks - $45,000 Boiler Upgrades - $40,000					
Planning & Design										
Construction										
William Allen School		Property Acquisition - $350,000		Capacity Additions / Reno - $1,353,000 Site / Oil Tanks- $265,000 Ceiling and Lighting Reno - $153,000						Mech Upgrades - $30,000
Planning & Design										
Construction										
Nancy Loud School		Site / Oil Tanks- $91,000			Reno / Upgrades- $176,500 Boiler Upgrades - $40,000					
Planning & Design										
Construction										
Gonic School	Door Hardware - $9,000	Site / Oil Tank- $90,000					Interior Reno - $239,000 Upgrades/Repairs - $45,000			
Planning & Design										
Construction										
McClelland School		Mech Upgrade - $40,000 Boiler Upgrade $60,000					Upgrades/Repairs- $273,000			
Planning & Design										
Construction										
Rochester Middle School	Generator Study - $10,000	Guidance / FCS Reno - $60,000 FCS Equipment - $75,000 Generator Improvements - $TBD Mech Repairs / Upgrades - $95,000			Boiler Upgrade - $100,000		Site Improvements - $250,000			
Planning & Design										
Construction										
Rochester High School										
Planning & Design										
Construction										

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Rochester School District
Primary Schools Space Study

Summer 2011
Comprehensive Report

APPENDIX

Energy Benchmarking Reports

- New Hampshire EnergySmart Schools

LAVALLEE I BRENSINGER ARCHITECTS

NEW HAMPSHIRE ENERGYSMART SCHOOLS PROGRAM

Energy Benchmarking Report for:

William Allen Elementary School

Rochester, NH

Period: ***July 1, 2010*** through ***June 30, 2011***

PREPARED BY:

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Portsmouth, NH 03801

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Table of Contents

I. Introduction

The Sustainable Energy Division of the New Hampshire Public Utilities Commission, with support from the New Hampshire Department of Education has sponsored TRC to develop the New Hampshire ***EnergySmart Schools Program*** to support New Hampshire K-12 public and private schools in the pursuit of energy efficiency and sustainability initiatives.

Energy efficiency has become an increasingly important issue for schools due to tightening budgets and rising energy costs. Since 2003, the prices of natural gas, fuel oil and electricity have increased by 123%, 107% and 32% respectively. Schools that have participated in energy benchmarking programs have shown a decrease in overall energy use by approximately 22% through the adoption of energy efficiency measures.

Tracking and documenting the energy use and associated carbon emissions in the state's K-12 schools will allow New Hampshire to account for the impact of its energy efficiency and renewable energy programs and determine which have the greatest effect. The analysis in this report, provided by the ***EnergySmart Schools Program*** is designed to help you:

- Understand the energy consumption and cost trends at each of your school buildings.
- Learn how your buildings are performing compared to other schools locally and nationally.
- Identify opportunities for improving operations and reducing costs.
- Take advantage of resources to implement efficiency improvements and save money.

The analysis was based on the information provided on the *Building Data Request Form* submitted, which included building descriptions, energy suppliers and other information. The building's utility bills were also used to assess its electricity and heating fuel consumption for the year(s) provided.

The energy performance for your school has been compared to national data for similar school facilities through EPA's ENERGY STAR® Portfolio Manager. Also shown are the five major benchmarks used to analyze building performance, which include: electricity use; heating fuel use; weather-normalized heating fuel use; total cost; and total cost per student, all of which have been normalized for comparison by square footage and weather. As part of the program's focus on sustainability, your school's carbon footprint is also presented.

II. Benchmarking Analysis and Review Results

Building and energy usage of your school was analyzed to assess the basic nature of your energy consumption and utility costs. The Building Data Summary table shown below summarizes this information.

Table 1: Building Data Summary for William Allen Elementary School

Building Data			
District	SAU 54 Rochester School Department	**School Name**	William Allen Elementary School
City	Rochester	**Zip Code**	03867
Year Built	1964	**Floor Area (sq.ft.)**	57,000
Number of Students	339	**Number of PCs**	79
Weekly Operating Hours	60	**Months School Used**	12
Cooking?	YES	**% AC**	10
Pool Size?	N/A	**Months Pool Used**	0

Utility Data			
Data End Point	6/30/2011	**Total Cost ($)**	50,989
Electric Provider	PSNH	**Natural Gas Provider**	Unitil
Electricity Usage (kWh)	184,856	**Electricity Cost ($)**	30,248
Natural Gas Usage (therms)	17,470	**Natural Gas Cost ($)**	20,740
Fuel Oil Usage (gal)	0	**Fuel Oil Cost ($)**	0
Other Fuel Usage (gal)	0	**Other Fuel Cost ($)**	0

Energy Indicators			
EPA Score	89	**Electric Usage (kWh/sq.ft.)**	3.2
Heating Fuel Usage (kBtu/sq.ft.)	30.6	**Weather Adjusted Heating Usage Btu/sq.ft./HDD)**	4.2
Site Energy (kBtu/sq.ft.)	41.7	**Source Energy (kBtu/sq.ft.)**	69

Environmental Impact Indicators			
Greenhouse Gas Emissions			
Last Year Heating Fuel CO_2e (Mt)	92.8	**Last Year Total CO_2e (Mt)**	150.1
Last Year Electricity CO_2e (Mt)	57.3	**CO_2e Efficiency Savings Over Previous Year**	-2.8
EPA Target Score			
Target Score	Reached	**Site Energy Reduction Needed (kBtu/sq.ft.)**	N/A - Reached

Figures 1a, 1b, 2a and 2b display the energy use, demand and cost data tracked on a monthly basis. This demonstrates the energy consumption of your building over the course of the year. As a part of the program's focus on sustainability, your school's carbon footprint was also measured and is presented in Figure 3.

Figure 1a. Monthly Electric Use & Max Demand for William Allen Elementary

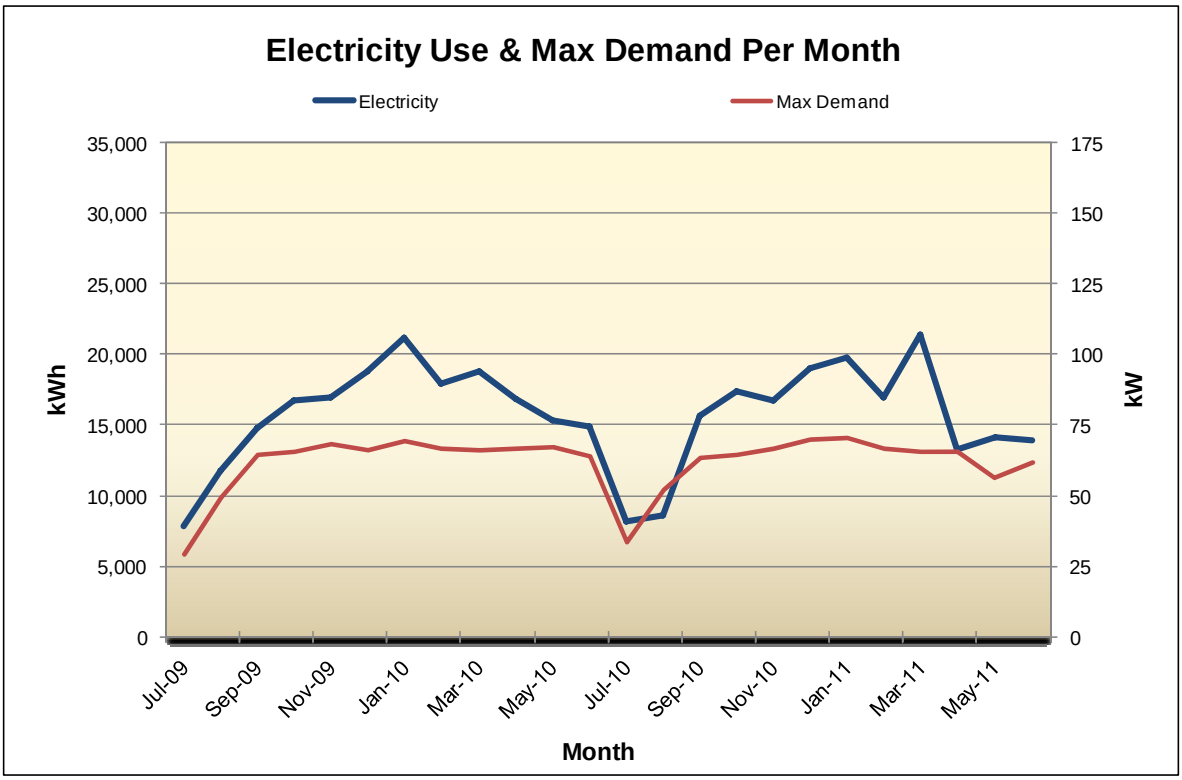
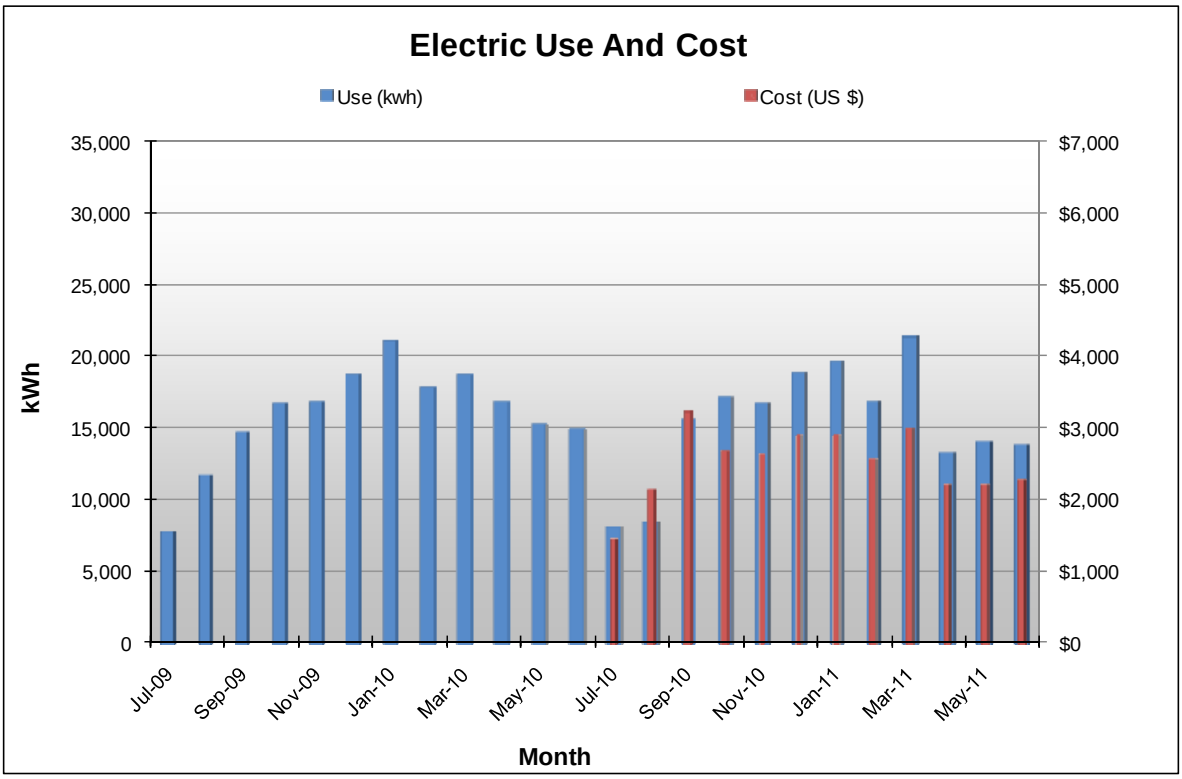


Figure 1b. Monthly Electric Use vs. Cost for William Allen Elementary



Note: Electric Cost was only available for the most recent 12 month period.

Figure 2a. Monthly Natural Gas Use for William Allen Elementary

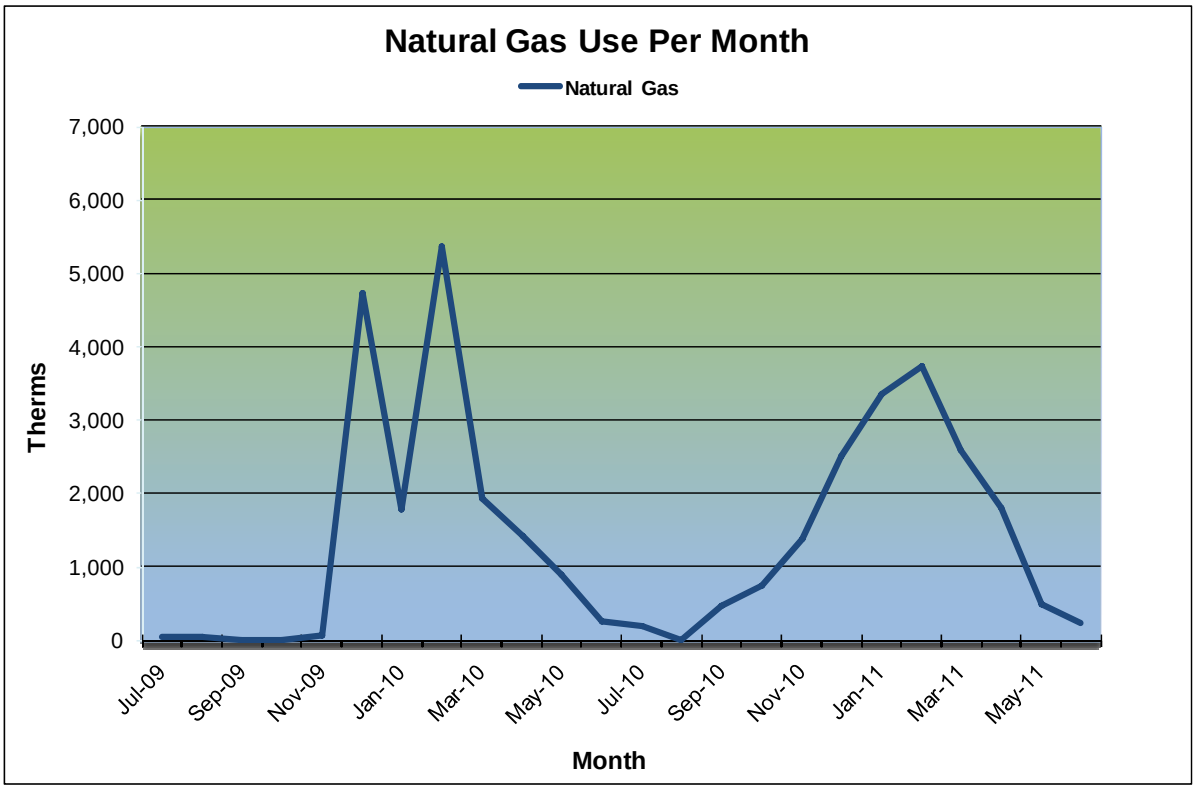


Figure 2b. Monthly Heating Fuel Use vs Cost for William Allen Elementary

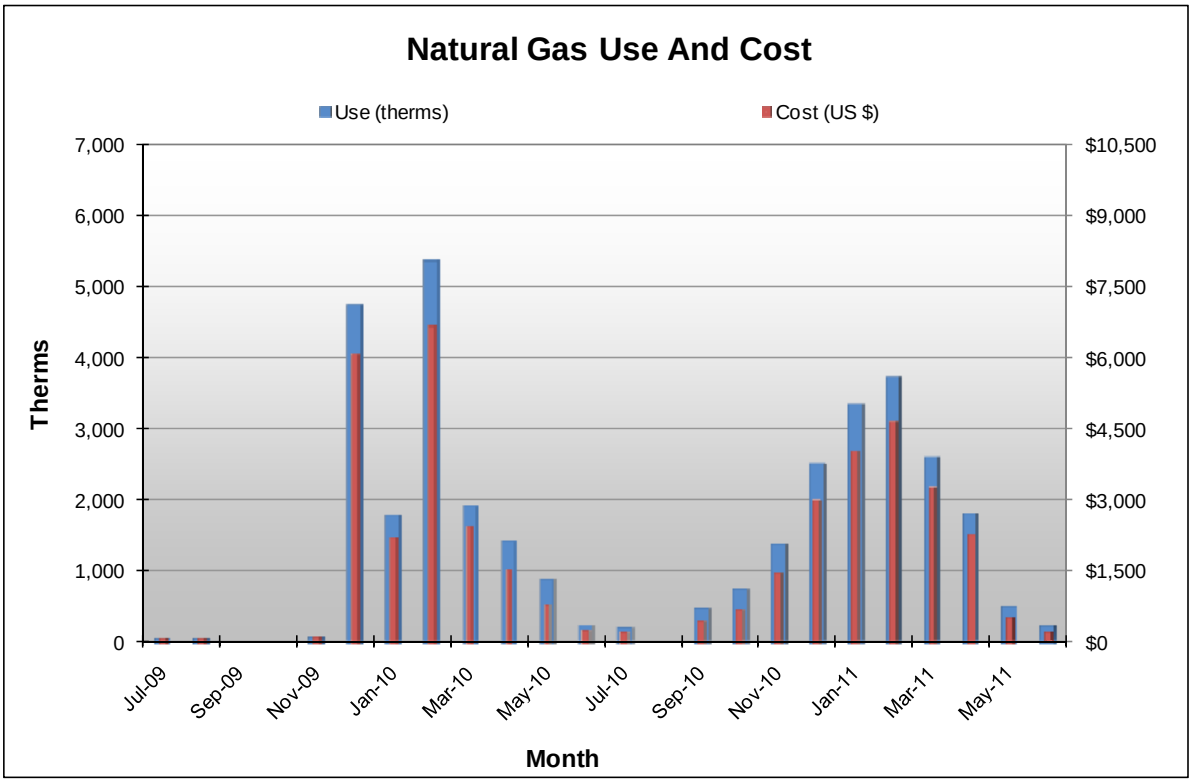
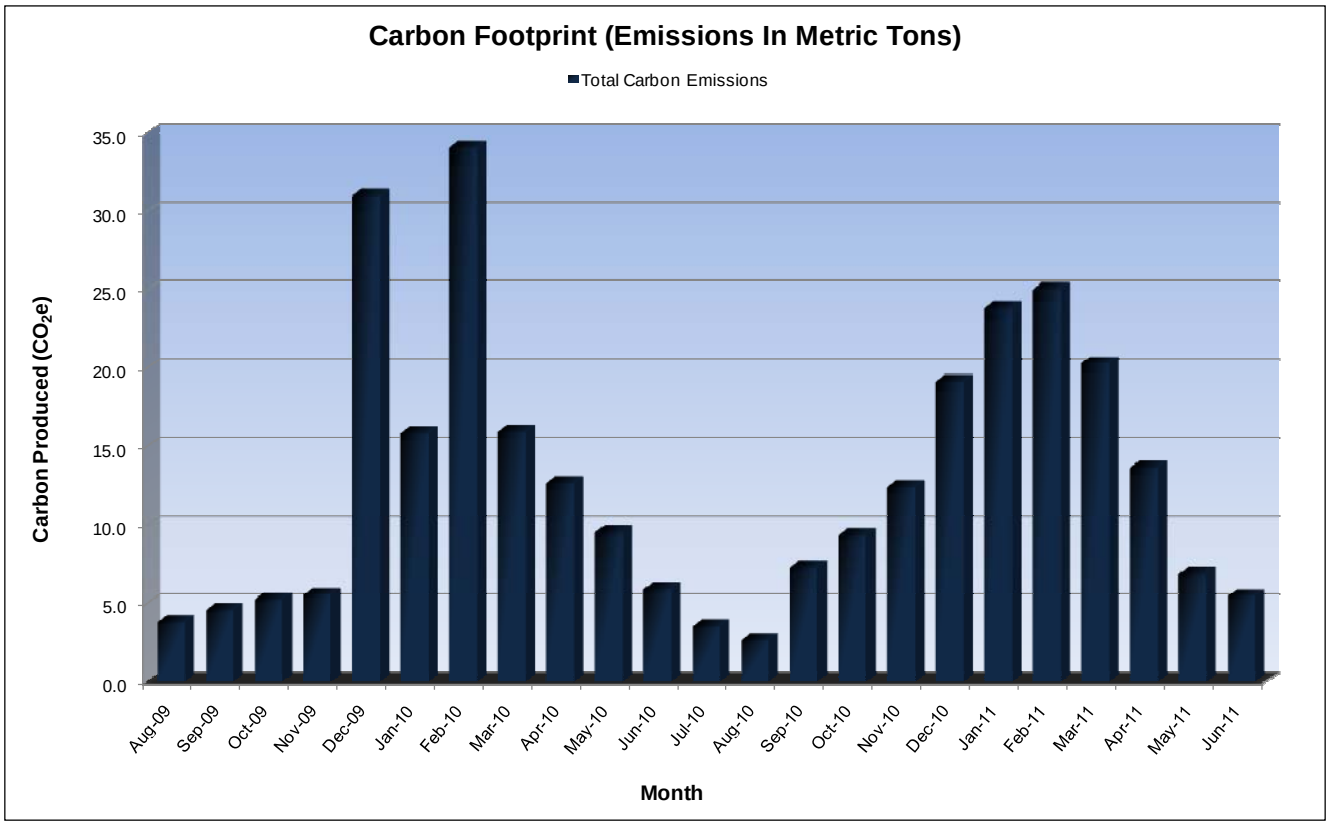


Figure 3. Monthly Greenhouse Gas Emissions for William Allen Elementary



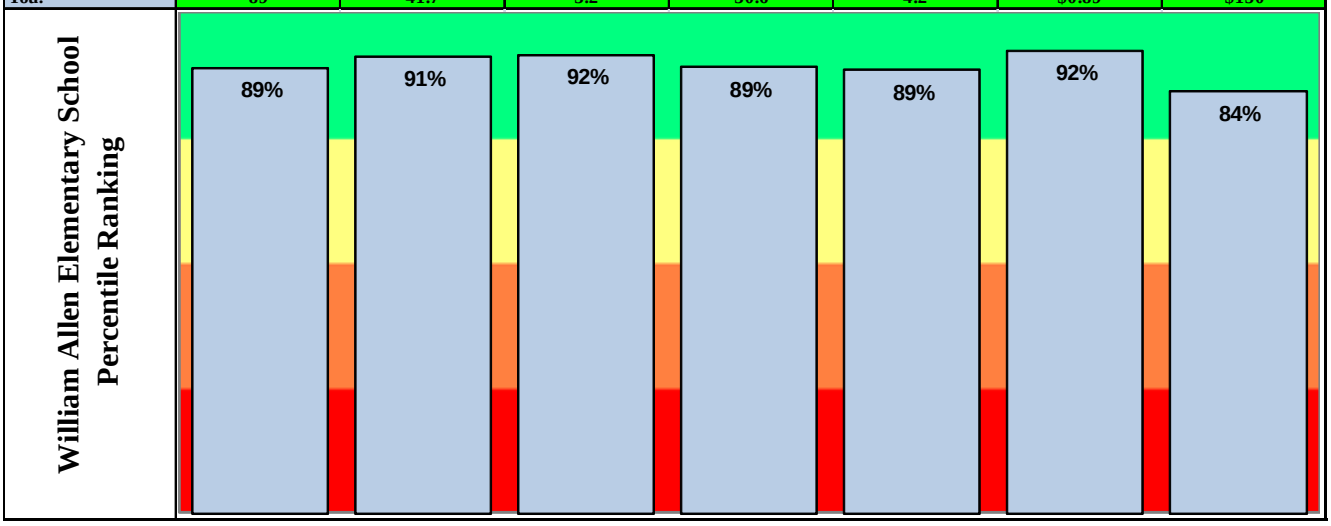
Benchmarking Data

To evaluate the energy and environmental performance of your school, the building data collected above has been compared against two different sets of school energy data: the U.S. Environmental Protection Agency's national data and New Hampshire specific state data. The results are illustrated in Figure 4 on the following page.

This will allow you to assess your building's performance relative to other buildings designed and constructed to the same codes and standards, operating under the same regulations and schedules and similar weather conditions. The indicators are calculated on a *per square foot* or *per student* basis, so you can compare your school to different sized schools.

Figure 4. EnergySmart Schools Benchmarks for William Allen Elementary School

Schools	U.S. EPA Portfolio Manager Score	New Hampshire State Schools (Annual Data)					
		Total Energy Use (kBtu/sq.ft.)	Electric Use (kWh/sq.ft.)	Heating Fuel Use (kBtu/sq.ft.)	Weather Adjusted Heating Fuel Use (Btu/sq.ft./HDD)	Total Energy Cost ($/sq.ft.)	Total Energy Cost ($/student)
NH Average:	50	60.3	5.2	41.7	5.7	$1.42	$256
You:	89	41.7	3.2	30.6	4.2	$0.89	$150



Major Benchmark Indicators

1. Total Energy Use, kBtu/sq.ft.

This indicator shows how much total energy your school consumes each year. It includes the energy used for heating, cooling (if any), lights, cooking, computers, etc.

Your school's total energy use of 41.7 kBtu per square foot per year (kBtu/sq.ft.) is better than the New Hampshire K-12 schools state average of 60.3 kBtu/sq.ft. Your total energy use figure is lower than 91% of New Hampshire K-12 schools. The EnergySmart School Report is weather normalized so fuel consumption for heating takes the difference in climate between northern and southern New Hampshire into account.

This is a good indicator of how well, overall, your school is performing. However, it doesn't help you find ***where*** in your building to look for improvement opportunities. Multiple factors included on the following pages can help with that. Analysis of energy consumption for this program does not control for operational variations. An example is an improperly ventilated school may appear to have lower energy consumption. Ventilation systems that are not operating properly result in lower indoor air quality.

2. Electricity Data

Most electric utilities use the following two factors to estimate your electricity bill – Electric Use and Electric Demand.

a. Electric Use, kWh/sq.ft.

This shows how well the building does with its lights, cooling/air conditioners and cafeteria systems (if any), and what's referred to as "plug load." Plug load is anything that plugs into a socket. The major plug loads are generally computers (including monitors, printers and copiers), refrigerators, coffee machines, fans, shop equipment and projectors. If electric consumption is much higher than average, but heating fuel use (see below) is average or better, then focus your efforts on the electric-powered elements.

New Hampshire schools state average electric use is 5.2 kWh per square foot. Your school's electric consumption of 3.2 kWh per square foot this year is lower than 92% of New Hampshire schools benchmarked through the New Hampshire EnergySmart Schools Program.

b. Electric Demand, Watts/sq.ft.

Demand is a measure of the maximum electric draw in kW that your building places on the grid and is measured by adding up the kW draw for a 15 minute period. To give an analogy, if electricity usage is the amount of water going through a hose in gallons, electric demand would be how fast that water flows expressed in gallons per minute. Whichever 15 minute period during your monthly billing cycle places the highest kW demand on the grid is the demand factor applied to your bill. The best way to improve this demand factor is to stagger the times when your electrical systems draw at their maximum or reduce unnecessary electric load altogether.

The average electric demand for New Hampshire schools is 1.9 watts per square foot. Your school's electric demand is 1.2 watts per square foot and is lower than 91% of New Hampshire Schools benchmarked through the New Hampshire EnergySmart Schools Program.

3. Heating Fuel Use, kBtu/sq.ft.

Reviewing these indicators is relatively straightforward. If your school's heating fuel use is much higher than average, an audit of your heating system along with your building envelope - doors, windows, roof - is recommended. This factor is 'fuel-neutral' as it works for either fuel oil or natural gas heating systems.

New Hampshire K-12 schools state average heating fuel use is 41.7 kBtu/sq.ft. or 5.7 Btu/sq.ft./HDD. Your school's heating fuel use of 30.6 kBtu/sq.ft. per year is lower than 89% of other New Hampshire schools in the database. Your school's weather adjusted heating fuel use of 4.2 Btu/sq.ft./HDD is also lower than 89% of other New Hampshire schools benchmarked through the New Hampshire EnergySmart Schools Program.

4. Energy Cost, $/sq.ft. & $/student

Cost is the bottom line. These numbers help you understand, in terms of budget, the gain through energy efficiency improvements. New Hampshire K-12 schools state averages $1.42/sq.ft. and $256/student.

Your school's annual energy cost of $0.89 per square foot is lower than 92% of other New Hampshire benchmarked schools. Your school's cost expressed on a per student basis of $150 is lower than 84% of other New Hampshire schools benchmarked through the New Hampshire EnergySmart Schools Program.

5. U.S. EPA *Portfolio Manager* Score

Portfolio Manager is a benchmarking model based on a national set of data from K-12 schools. It is provided by the U.S. Environmental Protection Agency's ENERGY STAR® Program. The impact of factors outside of your control (such as location, occupancy and operating hours) are removed, providing a 1-100 ranking of a school's energy performance relative to the national school building market. A score of 50 represents the national average and a score of 100 is best. Schools that achieve a score of 75 or higher are eligible for EPA's ENERGY STAR® Building Label, the national symbol for protecting the environment through energy efficiency. Districts can achieve ENERGY STAR® Leader Awards in recognition if their buildings, on average, improve by 10%, 20%, 30%, etc. over their baseline year of reported energy use or if the district's overall weighted average *Portfolio Manager* Score is at least a 75.

Your school's *Portfolio Manager* Score of 89 places it higher than 89% of K-12 schools nationwide. As noted above, this rating potentially qualifies your school for the prestigious ENERGY STAR® Label for Buildings.

III. Potential Energy Saving Opportunities

Based on the preceding analysis of your school's energy performance, implementation of the following recommendations can help you save energy and money. The first step is to look at reducing electrical lighting and HVAC consumption (burners, circulators and fans) which typically account for 67% of a building's electric consumption.

- **Perform an Energy Audit on the Building**

An energy audit involves a comprehensive analysis of the building's general characteristics, its energy use and allocation of that use amongst the facility's energy end uses. The goal is to identify sources of potential energy savings. Your auditor should develop a list of recommendations that will result in substantial energy and operational cost savings. These may include, building envelope improvement and mechanical systems, lighting upgrades, equipment replacement and installation of lighting and HVAC control mechanisms, among others.

A good audit should include information specific to each recommendation which *at least* includes approximate annual energy unit and cost savings, demand reduction, installation cost, lifetime cost savings and information related to cost-effectiveness. This will help to prioritize the recommendations based on their energy efficiency and shortest payback.

The recommendations provided in an energy audit report may reduce facility energy bills by 20% or more in addition to improving occupant health and comfort. Following this report, an energy audit is the next step in realizing the full potential of energy savings opportunities.

- **Request Retro-Commissioning**

Retro-commissioning is a detailed process applied to existing facilities aimed at correcting many of the degradations and inefficiencies that are indicative of older and/or poorly performing buildings. Many older buildings tend to be less comfortable and operate less efficiently when not properly commissioned. Retro-commissioning includes a detailed energy audit and focuses on not only potential energy savings but also the interaction of the building's equipments and mechanical systems with an eye toward restoring it to optimal performance.

In contrast to an energy audit, this optimization focuses on operational improvements to existing equipment, rather than replacement. Apart from energy savings, other improvements and benefits include substantial operation and maintenance (O&M) cost savings, improved air quality, occupant comfort, health and safety, equipment controls, and improved system interactivity.

In addition to providing recommendations, retro-commissioning includes implementation of the recommended improvements and hence the cost for retro-commissioning is higher than an audit. However, when the costs of improvements are added to the energy audit cost, prices may be comparable. If high O&M costs or occupant health, comfort and safety are concerns in addition to reduction in energy use, retro-commissioning may be a suitable strategy.

- **Upgrade Lighting Systems**

Lighting typically accounts for 30-60% of all energy consumed in school buildings. Additionally, the electrical energy consumed by lights during the summer creates heat and increases cooling costs.

William Allen Elementary School's electricity consumption is significantly low (better) compared to other schools in the State. Even so, upgraded lighting systems in high consumption areas like classrooms, gymnasiums, libraries, offices, etc. can reduce costs, improve the lighting quality and increase occupant comfort and productivity.

Over-lit Spaces: Light levels should be recorded in classrooms and hallways to ensure they are not over-lit, 40-50 foot candles are adequate light levels for an instructional space. If classroom light levels are much higher than 50 foot candles, William Allen Elementary School should consider de-lamping classrooms or installing dimming ballasts, which dim the lights when outdoor light levels are adequate. In over-lit hallway spaces photo sensors can be installed to turn lights off completely when light levels exceed a pre-set threshold.

In over-lit spaces a T8 to Super T8 lighting retro-fit can reduce the number of light fixtures needed. Super T8 lamps use between 4 and 7 Watts less electricity than standard T8 lamps, but they produce more light per Watt. In some cases this increase in light per Watt can allow for the removal of an entire lamp, saving 32 Watts. The room characteristics must be factored in before this type of retro-fit. The shape of the space, ceiling height, color of the walls, etc. all need to be taken into account when exploring a de-lamping project. We recommend that before retro-fitting the entire facility, begin by changing one classroom and monitor the comfort level of the occupants at William Allen Elementary School.

Another proven energy reduction measure with a short payback period is to identify any areas where your school may still be using metal halide lighting. Typically metal halide lights are found in gymnasiums or cafeteria areas, many districts have been very satisfied by replacing these lights with high bay T5 lighting fixtures. In addition to the reduced operational wattage, high bay T5 lights turn on instantly, as opposed to metal halide fixtures which have an extended warm up period. The long warm up period associated with metal halides typically leads to the lights being left on all day, at 250 to 400 watts a fixture; the costs begin to add up. Adding occupancy sensors to high bay T5 fixtures further reduces the payback period.

Occupancy Sensors: We recommend that you explore the use of occupancy sensors to ensure that lights are turned off in unoccupied spaces. Lights controlled by occupancy sensors typically run a third of the time when compared with manually controlled lighting. Reduced runtime leads to decreases in both energy usage and operation and maintenance costs. Additionally, a study conducted in Massachusetts found that controlling the security lighting with occupancy sensors reduced vandalism; neighbors and police recognized something wrong when the lights were on in a building that was typically dark and investigated.

To summarize and add a few ways in which William Allen Elementary School may be able to conserve energy and cost through lighting upgrades is to:

- Design light quantity and quality for the task and occupants' needs in that area.
- Maximize lamp and ballast efficiency.
- Activate the power saving features on office equipment such as copiers, printers and fax machines and ensure that they are turned off at the end of the day.
- Use automatic controls to turn lights off or dim lights in unoccupied spaces.
- Establish a maintenance schedule for group re-lamping and fixture cleaning.
- Replace T12 fixtures with the most efficient fixtures which may include T8/super T8/T5 fixtures.
- Replace incandescent lighting with compact fluorescent technology.

- Replace incandescent exit lighting which consumes 30 Watts with LED type exit lights with 1.5 Watts consumption. LED units last up to 10 years, which is a maintenance advantage.
- Install daylight sensors in areas with significant natural light.
- Install occupancy sensors in areas that are often unoccupied.
- Lighting retrofits reduce maintenance costs associated with lighting that is close to end of life.
- Establish a regular cleaning schedule particularly for areas where student safety of low light levels may be a concern, such as shop classes.
- Look to make lamp and fixture selection as uniform as possible to reduce maintenance and inventory overhead.
- Educate students and staff to turn off lights when rooms are unoccupied.

Lighting upgrades seek to reduce the connected electrical load (kW) and energy consumption (kWh) of lighting equipment. Lighting controls can also significantly reduce operating hours and costs by turning off lighting when spaces are unoccupied or sufficiently lit by natural light.

- **Install NEMA Premium Motors and VFDs**

Commercial and industrial electric motor-driven systems consume approximately 23% of all electricity in the U.S., making it the single largest category contributor to electric use in the country. With very high operating hours, the annual energy cost to run a system is more than its installation cost. Even a small increase in the efficiency of an electric motor can result in substantial energy cost savings. Typical opportunities for motor upgrades in schools include: ventilation fans, and heating and cooling system pumps and fans.

Motors with efficiency up to 90% are available to replace the older ones with efficiency less than 75%. Although standards for efficiency of new equipment are set by the Energy Policy Act, motor efficiency can be further increased by selecting Premium Efficiency motors as specified by the National Electrical Manufacturers Association (NEMA). This can cut the electric motor system demand by as much as 18%.

Savings can be increased further by optimizing system performance through the use of variable frequency drives (VFDs). When system load is known to vary substantially, these flow control systems can be utilized to match system output to system demand, significantly reducing energy usage during partial load hours. By employing high-efficiency motors and VFDs, facility owners can improve environmental conditions, utilize better control of motor-driven processes, and reduce waste output.

- **Install Demand Control Ventilation**

Demand control ventilation (DCV) monitors indoor air CO_2 content as a result of occupancy production levels and uses this data to regulate the amount of outdoor air that is permitted for ventilation. In order to ensure adequate air quality, standard ventilation systems permit outside air based on estimated occupancy levels in CFM, cubic feet per minute/occupant. However, during low occupancy hours, the space may become over ventilated due to decreased CO_2 levels and unnecessary ventilation results in wasted energy. DCV reduces unnecessary outdoor air intake by regulating ventilation based on actual CO_2 levels, saving energy. DCV is most suited for areas where occupancy levels are known to fluctuate considerably such as auditoriums, cafeterias, and gymnasiums.

Install Energy Recovery Ventilators. According to energy recovery equipment manufacturer's typical paybacks are less than 5 years for schools without cooling. The keys to success with ventilation retrofits are going with fewer larger units with long run hours as opposed to several small units with limited run time. Equipment with moisture recovery capabilities would cut humidity up to 50% during the cooling season.

- **Improve/Replace Inefficient Heating Systems**

Replacing an old boiler that is < 70% efficient with a modern 85-90% efficient natural gas-fired furnace alone will reduce heating costs by 15-20%. This combined with additional system improvements and installation of advanced HVAC control mechanisms can result in up to 20%+ heating load reduction.

Because of the high capital cost of new heating systems, some financial analysis should be performed to assess the cost-effectiveness of immediate replacement. If the current system is fairly new, replacement may not be immediately justifiable from a financial standpoint. However, as is the case with cooling systems, early replacement may prove to be a more cost-effective solution than waiting until existing systems fail or reach the end of their estimated useful life.

- **Improve/Replace Inefficient Air Conditioning Systems**

The useful life of a rooftop A/C unit is generally 12-18 years. However, depending on the efficiency, early replacement of outdated, inefficient, split, or packaged rooftop air conditioning units with new A/C systems that are 15% more efficient than 10-15 year old equipments can considerably reduce annual energy consumption. The energy cost savings and maintenance savings offset the high installation cost of a more efficient system. Installing thermostats and/or economizers on new or existing A/C systems will further reduce the cooling demand.

Economizers provide "free" cooling by using controllable dampers that bring in outside air to cool the space when the outdoor temperature or enthalpy is below the building's return air conditions. Although they require operation by a well calibrated and maintained control system, economizers have impressive energy-saving capabilities.

Install Occupancy Controlled/Programmable Thermostats

Combining efficient HVAC equipment with occupancy controlled and programmable thermostats can save a facility up to 10% of its annual heating and cooling costs:

- Areas with unpredictable occupancy on a daily/weekly basis - gym, bathrooms, outdoors: Use an *occupancy controlled thermostat* - a thermostat paired with a sensor and/or door detector to identify movement/occupancy. If occupancy is sensed by the sensor, the thermostat goes into an occupied mode (i.e. programmed set point). If a pre-programmed time frame elapses (i.e. 30 minutes) and no occupancy is sensed during that time, the thermostat goes into an unoccupied mode (e.g., setback set point or off) until occupancy is sensed again. This reduces the overall time the heating or cooling system is running, saving energy.

- Areas with predictable occupancy: e.g.: classrooms, cafeteria, offices: A *programmable thermostat* is recommended. This device is programmed on a schedule to reduce the heating or cooling output of the facility's HVAC systems in relation to its predetermined occupancy schedule. In this way, the thermostat acts to set-back or set-up the facility temperature during unoccupied hours, and re-establish a comfortable facility temperature during business hours. By employing programmable thermostat technology, the heating and cooling system demand coincides with occupancy level, reducing energy usage.

- **Install Vending Misers on Vending Machines**

Vending misers for refrigerated and non-refrigerated vending machines is an often overlooked source of potential savings. Uncontrolled, vending machine lights remain on 24/7, consuming a constant amount of energy year round. By controlling these lights with an occupancy sensor, energy consumption attributed to vending machines can be reduced considerably, in many cases, by as much as 50% and can save up to $150 per machine per year.

In the case of refrigerated vending machines, electric demand can be further reduced by controlling the machines' refrigeration systems. In a manner similar to programmable thermostats, vending misers for refrigerated machines act on a pre-set occupancy schedule to allow a marginal increase in operating temperature during non-business hours. Although products in the machine are delivered to the customer at the same temperature as in an uncontrolled vending machine, products are not being cooled unnecessarily when the machine is not in use, significantly reducing the machine's energy consumption. Because of the relatively low vending miser installation cost and high operating hours of vending machines, this improvement is typically cost-effective with a very short payback period.

- **Install ENERGY STAR® Rated Equipment / Plug Load Control**

Plug loads (computers, televisions, coffee makers, etc.) account for, on average, about 10% of total energy consumption. One of the easiest and most cost-effective energy saving strategies is the reduction of electric usage through installation of efficient appliances and the control of plug loads. In addition to utilizing ENERGY STAR® qualified appliances, greater savings can be realized through the various devices available that control every day plug loads.

By connecting non-critical loads (coffee makers, fans, microwave ovens, etc.) to an occupancy or timer controlled power strip, significant energy savings can be achieved. These savings result not only from the neglect of the user to turn the device off manually, but also from reduction of "phantom load". Phantom load is the small but constant energy draw from many plug-in devices when not in use. By connecting certain appliances to an occupancy controlled power strip, phantom load can be eliminated by cutting power supply to those devices. When replacing or ordering new equipment, emphasize ENERGY STAR® devices when they are available. Also, purchase controlled power strips and connect appropriate devices to those strips to reduce unnecessary consumption due to phantom load and appliances left on. The EPA offers free computer power management software which has saved some districts as much as $75 per computer per year, the software can be found at http://www.energystar.gov/index.cfm?c=power_mgt.pr_power_mgt_low_carbon_join.

IV. Resources:

The State of New Hampshire along with the utility companies offer multiple programs designed to improve the energy efficiency of schools through financial incentives and technical support, including:

Northeast Energy Efficiency Partnerships:

- **Northeast Collaborative for High Performance Schools (NE-CHPS)**
  NE-CHPS is a set of building and design standards for all schools from pre-K through community colleges tailored specifically for NH state code requirements, the New England climate, and the environmental priorities of the region. NH Department of Education offers up to a 3% re-imbursement for New Construction School projects. To learn more about NE-CHPS and incentive programs please visit: http://neep.org/public-policy/hpse/hpse-nechps.

New Hampshire Public Utilities Commission:

- **New Hampshire Pay for Performance**
  This program addresses the energy efficiency improvement needs of the commercial and industrial sector. The Program is implemented through a network of qualified Program Partners. Incentives will be paid out on the following three payment schedule: Incentive #1: Is based on the area of conditioned space in square feet. Incentive #2: Per/kWh saved and Per/MMBTU saved based on projected savings and paid at construction completion. Incentive #3: Per/kWh saved and Per/MMBTU saved based on actual energy savings performance one year post construction. Total performance incentives (#2 and #3) will be capped at $200,000 or 50% of project cost on a per project basis. For more information visit http://nhp4p.com.

- **New Hampshire Public Utilities Commission's Renewable Energy Rebates**
  The Sustainable Energy Division provides an incentive program for solar electric (photovoltaic or PV) arrays and solar thermal systems for domestic hot water, space and process heat, with a capacity of 100 kW or equivalent thermal output or less. The rebate for PV systems as follows: $1.00 per Watt, capped at 25% of the costs of the system or $50,000, whichever is less. For solar hot water (SHW) systems, the base rebate is $0.07 per rated or modeled kBtu/year, capped at 25% of the cost of the facility or $50,000, whichever is less, as a one-time incentive payment. http://www.puc.state.nh.us/Sustainable%20Energy/RenewableEnergyRebates-CI.html.

New Hampshire Community Development Finance Authority:

- **New Hampshire Community Development Finance Authority Revolving Loan Fund**
  The Enterprise Energy Fund is a low-interest loan and grant program available to businesses and nonprofit organizations to help finance energy improvements and renewable energy projects in their buildings. The loans will range from $10,000 to $500,000. Larger amounts will be considered on a case by case basis. The program is available to finance improvements to the overall energy-efficiency performance of buildings owned by businesses and nonprofits, thereby lowering their overall energy costs and the associated carbon emissions. More information about the program can be found on their website www.nhcdfa.org. These activities may include:

  - Improvements to the building's envelope, including air sealing and insulation in the walls, attics and foundations;
  - Improvements to HVAC equipment and air exchange;
  - Installation of renewable energy systems;
  - Improvements to lighting, equipment, and other electrical systems; and
  - Conduction of comprehensive, fuel-blind energy audits.

Public Service of New Hampshire (PSNH):

- **Commercial (Electric) Energy Efficiency Incentive Programs**
  This program targets any commercial/industrial member building a new facility, undergoing a major renovation, or replacing failed (end-of-life) equipment. The program offers prescriptive and custom rebates for lighting and lighting controls, motors, VFDs, HVAC systems, chillers and custom projects. http://www.psnh.com/SaveEnergyMoney/For-Business/Energy-Saving-Programs-and-Incentives.aspx

- **SmartSTART**
  The SmartSTART (Savings Through Affordable Retrofit Technologies) advantage is simple - pay nothing out of pocket to have energy efficiency products and services installed in your building. The Smart Start program is limited to PSNH's municipal customers only and includes schools. The program is available on a first-come, first served basis to projects which have been pre-qualified by PSNH. The cost of the improvements is fronted by PSNH which is then repaid over time by the municipality or school using the savings generated by the products themselves! This program is for lighting and lighting controls, air sealing, insulation and other verifiable energy savings measures which have sufficient kilowatt-hour savings. For more information on this program visit:
  http://www.psnh.com/SaveEnergyMoney/For-Business/Municipal-Smart-Start-Program.aspx

- **Schools Program**
  For major renovation or equipment replacement projects, this program offers prescriptive and custom rebates for energy efficient lighting, motors, HVAC, chillers, and variable frequency drives to towns or cities that install energy efficient equipment at their schools. Financial incentives are available for qualifying energy efficient equipment. Technical assistance is also offered through the Schools Program. http://www.psnh.com/SaveEnergyMoney/Large-Power/Schools-Program.aspx

Unitil:

- **Commercial and Industrial Energy Efficiency Programs**
  Subject to program qualifications and availability of funding - Unitil offers different programs for its commercial, industrial, and institutional customers in New Hampshire: the Small Business Energy Efficiency Program, the Small Commercial and Industrial Program, the Large Commercial and Industrial Program, the Large Commercial and Industrial (C&I) Retrofit Program, and the Large C&I New Construction Program. Rebates are available for various technologies including water heaters, lighting, lighting controls/sensors, chillers, furnaces, boilers, central air conditioners, compressed air, programmable thermostats, energy management systems/building controls, motors, motor VFDs, processing and manufacturing equipment, LED exit signs, commercial cooking and refrigeration equipment. http://www.unitil.com/.

Clean Air – Cool Planet:

- **Community Energy Efficiency**
  CA-CP works with communities throughout the Northeast to find solutions to climate change and build constituencies for effective climate policies and actions. Much of their work focuses on successful models for energy efficiency and renewable energy planning. They advise and partner with citizens, educators, faith groups, small businesses, municipal governments, and other local leaders. They explore cost-effective opportunities that exist for communities to reduce their emissions as well as their vulnerability to climate impacts. One such example is CA-CP's partnership with the University of NH, NH Sustainable Energy Association and UNH Cooperative Extension to create www.myenergyplan.net, a groundbreaking suite of web and outreach tools for individual action used by households, schools and community groups around the northeast. http://www.cleanair-coolplanet.org/for_communities/index.php.

Environmental Protection Agency (EPA):

- **ENERGY STAR Challenge for Schools**
  EPA is challenging school administrators and building managers to improve energy efficiency throughout their facilities. More than 500 school districts across the country are helping to fight climate change by committing to reducing their energy use with help from ENERGY STAR. Schools that take the ENERGY STAR Challenge can use energy tracking tools, technical guidance, case studies and other ENERGY STAR tools and resources to help them improve their energy efficiency. More information can be found at:
  http://yosemite.epa.gov/opa/admpress.nsf/d985312f6895893b852574ac005f1e40/d74f768ecfa9e11f8525762500522260!OpenDocument

For additional assistance in helping you save money and improve school conditions, please call TRC at (603) 766-1913 or (877) 442-9181.

NEW HAMPSHIRE ENERGYSMART SCHOOLS PROGRAM

Energy Benchmarking Report for:

Spaulding High School

Rochester, NH

Period: ***July 1, 2010*** through ***June 30, 2011***

PREPARED BY:

155 Fleet Street, Suite #305

Portsmouth, NH 03801

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Table of Contents

I. Introduction

The Sustainable Energy Division of the New Hampshire Public Utilities Commission, with support from the New Hampshire Department of Education has sponsored TRC to develop the New Hampshire ***EnergySmart Schools Program*** to support New Hampshire K-12 public and private schools in the pursuit of energy efficiency and sustainability initiatives.

Energy efficiency has become an increasingly important issue for schools due to tightening budgets and rising energy costs. Since 2003, the prices of natural gas, fuel oil and electricity have increased by 123%, 107% and 32% respectively. Schools that have participated in energy benchmarking programs have shown a decrease in overall energy use by approximately 22% through the adoption of energy efficiency measures.

Tracking and documenting the energy use and associated carbon emissions in the state's K-12 schools will allow New Hampshire to account for the impact of its energy efficiency and renewable energy programs and determine which have the greatest effect. The analysis in this report, provided by the ***EnergySmart Schools Program*** is designed to help you:

- Understand the energy consumption and cost trends at each of your school buildings.
- Learn how your buildings are performing compared to other schools locally and nationally.
- Identify opportunities for improving operations and reducing costs.
- Take advantage of resources to implement efficiency improvements and save money.

The analysis was based on the information provided on the *Building Data Request Form* submitted, which included building descriptions, energy suppliers and other information. The building's utility bills were also used to assess its electricity and heating fuel consumption for the year(s) provided.

The energy performance for your school has been compared to national data for similar school facilities through EPA's ENERGY STAR® Portfolio Manager. Also shown are the five major benchmarks used to analyze building performance, which include: electricity use; heating fuel use; weather-normalized heating fuel use; total cost; and total cost per student, all of which have been normalized for comparison by square footage and weather. As part of the program's focus on sustainability, your school's carbon footprint is also presented.

II. Benchmarking Analysis and Review Results

Building and energy usage of your school was analyzed to assess the basic nature of your energy consumption and utility costs. The Building Data Summary table shown below summarizes this information.

Table 1: Building Data Summary for Spaulding High School

Building Data			
District	SAU 54 Rochester School Department	**School Name**	Spaulding High School
City	Rochester	**Zip Code**	03867
Year Built	1939	**Floor Area (sq.ft.)**	246,000
Number of Students	1,496	**Number of PCs**	493
Weekly Operating Hours	80	**Months School Used**	12
Cooking?	YES	**% AC**	20
Pool Size?	N/A	**Months Pool Used**	0

Utility Data			
Data End Point	6/30/2011	**Total Cost ($)**	236,499
Electric Provider	PSNH	**Natural Gas Provider**	Unitil
Electricity Usage (kWh)	1,027,000	**Electricity Cost ($)**	144,331
Natural Gas Usage (therms)	90,954	**Natural Gas Cost ($)**	92,168
Fuel Oil Usage (gal)	0	**Fuel Oil Cost ($)**	0
Other Fuel Usage (gal)	0	**Other Fuel Cost ($)**	0

Energy Indicators			
EPA Score	96	**Electric Usage (kWh/sq.ft.)**	4.2
Heating Fuel Usage (kBtu/sq.ft.)	37.0	**Weather Adjusted Heating Usage Btu/sq.ft./HDD)**	5.1
Site Energy (kBtu/sq.ft.)	51.2	**Source Energy (kBtu/sq.ft.)**	86

Environmental Impact Indicators			
Greenhouse Gas Emissions			
Last Year Heating Fuel CO_2e (Mt)	483.9	**Last Year Total CO_2e (Mt)**	802.5
Last Year Electricity CO_2e (Mt)	318.6	**CO_2e Efficiency Savings Over Previous Year**	-216.3
EPA Target Score			
Target Score	Reached	**Site Energy Reduction Needed (kBtu/sq.ft.)**	N/A - Reached

Figures 1a, 1b, 2a and 2b display the energy use, demand and cost data tracked on a monthly basis. This demonstrates the energy consumption of your building over the course of the year. As a part of the program's focus on sustainability, your school's carbon footprint was also measured and is presented in Figure 3.

Figure 1a. Monthly Electric Use & Max Demand for Spaulding High School

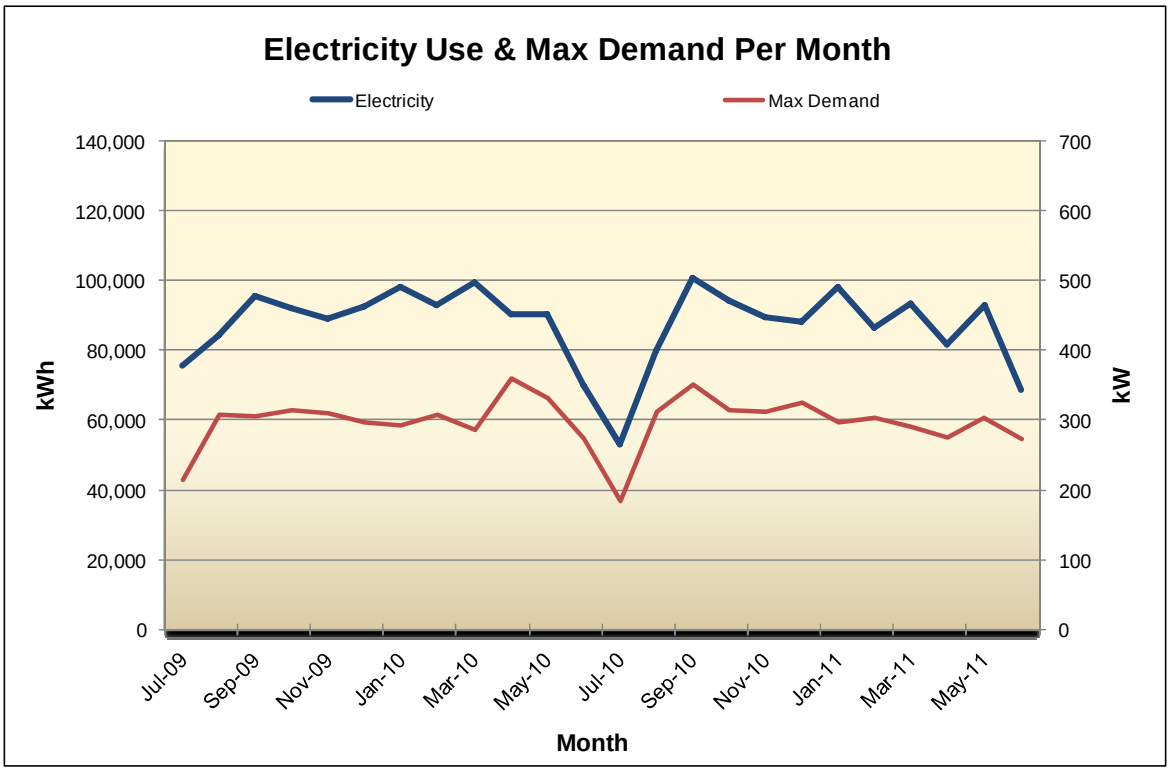
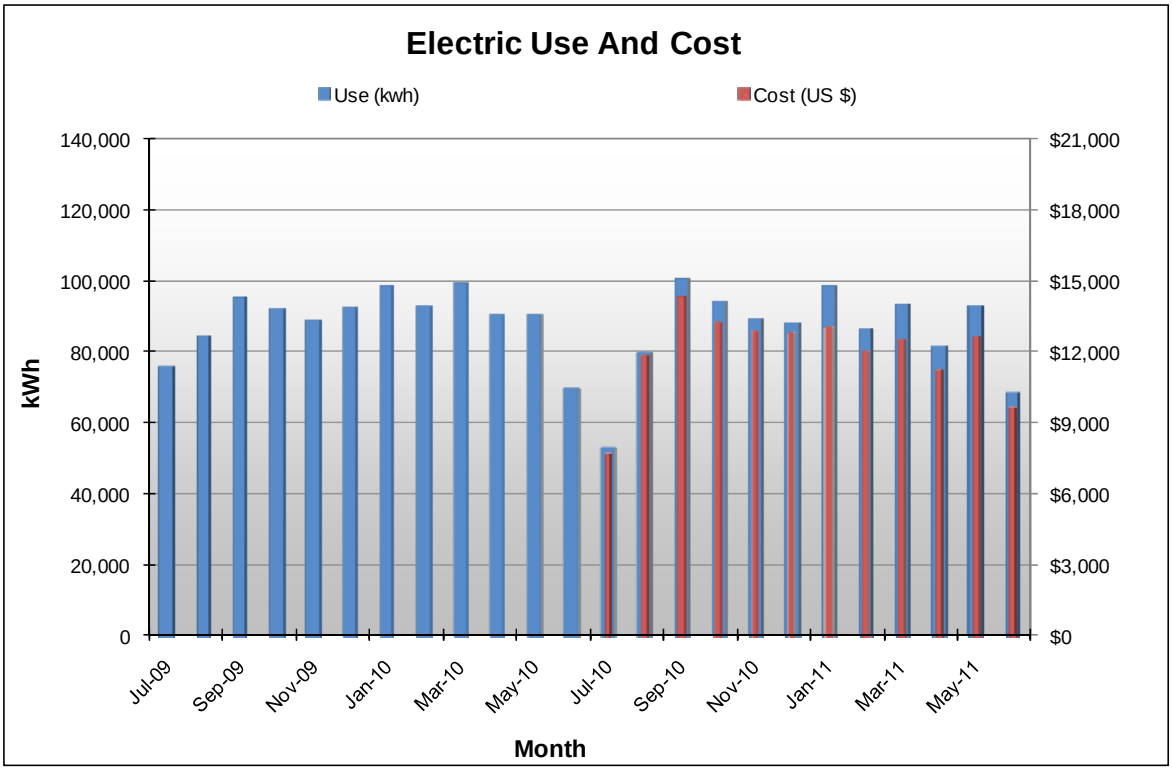


Figure 1b. Monthly Electric Use vs. Cost for Spaulding High School



Note: Electric Cost was only available for the most recent 12 month period.

Figure 2a. Monthly Natural Gas Use for Spaulding High School

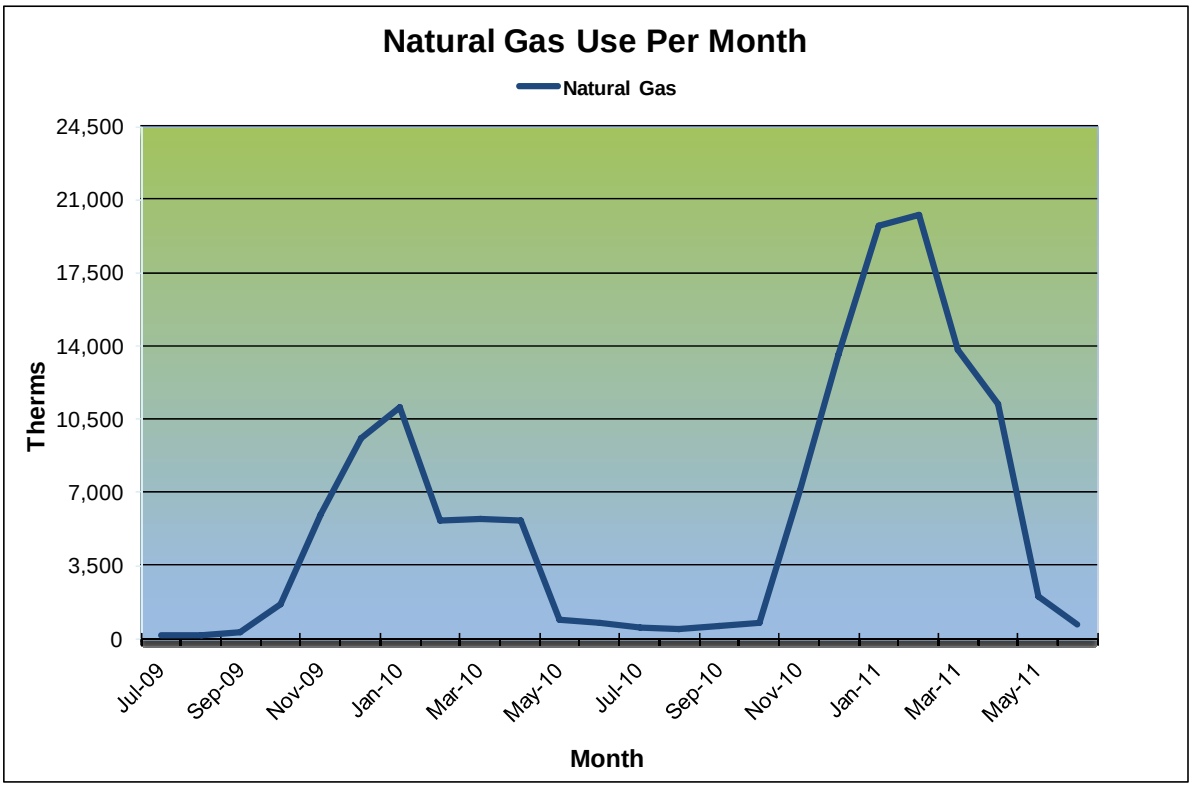


Figure 2b. Monthly Natural Gas Use vs Cost for Spaulding High School

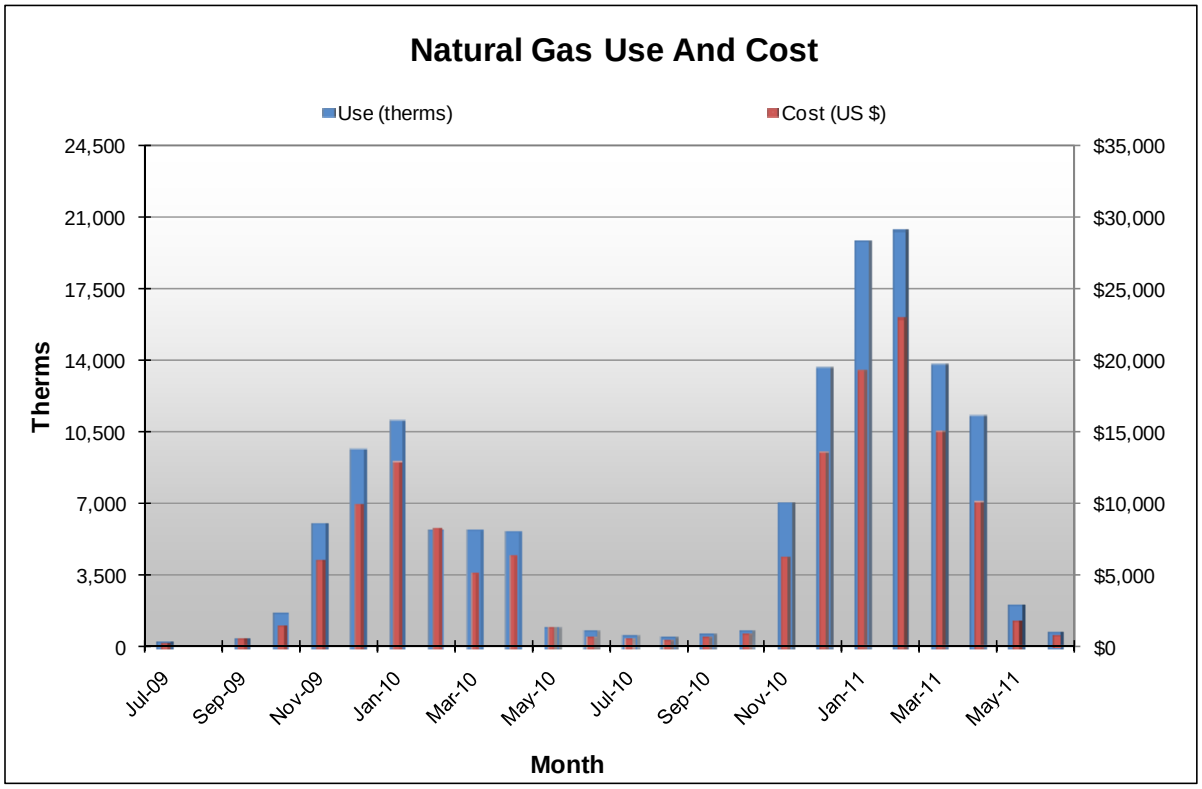
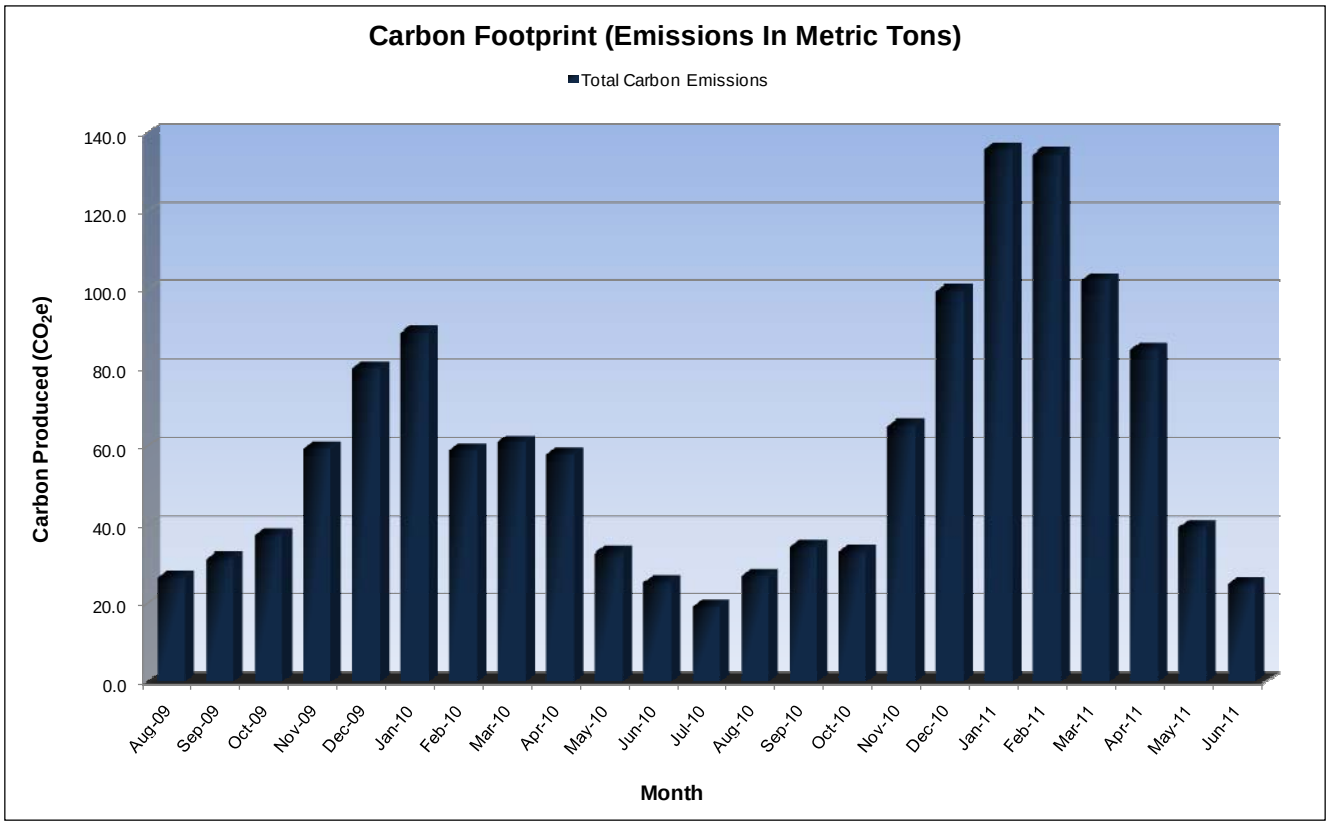


Figure 3. Monthly Greenhouse Gas Emissions for Spaulding High School



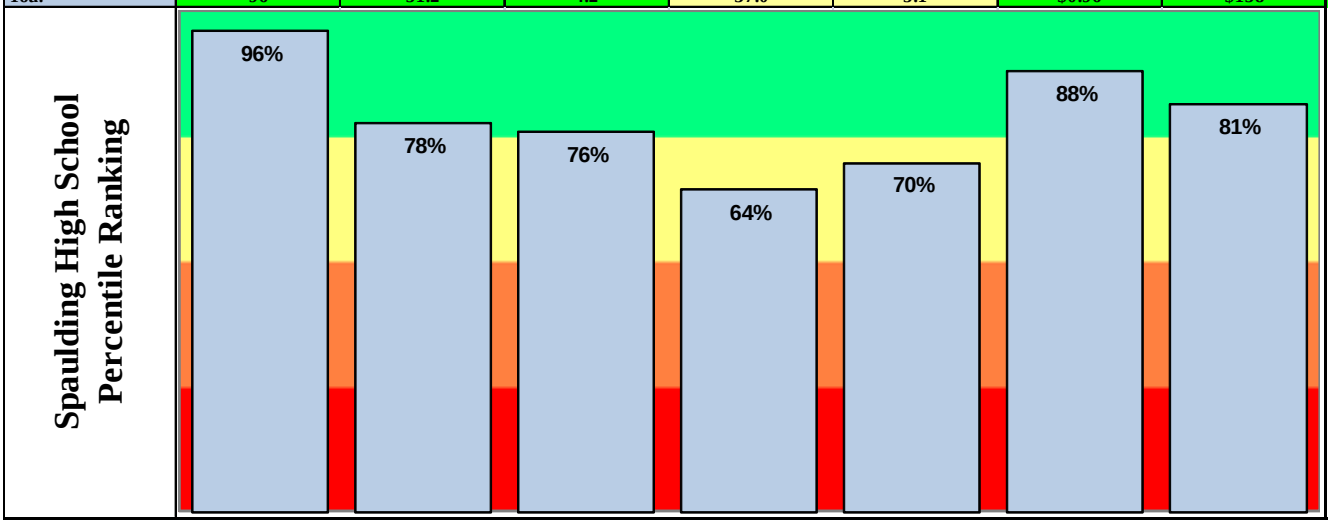
Benchmarking Data

To evaluate the energy and environmental performance of your school, the building data collected above has been compared against two different sets of school energy data: the U.S. Environmental Protection Agency's national data and New Hampshire specific state data. The results are illustrated in Figure 4 on the following page.

This will allow you to assess your building's performance relative to other buildings designed and constructed to the same codes and standards, operating under the same regulations and schedules and similar weather conditions. The indicators are calculated on a *per square foot* or *per student* basis, so you can compare your school to different sized schools.

Figure 4. EnergySmart Schools Benchmarks for Spaulding High School

Schools	U.S. EPA Portfolio Manager Score	New Hampshire State Schools (Annual Data)					
		Total Energy Use (kBtu/sq.ft.)	Electric Use (kWh/sq.ft.)	Heating Fuel Use (kBtu/sq.ft.)	Weather Adjusted Heating Fuel Use (Btu/sq.ft./HDD)	Total Energy Cost ($/sq.ft.)	Total Energy Cost ($/student)
NH Average:	50	60.3	5.2	41.7	5.7	$1.42	$256
You:	96	51.2	4.2	37.0	5.1	$0.96	$158



Major Benchmark Indicators

1. Total Energy Use, kBtu/sq.ft.

This indicator shows how much total energy your school consumes each year. It includes the energy used for heating, cooling (if any), lights, cooking, computers, etc.

Your school's total energy use of 51.2 kBtu per square foot per year (kBtu/sq.ft.) is better than the New Hampshire K-12 schools state average of 60.3 kBtu/sq.ft. Your total energy use figure is lower than 78% of New Hampshire K-12 schools. The EnergySmart School Report is weather normalized so fuel consumption for heating takes the difference in climate between northern and southern New Hampshire into account.

This is a good indicator of how well, overall, your school is performing. However, it doesn't help you find ***where*** in your building to look for improvement opportunities. Multiple factors included on the following pages can help with that. Analysis of energy consumption for this program does not control for operational variations. An example is an improperly ventilated school may appear to have lower energy consumption. Ventilation systems that are not operating properly result in lower indoor air quality.

2. Electricity Data

Most electric utilities use the following two factors to estimate your electricity bill – Electric Use and Electric Demand.

a. Electric Use, kWh/sq.ft.

This shows how well the building does with its lights, cooling/air conditioners and cafeteria systems (if any), and what's referred to as "plug load." Plug load is anything that plugs into a socket. The major plug loads are generally computers (including monitors, printers and copiers), refrigerators, coffee machines, fans, shop equipment and projectors. If electric consumption is much higher than average, but heating fuel use (see below) is average or better, then focus your efforts on the electric-powered elements.

New Hampshire schools state average electric use is 5.2 kWh per square foot. Your school's electric consumption of 4.2 kWh per square foot this year is lower than 76% of New Hampshire schools benchmarked through the New Hampshire EnergySmart Schools Program.

b. Electric Demand, Watts/sq.ft.

Demand is a measure of the maximum electric draw in kW that your building places on the grid and is measured by adding up the kW draw for a 15 minute period. To give an analogy, if electricity usage is the amount of water going through a hose in gallons, electric demand would be how fast that water flows expressed in gallons per minute. Whichever 15 minute period during your monthly billing cycle places the highest kW demand on the grid is the demand factor applied to your bill. The best way to improve this demand factor is to stagger the times when your electrical systems draw at their maximum or reduce unnecessary electric load altogether.

The average electric demand for New Hampshire schools is 1.9 watts per square foot. Your school's electric demand is 1.4 watts per square foot and is lower than 85% of New Hampshire Schools benchmarked through the New Hampshire EnergySmart Schools Program.

3. Heating Fuel Use, kBtu/sq.ft.

Reviewing these indicators is relatively straightforward. If your school's heating fuel use is much higher than average, an audit of your heating system along with your building envelope - doors, windows, roof - is recommended. This factor is 'fuel-neutral' as it works for either fuel oil or natural gas heating systems.

New Hampshire K-12 schools state average heating fuel use is 41.7 kBtu/sq.ft. or 5.7 Btu/sq.ft./HDD. Your school's heating fuel use of 37.0 kBtu/sq.ft. per year is lower than 64% of other New Hampshire schools in the database. Your school's weather adjusted heating fuel use of 5.1 Btu/sq.ft./HDD is lower than 70% of other New Hampshire schools benchmarked through the New Hampshire EnergySmart Schools Program.

4. Energy Cost, $/sq.ft. & $/student

Cost is the bottom line. These numbers help you understand, in terms of budget, the gain through energy efficiency improvements. New Hampshire K-12 schools state averages $1.42/sq.ft. and $256/student.

Your school's annual energy cost of $0.96 per square foot is lower than 88% of other New Hampshire benchmarked schools. Your school's cost expressed on a per student basis of $158 is lower than 81% of other New Hampshire schools benchmarked through the New Hampshire EnergySmart Schools Program.

5. U.S. EPA *Portfolio Manager* Score

Portfolio Manager is a benchmarking model based on a national set of data from K-12 schools. It is provided by the U.S. Environmental Protection Agency's ENERGY STAR® Program. The impact of factors outside of your control (such as location, occupancy and operating hours) are removed, providing a 1-100 ranking of a school's energy performance relative to the national school building market. A score of 50 represents the national average and a score of 100 is best. Schools that achieve a score of 75 or higher are eligible for EPA's ENERGY STAR® Building Label, the national symbol for protecting the environment through energy efficiency. Districts can achieve ENERGY STAR® Leader Awards in recognition if their buildings, on average, improve by 10%, 20%, 30%, etc. over their baseline year of reported energy use or if the district's overall weighted average *Portfolio Manager* Score is at least a 75.

Your school's *Portfolio Manager* Score of 96 places it higher than 96% of K-12 schools nationwide. As noted above, this rating potentially qualifies your school for the prestigious ENERGY STAR® Label for Buildings.

III. Potential Energy Saving Opportunities

Based on the preceding analysis of your school's energy performance, implementation of the following recommendations can help you save energy and money. The first step is to look at reducing electrical lighting and HVAC consumption (burners, circulators and fans) which typically account for 67% of a building's electric consumption.

- **Perform an Energy Audit on the Building**

An energy audit involves a comprehensive analysis of the building's general characteristics, its energy use and allocation of that use amongst the facility's energy end uses. The goal is to identify sources of potential energy savings. Your auditor should develop a list of recommendations that will result in substantial energy and operational cost savings. These may include, building envelope improvement and mechanical systems, lighting upgrades, equipment replacement and installation of lighting and HVAC control mechanisms, among others.

A good audit should include information specific to each recommendation which *at least* includes approximate annual energy unit and cost savings, demand reduction, installation cost, lifetime cost savings and information related to cost-effectiveness. This will help to prioritize the recommendations based on their energy efficiency and shortest payback.

The recommendations provided in an energy audit report may reduce facility energy bills by 20% or more in addition to improving occupant health and comfort. Following this report, an energy audit is the next step in realizing the full potential of energy savings opportunities.

- **Request Retro-Commissioning**

Retro-commissioning is a detailed process applied to existing facilities aimed at correcting many of the degradations and inefficiencies that are indicative of older and/or poorly performing buildings. Many older buildings tend to be less comfortable and operate less efficiently when not properly commissioned. Retro-commissioning includes a detailed energy audit and focuses on not only potential energy savings but also the interaction of the building's equipments and mechanical systems with an eye toward restoring it to optimal performance.

In contrast to an energy audit, this optimization focuses on operational improvements to existing equipment, rather than replacement. Apart from energy savings, other improvements and benefits include substantial operation and maintenance (O&M) cost savings, improved air quality, occupant comfort, health and safety, equipment controls, and improved system interactivity.

In addition to providing recommendations, retro-commissioning includes implementation of the recommended improvements and hence the cost for retro-commissioning is higher than an audit. However, when the costs of improvements are added to the energy audit cost, prices may be comparable. If high O&M costs or occupant health, comfort and safety are concerns in addition to reduction in energy use, retro-commissioning may be a suitable strategy.

- **Upgrade Lighting Systems**

Lighting typically accounts for 30-60% of all energy consumed in school buildings. Additionally, the electrical energy consumed by lights during the summer creates heat and increases cooling costs.

Spaulding High School's electricity consumption is low (better) compared to other schools in the State. Even so, upgraded lighting systems in high consumption areas like classrooms, gymnasiums, libraries, offices, etc. can reduce costs, improve the lighting quality and increase occupant comfort and productivity.

Over-lit Spaces: Light levels should be recorded in classrooms and hallways to ensure they are not over-lit, 40-50 foot candles are adequate light levels for an instructional space. If classroom light levels are much higher than 50 foot candles, Spaulding High School should consider de-lamping classrooms or installing dimming ballasts, which dim the lights when outdoor light levels are adequate. In over-lit hallway spaces photo sensors can be installed to turn lights off completely when light levels exceed a pre-set threshold.

In over-lit spaces a T8 to Super T8 lighting retro-fit can reduce the number of light fixtures needed. Super T8 lamps use between 4 and 7 Watts less electricity than standard T8 lamps, but they produce more light per Watt. In some cases this increase in light per Watt can allow for the removal of an entire lamp, saving 32 Watts. The room characteristics must be factored in before this type of retro-fit. The shape of the space, ceiling height, color of the walls, etc. all need to be taken into account when exploring a de-lamping project. We recommend that before retro-fitting the entire facility, begin by changing one classroom and monitor the comfort level of the occupants at Spaulding High School.

Another proven energy reduction measure with a short payback period is to identify any areas where your school may still be using metal halide lighting. Typically metal halide lights are found in gymnasiums or cafeteria areas, many districts have been very satisfied by replacing these lights with high bay T5 lighting fixtures. In addition to the reduced operational wattage, high bay T5 lights turn on instantly, as opposed to metal halide fixtures which have an extended warm up period. The long warm up period associated with metal halides typically leads to the lights being left on all day, at 250 to 400 watts a fixture; the costs begin to add up. Adding occupancy sensors to high bay T5 fixtures further reduces the payback period.

Occupancy Sensors: We recommend that you explore the use of occupancy sensors to ensure that lights are turned off in unoccupied spaces. Lights controlled by occupancy sensors typically run a third of the time when compared with manually controlled lighting. Reduced runtime leads to decreases in both energy usage and operation and maintenance costs. Additionally, a study conducted in Massachusetts found that controlling the security lighting with occupancy sensors reduced vandalism; neighbors and police recognized something wrong when the lights were on in a building that was typically dark and investigated.

To summarize and add a few ways in which Spaulding High School may be able to conserve energy and cost through lighting upgrades is to:

- Design light quantity and quality for the task and occupants' needs in that area.
- Maximize lamp and ballast efficiency.
- Activate the power saving features on office equipment such as copiers, printers and fax machines and ensure that they are turned off at the end of the day.
- Use automatic controls to turn lights off or dim lights in unoccupied spaces.
- Establish a maintenance schedule for group re-lamping and fixture cleaning.
- Replace T12 fixtures with the most efficient fixtures which may include T8/super T8/T5 fixtures.
- Replace incandescent lighting with compact fluorescent technology.

- Replace incandescent exit lighting which consumes 30 Watts with LED type exit lights with 1.5 Watts consumption. LED units last up to 10 years, which is a maintenance advantage.
- Install daylight sensors in areas with significant natural light.
- Install occupancy sensors in areas that are often unoccupied.
- Lighting retrofits reduce maintenance costs associated with lighting that is close to end of life.
- Establish a regular cleaning schedule particularly for areas where student safety of low light levels may be a concern, such as shop classes.
- Look to make lamp and fixture selection as uniform as possible to reduce maintenance and inventory overhead.
- Educate students and staff to turn off lights when rooms are unoccupied.

Lighting upgrades seek to reduce the connected electrical load (kW) and energy consumption (kWh) of lighting equipment. Lighting controls can also significantly reduce operating hours and costs by turning off lighting when spaces are unoccupied or sufficiently lit by natural light.

- **Install NEMA Premium Motors and VFDs**

Commercial and industrial electric motor-driven systems consume approximately 23% of all electricity in the U.S., making it the single largest category contributor to electric use in the country. With very high operating hours, the annual energy cost to run a system is more than its installation cost. Even a small increase in the efficiency of an electric motor can result in substantial energy cost savings. Typical opportunities for motor upgrades in schools include: ventilation fans, and heating and cooling system pumps and fans.

Motors with efficiency up to 90% are available to replace the older ones with efficiency less than 75%. Although standards for efficiency of new equipment are set by the Energy Policy Act, motor efficiency can be further increased by selecting Premium Efficiency motors as specified by the National Electrical Manufacturers Association (NEMA). This can cut the electric motor system demand by as much as 18%.

Savings can be increased further by optimizing system performance through the use of variable frequency drives (VFDs). When system load is known to vary substantially, these flow control systems can be utilized to match system output to system demand, significantly reducing energy usage during partial load hours. By employing high-efficiency motors and VFDs, facility owners can improve environmental conditions, utilize better control of motor-driven processes, and reduce waste output.

- **Install Demand Control Ventilation**

Demand control ventilation (DCV) monitors indoor air CO_2 content as a result of occupancy production levels and uses this data to regulate the amount of outdoor air that is permitted for ventilation. In order to ensure adequate air quality, standard ventilation systems permit outside air based on estimated occupancy levels in CFM, cubic feet per minute/occupant. However, during low occupancy hours, the space may become over ventilated due to decreased CO_2 levels and unnecessary ventilation results in wasted energy. DCV reduces unnecessary outdoor air intake by regulating ventilation based on actual CO_2 levels, saving energy. DCV is most suited for areas where occupancy levels are known to fluctuate considerably such as auditoriums, cafeterias, and gymnasiums.

Install Energy Recovery Ventilators. According to energy recovery equipment manufacturer's typical paybacks are less than 5 years for schools without cooling. The keys to success with ventilation retrofits are going with fewer larger units with long run hours as opposed to several small units with limited run time. Equipment with moisture recovery capabilities would cut humidity up to 50% during the cooling season.

- **Improve/Replace Inefficient Heating Systems**

Replacing an old boiler that is < 70% efficient with a modern 85-90% efficient natural gas-fired furnace alone will reduce heating costs by 15-20%. This combined with additional system improvements and installation of advanced HVAC control mechanisms can result in up to 20%+ heating load reduction.

Because of the high capital cost of new heating systems, some financial analysis should be performed to assess the cost-effectiveness of immediate replacement. If the current system is fairly new, replacement may not be immediately justifiable from a financial standpoint. However, as is the case with cooling systems, early replacement may prove to be a more cost-effective solution than waiting until existing systems fail or reach the end of their estimated useful life.

- **Improve/Replace Inefficient Air Conditioning Systems**

The useful life of a rooftop A/C unit is generally 12-18 years. However, depending on the efficiency, early replacement of outdated, inefficient, split, or packaged rooftop air conditioning units with new A/C systems that are 15% more efficient than 10-15 year old equipments can considerably reduce annual energy consumption. The energy cost savings and maintenance savings offset the high installation cost of a more efficient system. Installing thermostats and/or economizers on new or existing A/C systems will further reduce the cooling demand.

Economizers provide "free" cooling by using controllable dampers that bring in outside air to cool the space when the outdoor temperature or enthalpy is below the building's return air conditions. Although they require operation by a well calibrated and maintained control system, economizers have impressive energy-saving capabilities.

Install Occupancy Controlled/Programmable Thermostats

Combining efficient HVAC equipment with occupancy controlled and programmable thermostats can save a facility up to 10% of its annual heating and cooling costs:

- Areas with unpredictable occupancy on a daily/weekly basis - gym, bathrooms, outdoors: Use an *occupancy controlled thermostat* - a thermostat paired with a sensor and/or door detector to identify movement/occupancy. If occupancy is sensed by the sensor, the thermostat goes into an occupied mode (i.e. programmed set point). If a pre-programmed time frame elapses (i.e. 30 minutes) and no occupancy is sensed during that time, the thermostat goes into an unoccupied mode (e.g., setback set point or off) until occupancy is sensed again. This reduces the overall time the heating or cooling system is running, saving energy.

- Areas with predictable occupancy: e.g.: classrooms, cafeteria, offices: A *programmable thermostat* is recommended. This device is programmed on a schedule to reduce the heating or cooling output of the facility's HVAC systems in relation to its predetermined occupancy schedule. In this way, the thermostat acts to set-back or set-up the facility temperature during unoccupied hours, and re-establish a comfortable facility temperature during business hours. By employing programmable thermostat technology, the heating and cooling system demand coincides with occupancy level, reducing energy usage.

- **Install Vending Misers on Vending Machines**

Vending misers for refrigerated and non-refrigerated vending machines is an often overlooked source of potential savings. Uncontrolled, vending machine lights remain on 24/7, consuming a constant amount of energy year round. By controlling these lights with an occupancy sensor, energy consumption attributed to vending machines can be reduced considerably, in many cases, by as much as 50% and can save up to $150 per machine per year.

In the case of refrigerated vending machines, electric demand can be further reduced by controlling the machines' refrigeration systems. In a manner similar to programmable thermostats, vending misers for refrigerated machines act on a pre-set occupancy schedule to allow a marginal increase in operating temperature during non-business hours. Although products in the machine are delivered to the customer at the same temperature as in an uncontrolled vending machine, products are not being cooled unnecessarily when the machine is not in use, significantly reducing the machine's energy consumption. Because of the relatively low vending miser installation cost and high operating hours of vending machines, this improvement is typically cost-effective with a very short payback period.

- **Install ENERGY STAR® Rated Equipment / Plug Load Control**

Plug loads (computers, televisions, coffee makers, etc.) account for, on average, about 10% of total energy consumption. One of the easiest and most cost-effective energy saving strategies is the reduction of electric usage through installation of efficient appliances and the control of plug loads. In addition to utilizing ENERGY STAR® qualified appliances, greater savings can be realized through the various devices available that control every day plug loads.

By connecting non-critical loads (coffee makers, fans, microwave ovens, etc.) to an occupancy or timer controlled power strip, significant energy savings can be achieved. These savings result not only from the neglect of the user to turn the device off manually, but also from reduction of "phantom load". Phantom load is the small but constant energy draw from many plug-in devices when not in use. By connecting certain appliances to an occupancy controlled power strip, phantom load can be eliminated by cutting power supply to those devices. When replacing or ordering new equipment, emphasize ENERGY STAR® devices when they are available. Also, purchase controlled power strips and connect appropriate devices to those strips to reduce unnecessary consumption due to phantom load and appliances left on. The EPA offers free computer power management software which has saved some districts as much as $75 per computer per year, the software can be found at http://www.energystar.gov/index.cfm?c=power_mgt.pr_power_mgt_low_carbon_join.

IV. Resources:

The State of New Hampshire along with the utility companies offer multiple programs designed to improve the energy efficiency of schools through financial incentives and technical support, including:

Northeast Energy Efficiency Partnerships:

- **Northeast Collaborative for High Performance Schools (NE-CHPS)**
  NE-CHPS is a set of building and design standards for all schools from pre-K through community colleges tailored specifically for NH state code requirements, the New England climate, and the environmental priorities of the region. NH Department of Education offers up to a 3% re-imbursement for New Construction School projects. To learn more about NE-CHPS and incentive programs please visit: http://neep.org/public-policy/hpse/hpse-nechps.

New Hampshire Public Utilities Commission:

- **New Hampshire Pay for Performance**
  This program addresses the energy efficiency improvement needs of the commercial and industrial sector. The Program is implemented through a network of qualified Program Partners. Incentives will be paid out on the following three payment schedule: Incentive #1: Is based on the area of conditioned space in square feet. Incentive #2: Per/kWh saved and Per/MMBTU saved based on projected savings and paid at construction completion. Incentive #3: Per/kWh saved and Per/MMBTU saved based on actual energy savings performance one year post construction. Total performance incentives (#2 and #3) will be capped at $200,000 or 50% of project cost on a per project basis. For more information visit http://nhp4p.com.

- **New Hampshire Public Utilities Commission's Renewable Energy Rebates**
  The Sustainable Energy Division provides an incentive program for solar electric (photovoltaic or PV) arrays and solar thermal systems for domestic hot water, space and process heat, with a capacity of 100 kW or equivalent thermal output or less. The rebate for PV systems as follows: $1.00 per Watt, capped at 25% of the costs of the system or $50,000, whichever is less. For solar hot water (SHW) systems, the base rebate is $0.07 per rated or modeled kBtu/year, capped at 25% of the cost of the facility or $50,000, whichever is less, as a one-time incentive payment. http://www.puc.state.nh.us/Sustainable%20Energy/RenewableEnergyRebates-CI.html.

New Hampshire Community Development Finance Authority:

- **New Hampshire Community Development Finance Authority Revolving Loan Fund**
  The Enterprise Energy Fund is a low-interest loan and grant program available to businesses and nonprofit organizations to help finance energy improvements and renewable energy projects in their buildings. The loans will range from $10,000 to $500,000. Larger amounts will be considered on a case by case basis. The program is available to finance improvements to the overall energy-efficiency performance of buildings owned by businesses and nonprofits, thereby lowering their overall energy costs and the associated carbon emissions. More information about the program can be found on their website www.nhcdfa.org. These activities may include:

  - Improvements to the building's envelope, including air sealing and insulation in the walls, attics and foundations;
  - Improvements to HVAC equipment and air exchange;
  - Installation of renewable energy systems;
  - Improvements to lighting, equipment, and other electrical systems; and
  - Conduction of comprehensive, fuel-blind energy audits.

Public Service of New Hampshire (PSNH):

- **Commercial (Electric) Energy Efficiency Incentive Programs**
  This program targets any commercial/industrial member building a new facility, undergoing a major renovation, or replacing failed (end-of-life) equipment. The program offers prescriptive and custom rebates for lighting and lighting controls, motors, VFDs, HVAC systems, chillers and custom projects. http://www.psnh.com/SaveEnergyMoney/For-Business/Energy-Saving-Programs-and-Incentives.aspx

- **SmartSTART**
  The SmartSTART (Savings Through Affordable Retrofit Technologies) advantage is simple - pay nothing out of pocket to have energy efficiency products and services installed in your building. The Smart Start program is limited to PSNH's municipal customers only and includes schools. The program is available on a first-come, first served basis to projects which have been pre-qualified by PSNH. The cost of the improvements is fronted by PSNH which is then repaid over time by the municipality or school using the savings generated by the products themselves! This program is for lighting and lighting controls, air sealing, insulation and other verifiable energy savings measures which have sufficient kilowatt-hour savings. For more information on this program visit:
  http://www.psnh.com/SaveEnergyMoney/For-Business/Municipal-Smart-Start-Program.aspx

- **Schools Program**
  For major renovation or equipment replacement projects, this program offers prescriptive and custom rebates for energy efficient lighting, motors, HVAC, chillers, and variable frequency drives to towns or cities that install energy efficient equipment at their schools. Financial incentives are available for qualifying energy efficient equipment. Technical assistance is also offered through the Schools Program. http://www.psnh.com/SaveEnergyMoney/Large-Power/Schools-Program.aspx

Unitil:

- **Commercial and Industrial Energy Efficiency Programs**
  Subject to program qualifications and availability of funding - Unitil offers different programs for its commercial, industrial, and institutional customers in New Hampshire: the Small Business Energy Efficiency Program, the Small Commercial and Industrial Program, the Large Commercial and Industrial Program, the Large Commercial and Industrial (C&I) Retrofit Program, and the Large C&I New Construction Program. Rebates are available for various technologies including water heaters, lighting, lighting controls/sensors, chillers, furnaces, boilers, central air conditioners, compressed air, programmable thermostats, energy management systems/building controls, motors, motor VFDs, processing and manufacturing equipment, LED exit signs, commercial cooking and refrigeration equipment. http://www.unitil.com/.

Clean Air – Cool Planet:

- **Community Energy Efficiency**
  CA-CP works with communities throughout the Northeast to find solutions to climate change and build constituencies for effective climate policies and actions. Much of their work focuses on successful models for energy efficiency and renewable energy planning. They advise and partner with citizens, educators, faith groups, small businesses, municipal governments, and other local leaders. They explore cost-effective opportunities that exist for communities to reduce their emissions as well as their vulnerability to climate impacts. One such example is CA-CP's partnership with the University of NH, NH Sustainable Energy Association and UNH Cooperative Extension to create www.myenergyplan.net, a groundbreaking suite of web and outreach tools for individual action used by households, schools and community groups around the northeast. http://www.cleanair-coolplanet.org/for_communities/index.php.

Environmental Protection Agency (EPA):

- **ENERGY STAR Challenge for Schools**
  EPA is challenging school administrators and building managers to improve energy efficiency throughout their facilities. More than 500 school districts across the country are helping to fight climate change by committing to reducing their energy use with help from ENERGY STAR. Schools that take the ENERGY STAR Challenge can use energy tracking tools, technical guidance, case studies and other ENERGY STAR tools and resources to help them improve their energy efficiency. More information can be found at:
  http://yosemite.epa.gov/opa/admpress.nsf/d985312f6895893b852574ac005f1e40/d74f768ecfa9e11f8525762500522260!OpenDocument

For additional assistance in helping you save money and improve school conditions, please call TRC at (603) 766-1913 or (877) 442-9181.

NEW HAMPSHIRE ENERGYSMART SCHOOLS PROGRAM

Energy Benchmarking Report for:

School Street Elementary School

Rochester, NH

Period: ***July 1, 2010*** through ***June 30, 2011***

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I. Introduction

The Sustainable Energy Division of the New Hampshire Public Utilities Commission, with support from the New Hampshire Department of Education has sponsored TRC to develop the New Hampshire ***EnergySmart Schools Program*** to support New Hampshire K-12 public and private schools in the pursuit of energy efficiency and sustainability initiatives.

Energy efficiency has become an increasingly important issue for schools due to tightening budgets and rising energy costs. Since 2003, the prices of natural gas, fuel oil and electricity have increased by 123%, 107% and 32% respectively. Schools that have participated in energy benchmarking programs have shown a decrease in overall energy use by approximately 22% through the adoption of energy efficiency measures.

Tracking and documenting the energy use and associated carbon emissions in the state's K-12 schools will allow New Hampshire to account for the impact of its energy efficiency and renewable energy programs and determine which have the greatest effect. The analysis in this report, provided by the ***EnergySmart Schools Program*** is designed to help you:

- Understand the energy consumption and cost trends at each of your school buildings.
- Learn how your buildings are performing compared to other schools locally and nationally.
- Identify opportunities for improving operations and reducing costs.
- Take advantage of resources to implement efficiency improvements and save money.

The analysis was based on the information provided on the *Building Data Request Form* submitted, which included building descriptions, energy suppliers and other information. The building's utility bills were also used to assess its electricity and heating fuel consumption for the year(s) provided.

The energy performance for your school has been compared to national data for similar school facilities through EPA's ENERGY STAR® Portfolio Manager. Also shown are the five major benchmarks used to analyze building performance, which include: electricity use; heating fuel use; weather-normalized heating fuel use; total cost; and total cost per student, all of which have been normalized for comparison by square footage and weather. As part of the program's focus on sustainability, your school's carbon footprint is also presented.

II. Benchmarking Analysis and Review Results

Building and energy usage of your school was analyzed to assess the basic nature of your energy consumption and utility costs. The Building Data Summary table shown below summarizes this information.

Table 1: Building Data Summary for School Street Elementary School

Building Data			
District	SAU 54 Rochester School Department	**School Name**	School Street Elementary School
City	Rochester	**Zip Code**	03867
Year Built	1911	**Floor Area (sq.ft.)**	16,000
Number of Students	89	**Number of PCs**	34
Weekly Operating Hours	60	**Months School Used**	12
Cooking?	YES	**% AC**	10
Pool Size?	N/A	**Months Pool Used**	0

Utility Data			
Data End Point	6/30/2011	**Total Cost ($)**	20,468
Electric Provider	PSNH	**Natural Gas Provider**	N/A
Electricity Usage (kWh)	56,350	**Electricity Cost ($)**	9,024
Natural Gas Usage (therms)	0	**Natural Gas Cost ($)**	0
Fuel Oil Usage (gal)	5,551	**Fuel Oil Cost ($)**	11,444
Other Fuel Usage (gal)	0	**Other Fuel Cost ($)**	0

Energy Indicators			
EPA Score	89	**Electric Usage (kWh/sq.ft.)**	3.5
Heating Fuel Usage (kBtu/sq.ft.)	48.1	**Weather Adjusted Heating Usage Btu/sq.ft./HDD)**	6.6
Site Energy (kBtu/sq.ft.)	60.1	**Source Energy (kBtu/sq.ft.)**	89

Environmental Impact Indicators			
Greenhouse Gas Emissions			
Last Year Heating Fuel CO_2e (Mt)	56.6	**Last Year Total CO_2e (Mt)**	74.1
Last Year Electricity CO_2e (Mt)	17.5	**CO_2e Efficiency Savings Over Previous Year (Mt)**	-8.5
EPA Target Score			
Target Score	Reached	**Site Energy Reduction Needed (kBtu/sq.ft.)**	N/A - Reached

Figures 1a, 1b, 2a and 2b display the energy use, demand and cost data tracked on a monthly basis. This demonstrates the energy consumption of your building over the course of the year. As a part of the program's focus on sustainability, your school's carbon footprint was also measured and is presented in Figure 3.

Figure 1a. Monthly Electric Use & Max Demand for School Street Elementary

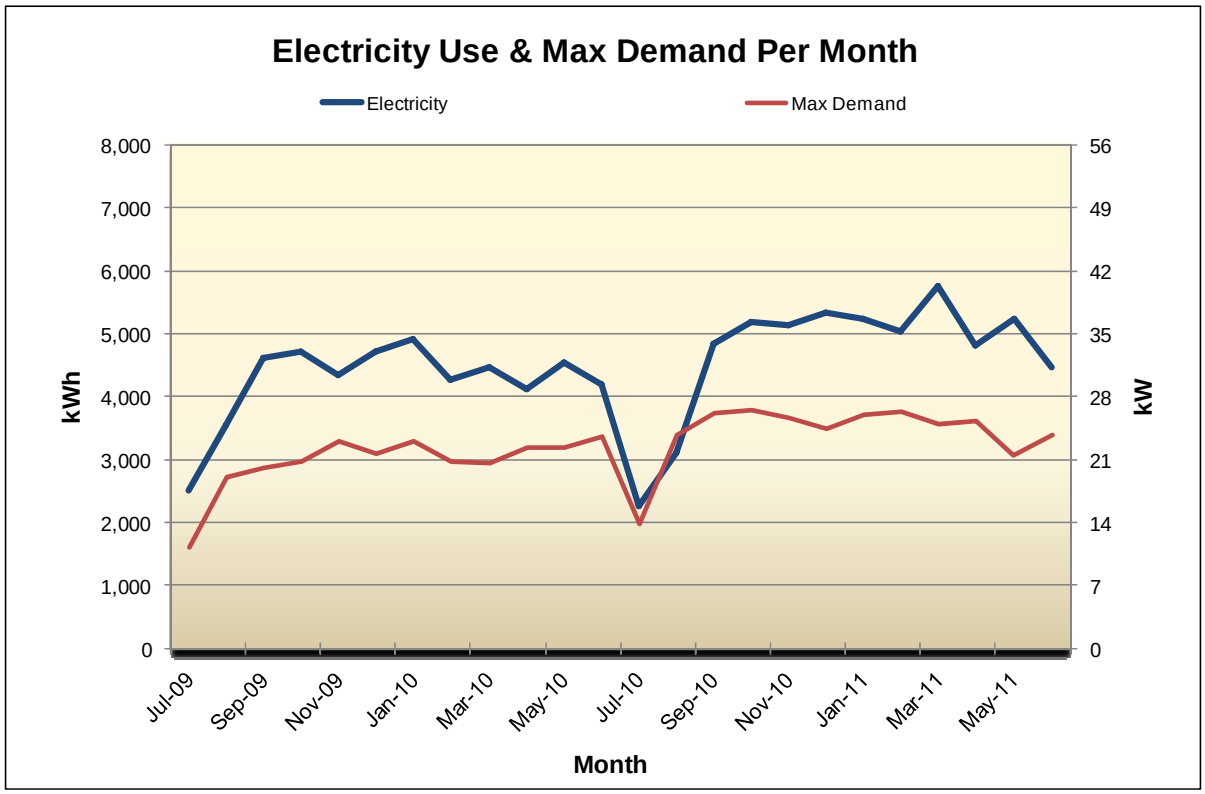


Figure 1b. Monthly Electric Use vs. Cost for School Street Elementary

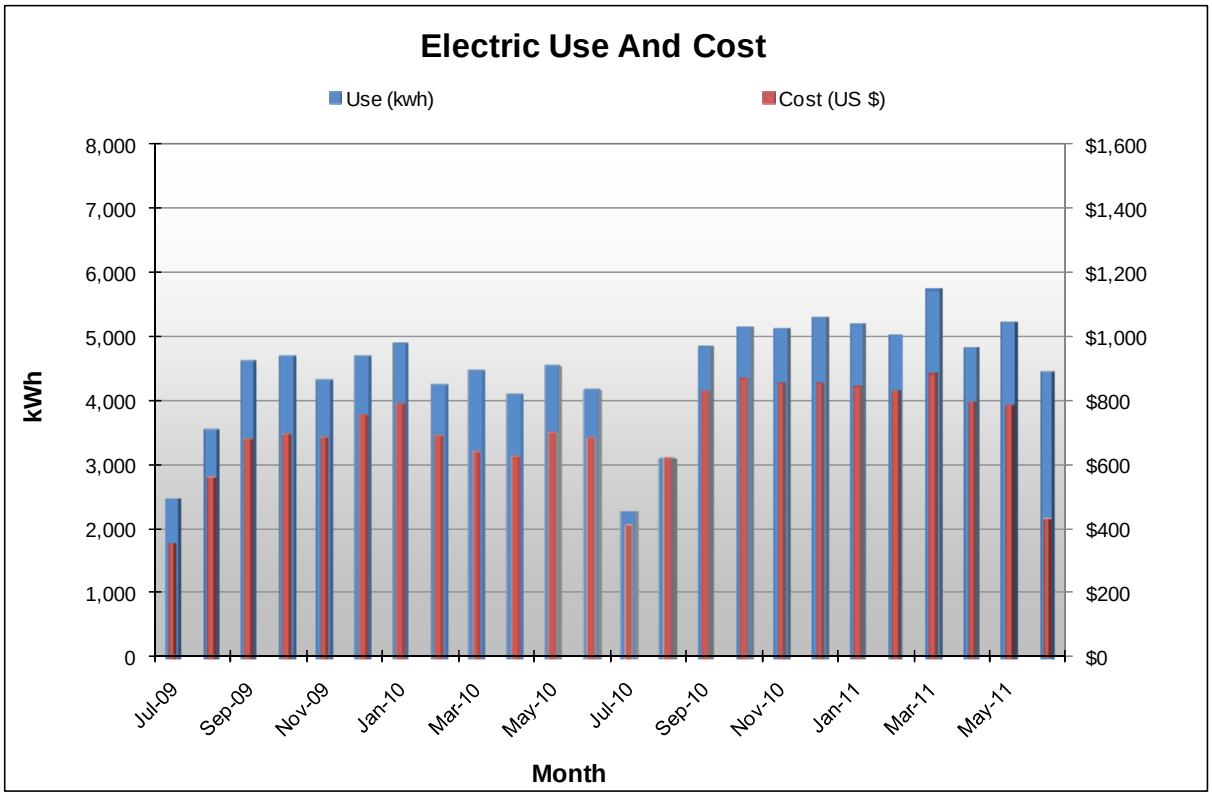


Figure 2a. Monthly Heating Fuel Use for School Street Elementary

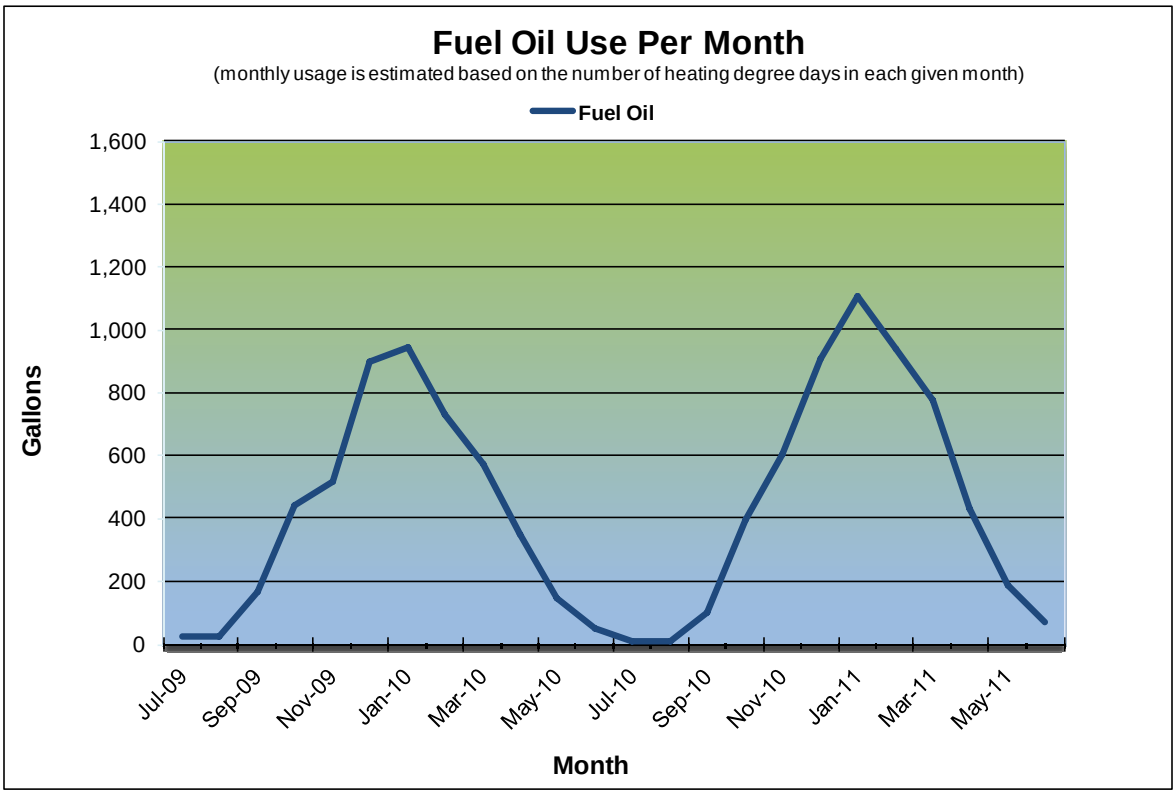


Figure 2b. Monthly Heating Fuel Use vs Cost for School Street Elementary

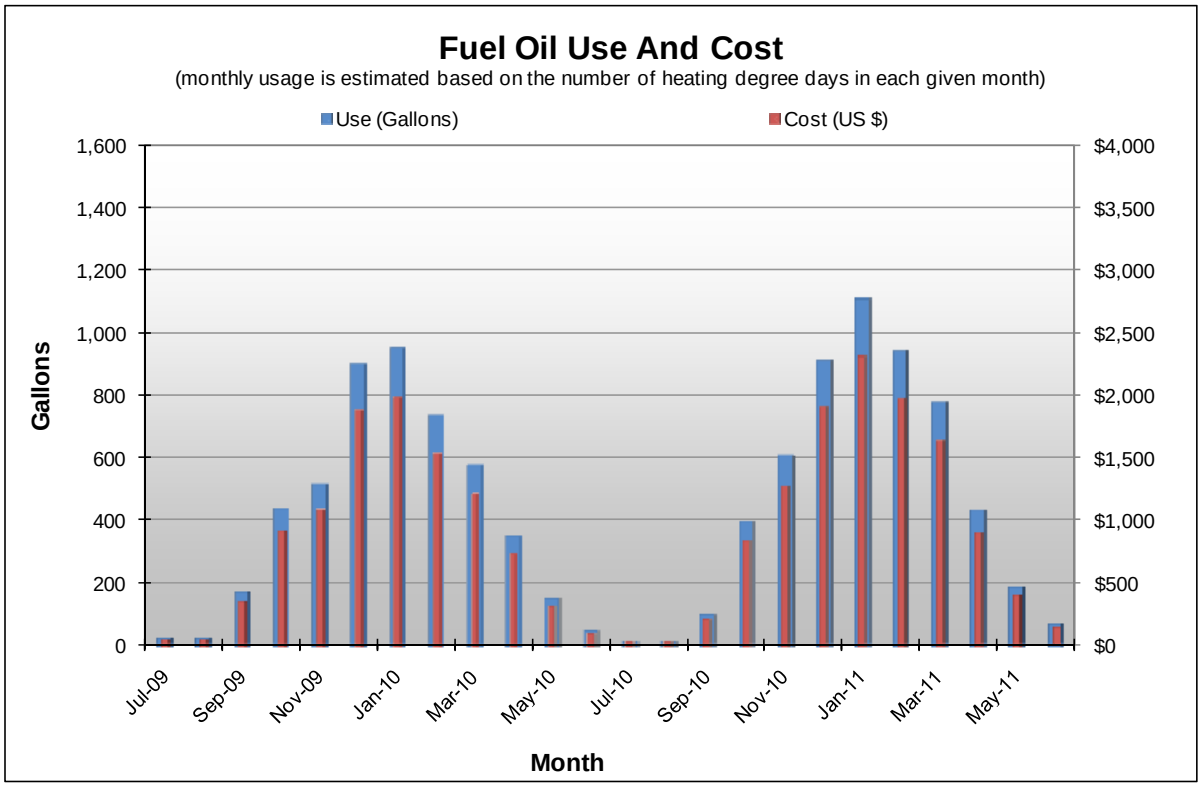
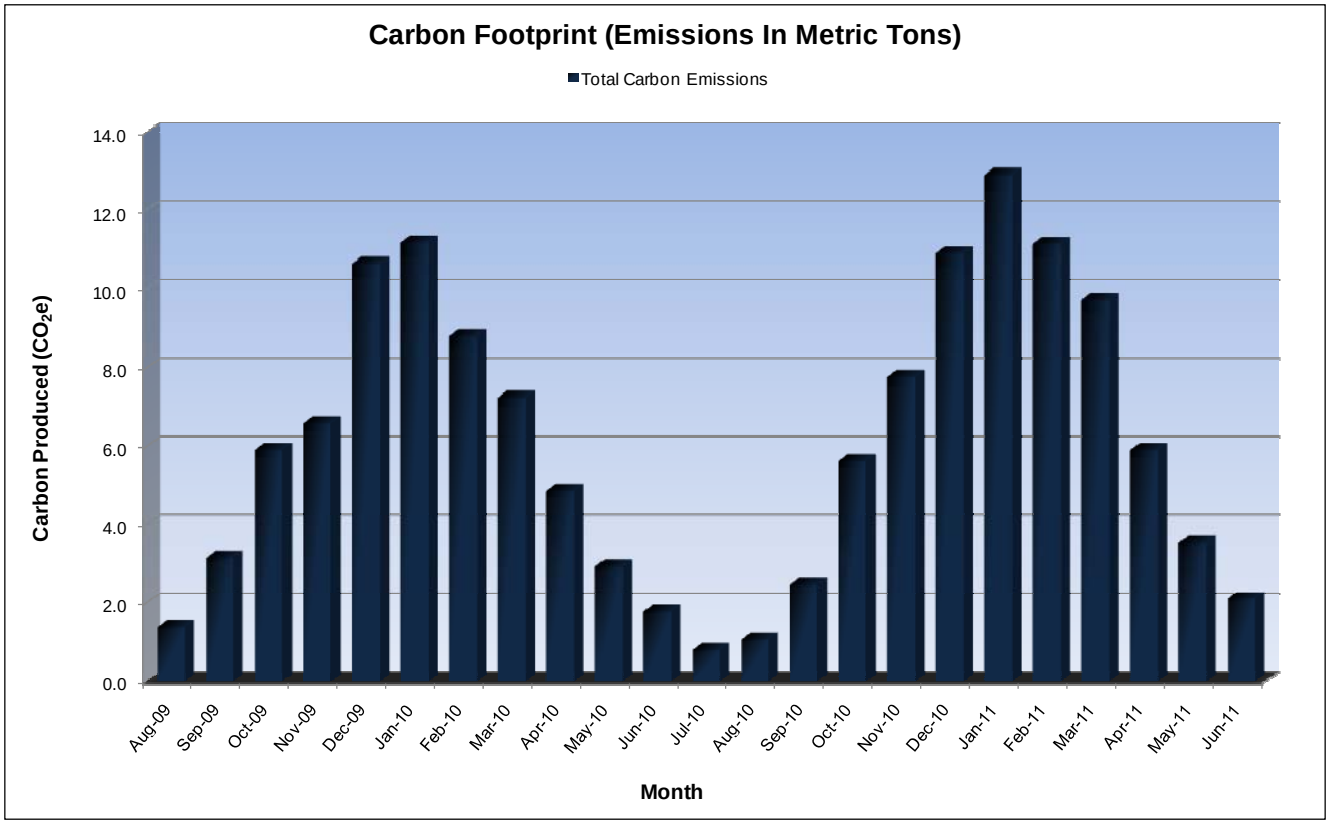


Figure 3. Monthly Greenhouse Gas Emissions for School Street Elementary School



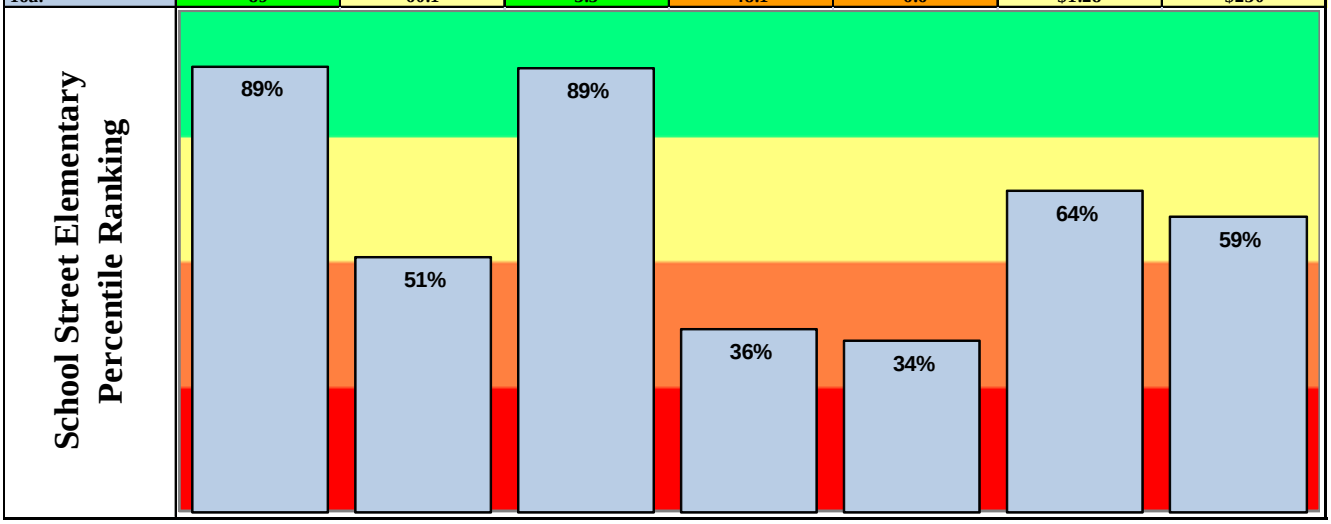
Benchmarking Data

To evaluate the energy and environmental performance of your school, the building data collected above has been compared against two different sets of school energy data: the U.S. Environmental Protection Agency's national data and New Hampshire specific state data. The results are illustrated in Figure 4 on the following page.

This will allow you to assess your building's performance relative to other buildings designed and constructed to the same codes and standards, operating under the same regulations and schedules and similar weather conditions. The indicators are calculated on a *per square foot* or *per student* basis, so you can compare your school to different sized schools.

Figure 4. EnergySmart Schools Benchmarks for School Street Elementary School

Schools	U.S. EPA Portfolio Manager Score	New Hampshire State Schools (Annual Data)					
		Total Energy Use (kBtu/sq.ft.)	Electric Use (kWh/sq.ft.)	Heating Fuel Use (kBtu/sq.ft.)	Weather Adjusted Heating Fuel Use (Btu/sq.ft./HDD)	Total Energy Cost ($/sq.ft.)	Total Energy Cost ($/student)
NH Average:	50	60.3	5.2	41.7	5.7	$1.42	$256
You:	89	60.1	3.5	48.1	6.6	$1.28	$230



Major Benchmark Indicators

1. Total Energy Use, kBtu/sq.ft.

This indicator shows how much total energy your school consumes each year. It includes the energy used for heating, cooling (if any), lights, cooking, computers, etc.

Your school's total energy use of 60.1 kBtu per square foot per year (kBtu/sq.ft.) is average compared to the New Hampshire K-12 schools state average of 60.3 kBtu/sq.ft. Your total energy use figure is lower than 51% of New Hampshire K-12 schools. The EnergySmart School Report is weather normalized so fuel consumption for heating takes the difference in climate between northern and southern New Hampshire into account.

This is a good indicator of how well, overall, your school is performing. However, it doesn't help you find ***where*** in your building to look for improvement opportunities. Multiple factors included on the following pages can help with that. Analysis of energy consumption for this program does not control for operational variations. An example is an improperly ventilated school may appear to have lower energy consumption. Ventilation systems that are not operating properly result in lower indoor air quality.

2. Electricity Data

Most electric utilities use the following two factors to estimate your electricity bill – Electric Use and Electric Demand.

a. Electric Use, kWh/sq.ft.

This shows how well the building does with its lights, cooling/air conditioners and cafeteria systems (if any), and what's referred to as "plug load." Plug load is anything that plugs into a socket. The major plug loads are generally computers (including monitors, printers and copiers), refrigerators, coffee machines, fans, shop equipment and projectors. If electric consumption is much higher than average, but heating fuel use (see below) is average or better, then focus your efforts on the electric-powered elements.

New Hampshire schools state average electric use is 5.2 kWh per square foot. Your school's electric consumption of 3.5 kWh per square foot this year is lower than 89% of New Hampshire schools benchmarked through the New Hampshire EnergySmart Schools Program.

b. Electric Demand, Watts/sq.ft.

Demand is a measure of the maximum electric draw in kW that your building places on the grid and is measured by adding up the kW draw for a 15 minute period. To give an analogy, if electricity usage is the amount of water going through a hose in gallons, electric demand would be how fast that water flows expressed in gallons per minute. Whichever 15 minute period during your monthly billing cycle places the highest kW demand on the grid is the demand factor applied to your bill. The best way to improve this demand factor is to stagger the times when your electrical systems draw at their maximum or reduce unnecessary electric load altogether.

The average electric demand for New Hampshire schools is 1.9 watts per square foot. Your school's electric demand is 1.7 watts per square foot and is lower than 68% of New Hampshire Schools benchmarked through the New Hampshire EnergySmart Schools Program.

3. Heating Fuel Use, kBtu/sq.ft.

Reviewing these indicators is relatively straightforward. If your school's heating fuel use is much higher than average, an audit of your heating system along with your building envelope - doors, windows, roof - is recommended. This factor is 'fuel-neutral' as it works for either fuel oil or natural gas heating systems.

New Hampshire K-12 schools state average heating fuel use is 41.7 kBtu/sq.ft. or 5.7 Btu/sq.ft./HDD. Your school's heating fuel use of 48.1 kBtu/sq.ft. per year is higher than 64% of other New Hampshire schools in the database. Your school's weather adjusted heating fuel use of 6.6 Btu/sq.ft./HDD is higher than 66% of other New Hampshire schools benchmarked through the New Hampshire EnergySmart Schools Program.

4. Energy Cost, $/sq.ft. & $/student

Cost is the bottom line. These numbers help you understand, in terms of budget, the gain through energy efficiency improvements. New Hampshire K-12 schools state averages $1.42/sq.ft. and $256/student.

Your school's annual energy cost of $1.28 per square foot is lower than 64% of other New Hampshire benchmarked schools. Your school's cost expressed on a per student basis of $230 is lower than 59% of other New Hampshire schools benchmarked through the New Hampshire EnergySmart Schools Program.

5. U.S. EPA *Portfolio Manager* Score

Portfolio Manager is a benchmarking model based on a national set of data from K-12 schools. It is provided by the U.S. Environmental Protection Agency's ENERGY STAR® Program. The impact of factors outside of your control (such as location, occupancy and operating hours) are removed, providing a 1-100 ranking of a school's energy performance relative to the national school building market. A score of 50 represents the national average and a score of 100 is best. Schools that achieve a score of 75 or higher are eligible for EPA's ENERGY STAR® Building Label, the national symbol for protecting the environment through energy efficiency. Districts can achieve ENERGY STAR® Leader Awards in recognition if their buildings, on average, improve by 10%, 20%, 30%, etc. over their baseline year of reported energy use or if the district's overall weighted average *Portfolio Manager* Score is at least a 75.

Your school's *Portfolio Manager* Score of 89 places it higher than 89% of K-12 schools nationwide. As noted above, this rating potentially qualifies your school for the prestigious ENERGY STAR® Label for Buildings.

III. Potential Energy Saving Opportunities

Based on the preceding analysis of your school's energy performance, implementation of the following recommendations can help you save energy and money. The first step is to look at reducing electrical lighting and HVAC consumption (burners, circulators and fans) which typically account for 67% of a building's electric consumption.

- **Perform an Energy Audit on the Building**

An energy audit involves a comprehensive analysis of the building's general characteristics, its energy use and allocation of that use amongst the facility's energy end uses. The goal is to identify sources of potential energy savings. Your auditor should develop a list of recommendations that will result in substantial energy and operational cost savings. These may include, building envelope improvement and mechanical systems, lighting upgrades, equipment replacement and installation of lighting and HVAC control mechanisms, among others.

A good audit should include information specific to each recommendation which *at least* includes approximate annual energy unit and cost savings, demand reduction, installation cost, lifetime cost savings and information related to cost-effectiveness. This will help to prioritize the recommendations based on their energy efficiency and shortest payback.

The recommendations provided in an energy audit report may reduce facility energy bills by 20% or more in addition to improving occupant health and comfort. Following this report, an energy audit is the next step in realizing the full potential of energy savings opportunities.

- **Request Retro-Commissioning**

Retro-commissioning is a detailed process applied to existing facilities aimed at correcting many of the degradations and inefficiencies that are indicative of older and/or poorly performing buildings. Many older buildings tend to be less comfortable and operate less efficiently when not properly commissioned. Retro-commissioning includes a detailed energy audit and focuses on not only potential energy savings but also the interaction of the building's equipments and mechanical systems with an eye toward restoring it to optimal performance.

In contrast to an energy audit, this optimization focuses on operational improvements to existing equipment, rather than replacement. Apart from energy savings, other improvements and benefits include substantial operation and maintenance (O&M) cost savings, improved air quality, occupant comfort, health and safety, equipment controls, and improved system interactivity.

In addition to providing recommendations, retro-commissioning includes implementation of the recommended improvements and hence the cost for retro-commissioning is higher than an audit. However, when the costs of improvements are added to the energy audit cost, prices may be comparable. If high O&M costs or occupant health, comfort and safety are concerns in addition to reduction in energy use, retro-commissioning may be a suitable strategy.

- **Upgrade Lighting Systems**

Lighting typically accounts for 30-60% of all energy consumed in school buildings. Additionally, the electrical energy consumed by lights during the summer creates heat and increases cooling costs.

School Street Elementary School's electricity consumption is low (better) compared to other schools in the State. Even so, upgraded lighting systems in high consumption areas like classrooms, gymnasiums, libraries, offices, etc. can reduce costs, improve the lighting quality and increase occupant comfort and productivity.

Over-lit Spaces: Light levels should be recorded in classrooms and hallways to ensure they are not over-lit, 40-50 foot candles are adequate light levels for an instructional space. If classroom light levels are much higher than 50 foot candles, School Street Elementary School should consider de-lamping classrooms or installing dimming ballasts, which dim the lights when outdoor light levels are adequate. In over-lit hallway spaces photo sensors can be installed to turn lights off completely when light levels exceed a pre-set threshold.

In over-lit spaces a T8 to Super T8 lighting retro-fit can reduce the number of light fixtures needed. Super T8 lamps use between 4 and 7 Watts less electricity than standard T8 lamps, but they produce more light per Watt. In some cases this increase in light per Watt can allow for the removal of an entire lamp, saving 32 Watts. The room characteristics must be factored in before this type of retro-fit. The shape of the space, ceiling height, color of the walls, etc. all need to be taken into account when exploring a de-lamping project. We recommend that before retro-fitting the entire facility, begin by changing one classroom and monitor the comfort level of the occupants at School Street Elementary School.

Another proven energy reduction measure with a short payback period is to identify any areas where your school may still be using metal halide lighting. Typically metal halide lights are found in gymnasiums or cafeteria areas, many districts have been very satisfied by replacing these lights with high bay T5 lighting fixtures. In addition to the reduced operational wattage, high bay T5 lights turn on instantly, as opposed to metal halide fixtures which have an extended warm up period. The long warm up period associated with metal halides typically leads to the lights being left on all day, at 250 to 400 watts a fixture; the costs begin to add up. Adding occupancy sensors to high bay T5 fixtures further reduces the payback period.

Occupancy Sensors: We recommend that you explore the use of occupancy sensors to ensure that lights are turned off in unoccupied spaces. Lights controlled by occupancy sensors typically run a third of the time when compared with manually controlled lighting. Reduced runtime leads to decreases in both energy usage and operation and maintenance costs. Additionally, a study conducted in Massachusetts found that controlling the security lighting with occupancy sensors reduced vandalism; neighbors and police recognized something wrong when the lights were on in a building that was typically dark and investigated.

To summarize and add a few ways in which School Street Elementary School may be able to conserve energy and cost through lighting upgrades is to:

- Design light quantity and quality for the task and occupants' needs in that area.
- Maximize lamp and ballast efficiency.
- Activate the power saving features on office equipment such as copiers, printers and fax machines and ensure that they are turned off at the end of the day.
- Use automatic controls to turn lights off or dim lights in unoccupied spaces.
- Establish a maintenance schedule for group re-lamping and fixture cleaning.
- Replace T12 fixtures with the most efficient fixtures which may include T8/super T8/T5 fixtures.
- Replace incandescent lighting with compact fluorescent technology.

- Replace incandescent exit lighting which consumes 30 Watts with LED type exit lights with 1.5 Watts consumption. LED units last up to 10 years, which is a maintenance advantage.
- Install daylight sensors in areas with significant natural light.
- Install occupancy sensors in areas that are often unoccupied.
- Lighting retrofits reduce maintenance costs associated with lighting that is close to end of life.
- Establish a regular cleaning schedule particularly for areas where student safety of low light levels may be a concern, such as shop classes.
- Look to make lamp and fixture selection as uniform as possible to reduce maintenance and inventory overhead.
- Educate students and staff to turn off lights when rooms are unoccupied.

Lighting upgrades seek to reduce the connected electrical load (kW) and energy consumption (kWh) of lighting equipment. Lighting controls can also significantly reduce operating hours and costs by turning off lighting when spaces are unoccupied or sufficiently lit by natural light.

- **Install NEMA Premium Motors and VFDs**

Commercial and industrial electric motor-driven systems consume approximately 23% of all electricity in the U.S., making it the single largest category contributor to electric use in the country. With very high operating hours, the annual energy cost to run a system is more than its installation cost. Even a small increase in the efficiency of an electric motor can result in substantial energy cost savings. Typical opportunities for motor upgrades in schools include: ventilation fans, and heating and cooling system pumps and fans.

Motors with efficiency up to 90% are available to replace the older ones with efficiency less than 75%. Although standards for efficiency of new equipment are set by the Energy Policy Act, motor efficiency can be further increased by selecting Premium Efficiency motors as specified by the National Electrical Manufacturers Association (NEMA). This can cut the electric motor system demand by as much as 18%.

Savings can be increased further by optimizing system performance through the use of variable frequency drives (VFDs). When system load is known to vary substantially, these flow control systems can be utilized to match system output to system demand, significantly reducing energy usage during partial load hours. By employing high-efficiency motors and VFDs, facility owners can improve environmental conditions, utilize better control of motor-driven processes, and reduce waste output.

- **Install Demand Control Ventilation**

Demand control ventilation (DCV) monitors indoor air CO_2 content as a result of occupancy production levels and uses this data to regulate the amount of outdoor air that is permitted for ventilation. In order to ensure adequate air quality, standard ventilation systems permit outside air based on estimated occupancy levels in CFM, cubic feet per minute/occupant. However, during low occupancy hours, the space may become over ventilated due to decreased CO_2 levels and unnecessary ventilation results in wasted energy. DCV reduces unnecessary outdoor air intake by regulating ventilation based on actual CO_2 levels, saving energy. DCV is most suited for areas where occupancy levels are known to fluctuate considerably such as auditoriums, cafeterias, and gymnasiums.

Install Energy Recovery Ventilators. According to energy recovery equipment manufacturer's typical paybacks are less than 5 years for schools without cooling. The keys to success with ventilation retrofits are going with fewer larger units with long run hours as opposed to several small units with limited run time. Equipment with moisture recovery capabilities would cut humidity up to 50% during the cooling season.

- **Improve/Replace Inefficient Heating Systems**

Replacing an old boiler that is < 70% efficient with a modern 85-90% efficient natural gas-fired furnace alone will reduce heating costs by 15-20%. This combined with additional system improvements and installation of advanced HVAC control mechanisms can result in up to 20%+ heating load reduction.

Because of the high capital cost of new heating systems, some financial analysis should be performed to assess the cost-effectiveness of immediate replacement. If the current system is fairly new, replacement may not be immediately justifiable from a financial standpoint. However, as is the case with cooling systems, early replacement may prove to be a more cost-effective solution than waiting until existing systems fail or reach the end of their estimated useful life.

- **Improve/Replace Inefficient Air Conditioning Systems**

The useful life of a rooftop A/C unit is generally 12-18 years. However, depending on the efficiency, early replacement of outdated, inefficient, split, or packaged rooftop air conditioning units with new A/C systems that are 15% more efficient than 10-15 year old equipments can considerably reduce annual energy consumption. The energy cost savings and maintenance savings offset the high installation cost of a more efficient system. Installing thermostats and/or economizers on new or existing A/C systems will further reduce the cooling demand.

Economizers provide "free" cooling by using controllable dampers that bring in outside air to cool the space when the outdoor temperature or enthalpy is below the building's return air conditions. Although they require operation by a well calibrated and maintained control system, economizers have impressive energy-saving capabilities.

Install Occupancy Controlled/Programmable Thermostats

Combining efficient HVAC equipment with occupancy controlled and programmable thermostats can save a facility up to 10% of its annual heating and cooling costs:

- Areas with unpredictable occupancy on a daily/weekly basis - gym, bathrooms, outdoors: Use an *occupancy controlled thermostat* - a thermostat paired with a sensor and/or door detector to identify movement/occupancy. If occupancy is sensed by the sensor, the thermostat goes into an occupied mode (i.e. programmed set point). If a pre-programmed time frame elapses (i.e. 30 minutes) and no occupancy is sensed during that time, the thermostat goes into an unoccupied mode (e.g., setback set point or off) until occupancy is sensed again. This reduces the overall time the heating or cooling system is running, saving energy.

- Areas with predictable occupancy: e.g.: classrooms, cafeteria, offices: A *programmable thermostat* is recommended. This device is programmed on a schedule to reduce the heating or cooling output of the facility's HVAC systems in relation to its predetermined occupancy schedule. In this way, the thermostat acts to set-back or set-up the facility temperature during unoccupied hours, and re-establish a comfortable facility temperature during business hours. By employing programmable thermostat technology, the heating and cooling system demand coincides with occupancy level, reducing energy usage.

- **Install Vending Misers on Vending Machines**

Vending misers for refrigerated and non-refrigerated vending machines is an often overlooked source of potential savings. Uncontrolled, vending machine lights remain on 24/7, consuming a constant amount of energy year round. By controlling these lights with an occupancy sensor, energy consumption attributed to vending machines can be reduced considerably, in many cases, by as much as 50% and can save up to $150 per machine per year.

In the case of refrigerated vending machines, electric demand can be further reduced by controlling the machines' refrigeration systems. In a manner similar to programmable thermostats, vending misers for refrigerated machines act on a pre-set occupancy schedule to allow a marginal increase in operating temperature during non-business hours. Although products in the machine are delivered to the customer at the same temperature as in an uncontrolled vending machine, products are not being cooled unnecessarily when the machine is not in use, significantly reducing the machine's energy consumption. Because of the relatively low vending miser installation cost and high operating hours of vending machines, this improvement is typically cost-effective with a very short payback period.

- **Install ENERGY STAR® Rated Equipment / Plug Load Control**

Plug loads (computers, televisions, coffee makers, etc.) account for, on average, about 10% of total energy consumption. One of the easiest and most cost-effective energy saving strategies is the reduction of electric usage through installation of efficient appliances and the control of plug loads. In addition to utilizing ENERGY STAR® qualified appliances, greater savings can be realized through the various devices available that control every day plug loads.

By connecting non-critical loads (coffee makers, fans, microwave ovens, etc.) to an occupancy or timer controlled power strip, significant energy savings can be achieved. These savings result not only from the neglect of the user to turn the device off manually, but also from reduction of "phantom load". Phantom load is the small but constant energy draw from many plug-in devices when not in use. By connecting certain appliances to an occupancy controlled power strip, phantom load can be eliminated by cutting power supply to those devices. When replacing or ordering new equipment, emphasize ENERGY STAR® devices when they are available. Also, purchase controlled power strips and connect appropriate devices to those strips to reduce unnecessary consumption due to phantom load and appliances left on. The EPA offers free computer power management software which has saved some districts as much as $75 per computer per year, the software can be found at http://www.energystar.gov/index.cfm?c=power_mgt.pr_power_mgt_low_carbon_join.

IV. Resources:

The State of New Hampshire along with the utility companies offer multiple programs designed to improve the energy efficiency of schools through financial incentives and technical support, including:

Northeast Energy Efficiency Partnerships:

- **Northeast Collaborative for High Performance Schools (NE-CHPS)**
  NE-CHPS is a set of building and design standards for all schools from pre-K through community colleges tailored specifically for NH state code requirements, the New England climate, and the environmental priorities of the region. NH Department of Education offers up to a 3% re-imbursement for New Construction School projects. To learn more about NE-CHPS and incentive programs please visit: http://neep.org/public-policy/hpse/hpse-nechps.

New Hampshire Public Utilities Commission:

- **New Hampshire Pay for Performance**
  This program addresses the energy efficiency improvement needs of the commercial and industrial sector. The Program is implemented through a network of qualified Program Partners. Incentives will be paid out on the following three payment schedule: Incentive #1: Is based on the area of conditioned space in square feet. Incentive #2: Per/kWh saved and Per/MMBTU saved based on projected savings and paid at construction completion. Incentive #3: Per/kWh saved and Per/MMBTU saved based on actual energy savings performance one year post construction. Total performance incentives (#2 and #3) will be capped at $200,000 or 50% of project cost on a per project basis. For more information visit http://nhp4p.com.

- **New Hampshire Public Utilities Commission's Renewable Energy Rebates**
  The Sustainable Energy Division provides an incentive program for solar electric (photovoltaic or PV) arrays and solar thermal systems for domestic hot water, space and process heat, with a capacity of 100 kW or equivalent thermal output or less. The rebate for PV systems as follows: $1.00 per Watt, capped at 25% of the costs of the system or $50,000, whichever is less. For solar hot water (SHW) systems, the base rebate is $0.07 per rated or modeled kBtu/year, capped at 25% of the cost of the facility or $50,000, whichever is less, as a one-time incentive payment. http://www.puc.state.nh.us/Sustainable%20Energy/RenewableEnergyRebates-CI.html.

New Hampshire Community Development Finance Authority:

- **New Hampshire Community Development Finance Authority Revolving Loan Fund**
  The Enterprise Energy Fund is a low-interest loan and grant program available to businesses and nonprofit organizations to help finance energy improvements and renewable energy projects in their buildings. The loans will range from $10,000 to $500,000. Larger amounts will be considered on a case by case basis. The program is available to finance improvements to the overall energy-efficiency performance of buildings owned by businesses and nonprofits, thereby lowering their overall energy costs and the associated carbon emissions. More information about the program can be found on their website www.nhcdfa.org. These activities may include:

  - Improvements to the building's envelope, including air sealing and insulation in the walls, attics and foundations;
  - Improvements to HVAC equipment and air exchange;
  - Installation of renewable energy systems;
  - Improvements to lighting, equipment, and other electrical systems; and
  - Conduction of comprehensive, fuel-blind energy audits.

Public Service of New Hampshire (PSNH):

- **Commercial (Electric) Energy Efficiency Incentive Programs**
  This program targets any commercial/industrial member building a new facility, undergoing a major renovation, or replacing failed (end-of-life) equipment. The program offers prescriptive and custom rebates for lighting and lighting controls, motors, VFDs, HVAC systems, chillers and custom projects. http://www.psnh.com/SaveEnergyMoney/For-Business/Energy-Saving-Programs-and-Incentives.aspx

- **SmartSTART**
  The SmartSTART (Savings Through Affordable Retrofit Technologies) advantage is simple - pay nothing out of pocket to have energy efficiency products and services installed in your building. The Smart Start program is limited to PSNH's municipal customers only and includes schools. The program is available on a first-come, first served basis to projects which have been pre-qualified by PSNH. The cost of the improvements is fronted by PSNH which is then repaid over time by the municipality or school using the savings generated by the products themselves! This program is for lighting and lighting controls, air sealing, insulation and other verifiable energy savings measures which have sufficient kilowatt-hour savings. For more information on this program visit:
  http://www.psnh.com/SaveEnergyMoney/For-Business/Municipal-Smart-Start-Program.aspx

- **Schools Program**
  For major renovation or equipment replacement projects, this program offers prescriptive and custom rebates for energy efficient lighting, motors, HVAC, chillers, and variable frequency drives to towns or cities that install energy efficient equipment at their schools. Financial incentives are available for qualifying energy efficient equipment. Technical assistance is also offered through the Schools Program. http://www.psnh.com/SaveEnergyMoney/Large-Power/Schools-Program.aspx

Unitil:

- **Commercial and Industrial Energy Efficiency Programs**
  Subject to program qualifications and availability of funding - Unitil offers different programs for its commercial, industrial, and institutional customers in New Hampshire: the Small Business Energy Efficiency Program, the Small Commercial and Industrial Program, the Large Commercial and Industrial Program, the Large Commercial and Industrial (C&I) Retrofit Program, and the Large C&I New Construction Program. Rebates are available for various technologies including water heaters, lighting, lighting controls/sensors, chillers, furnaces, boilers, central air conditioners, compressed air, programmable thermostats, energy management systems/building controls, motors, motor VFDs, processing and manufacturing equipment, LED exit signs, commercial cooking and refrigeration equipment. http://www.unitil.com/.

Clean Air – Cool Planet:

- **Community Energy Efficiency**
  CA-CP works with communities throughout the Northeast to find solutions to climate change and build constituencies for effective climate policies and actions. Much of their work focuses on successful models for energy efficiency and renewable energy planning. They advise and partner with citizens, educators, faith groups, small businesses, municipal governments, and other local leaders. They explore cost-effective opportunities that exist for communities to reduce their emissions as well as their vulnerability to climate impacts. One such example is CA-CP's partnership with the University of NH, NH Sustainable Energy Association and UNH Cooperative Extension to create www.myenergyplan.net, a groundbreaking suite of web and outreach tools for individual action used by households, schools and community groups around the northeast. http://www.cleanair-coolplanet.org/for_communities/index.php.

Environmental Protection Agency (EPA):

- **ENERGY STAR Challenge for Schools**
  EPA is challenging school administrators and building managers to improve energy efficiency throughout their facilities. More than 500 school districts across the country are helping to fight climate change by committing to reducing their energy use with help from ENERGY STAR. Schools that take the ENERGY STAR Challenge can use energy tracking tools, technical guidance, case studies and other ENERGY STAR tools and resources to help them improve their energy efficiency. More information can be found at:
  http://yosemite.epa.gov/opa/admpress.nsf/d985312f6895893b852574ac005f1e40/d74f768ecfa9e11f8525762500522260!OpenDocument

For additional assistance in helping you save money and improve school conditions, please call TRC at (603) 766-1913 or (877) 442-9181.

NEW HAMPSHIRE ENERGYSMART SCHOOLS PROGRAM

Energy Benchmarking Report for:

Rochester Middle School

Rochester, NH

Period: ***July 1, 2010*** through ***June 30, 2011***

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I. Introduction

The Sustainable Energy Division of the New Hampshire Public Utilities Commission, with support from the New Hampshire Department of Education has sponsored TRC to develop the New Hampshire ***EnergySmart Schools Program*** to support New Hampshire K-12 public and private schools in the pursuit of energy efficiency and sustainability initiatives.

Energy efficiency has become an increasingly important issue for schools due to tightening budgets and rising energy costs. Since 2003, the prices of natural gas, fuel oil and electricity have increased by 123%, 107% and 32% respectively. Schools that have participated in energy benchmarking programs have shown a decrease in overall energy use by approximately 22% through the adoption of energy efficiency measures.

Tracking and documenting the energy use and associated carbon emissions in the state's K-12 schools will allow New Hampshire to account for the impact of its energy efficiency and renewable energy programs and determine which have the greatest effect. The analysis in this report, provided by the ***EnergySmart Schools Program*** is designed to help you:

- Understand the energy consumption and cost trends at each of your school buildings.
- Learn how your buildings are performing compared to other schools locally and nationally.
- Identify opportunities for improving operations and reducing costs.
- Take advantage of resources to implement efficiency improvements and save money.

The analysis was based on the information provided on the *Building Data Request Form* submitted, which included building descriptions, energy suppliers and other information. The building's utility bills were also used to assess its electricity and heating fuel consumption for the year(s) provided.

The energy performance for your school has been compared to national data for similar school facilities through EPA's ENERGY STAR® Portfolio Manager. Also shown are the five major benchmarks used to analyze building performance, which include: electricity use; heating fuel use; weather-normalized heating fuel use; total cost; and total cost per student, all of which have been normalized for comparison by square footage and weather. As part of the program's focus on sustainability, your school's carbon footprint is also presented.

II. Benchmarking Analysis and Review Results

Building and energy usage of your school was analyzed to assess the basic nature of your energy consumption and utility costs. The Building Data Summary table shown below summarizes this information.

Table 1: Building Data Summary for Rochester Middle School

Building Data			
District	SAU 54 Rochester School Department	**School Name**	Rochester Middle School
City	Rochester	**Zip Code**	03867
Year Built	1992	**Floor Area (sq.ft.)**	168,736
Number of Students	967	**Number of PCs**	388
Weekly Operating Hours	80	**Months School Used**	12
Cooking?	YES	**% AC**	20
Pool Size?	N/A	**Months Pool Used**	0

Utility Data			
Data End Point	6/30/2011	**Total Cost ($)**	169,907
Electric Provider	PSNH	**Natural Gas Provider**	Unitil
Electricity Usage (kWh)	767,000	**Electricity Cost ($)**	108,341
Natural Gas Usage (therms)	44,725	**Natural Gas Cost ($)**	61,566
Fuel Oil Usage (gal)	0	**Fuel Oil Cost ($)**	0
Other Fuel Usage (gal)	0	**Other Fuel Cost ($)**	0

Energy Indicators			
EPA Score	89	**Electric Usage (kWh/sq.ft.)**	4.5
Heating Fuel Usage (kBtu/sq.ft.)	26.5	**Weather Adjusted Heating Usage Btu/sq.ft./HDD)**	3.7
Site Energy (kBtu/sq.ft.)	42.0	**Source Energy (kBtu/sq.ft.)**	80

Environmental Impact Indicators			
Greenhouse Gas Emissions			
Last Year Heating Fuel CO_2e (Mt)	237.9	**Last Year Total CO_2e (Mt)**	475.9
Last Year Electricity CO_2e (Mt)	238.0	**CO_2e Efficiency Savings Over Previous Year (Mt)**	-7.8
EPA Target Score			
Target Score	Reached	**Site Energy Reduction Needed (kBtu/sq.ft.)**	N/A - Reached

Figures 1a, 1b, 2a and 2b display the energy use, demand and cost data tracked on a monthly basis. This demonstrates the energy consumption of your building over the course of the year. As a part of the program's focus on sustainability, your school's carbon footprint was also measured and is presented in Figure 3.

Figure 1a. Monthly Electric Use & Max Demand for Rochester Middle School

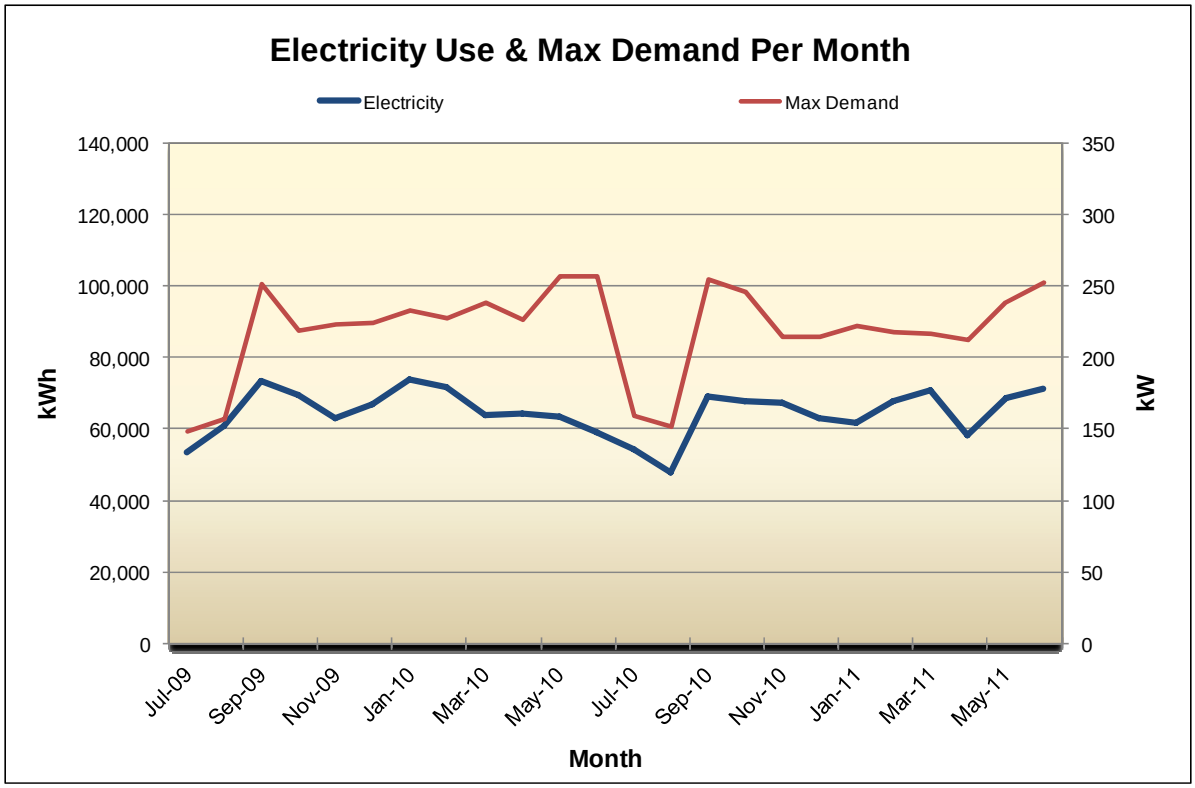


Figure 1b. Monthly Electric Use vs. Cost for Rochester Middle School

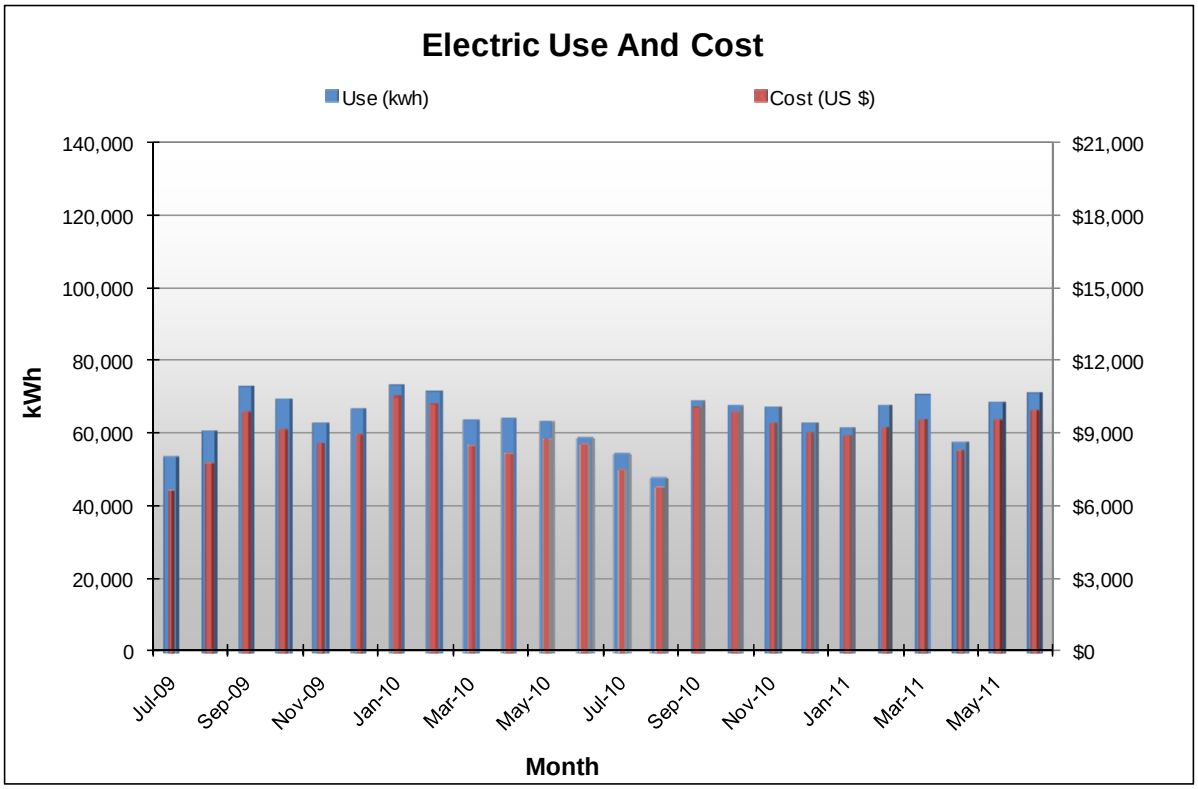


Figure 2a. Monthly Natural Gas Use for Rochester Middle School

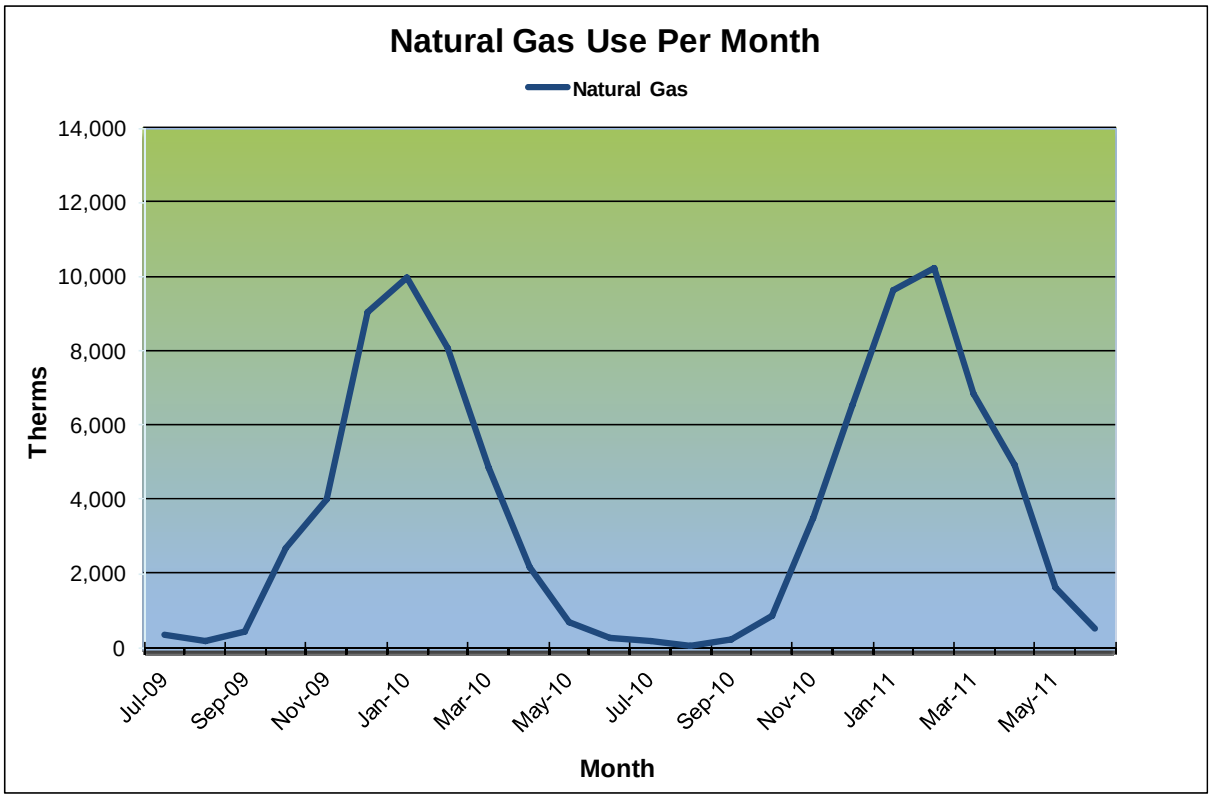


Figure 2b. Monthly Natural Gas Use vs Cost for Rochester Middle School

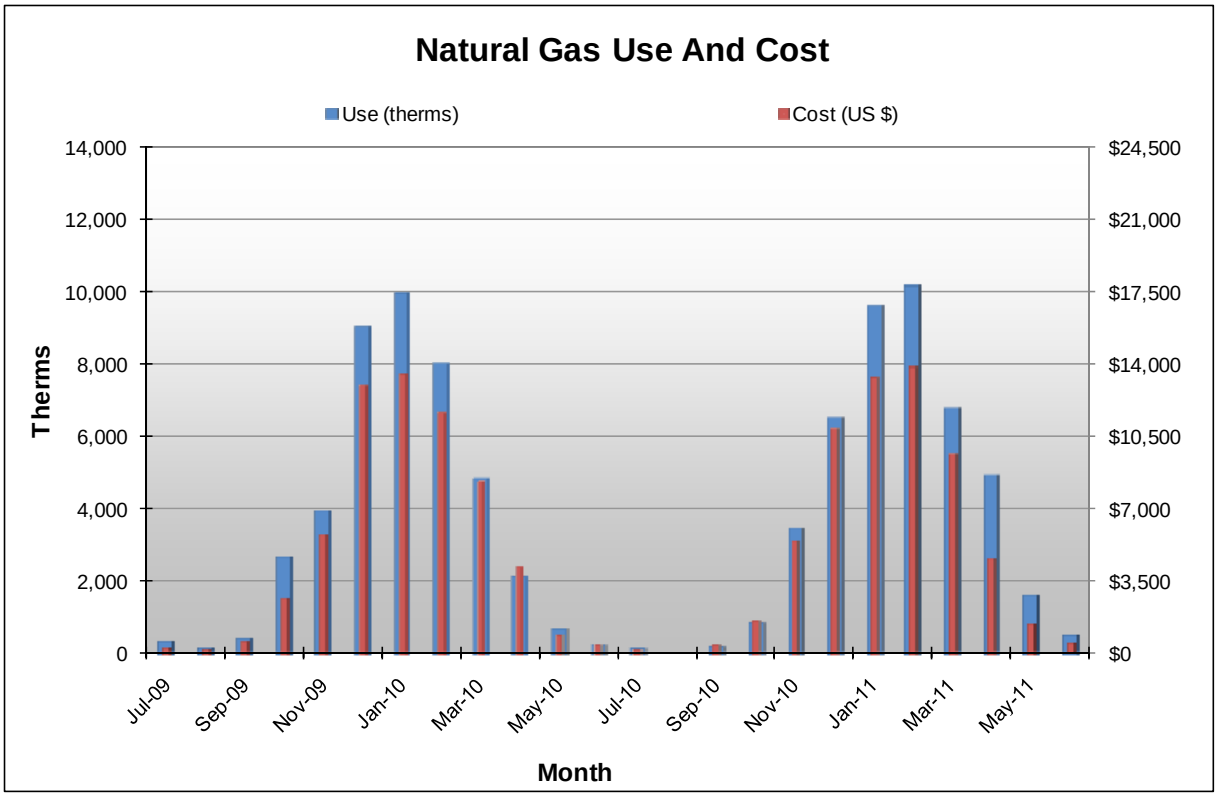
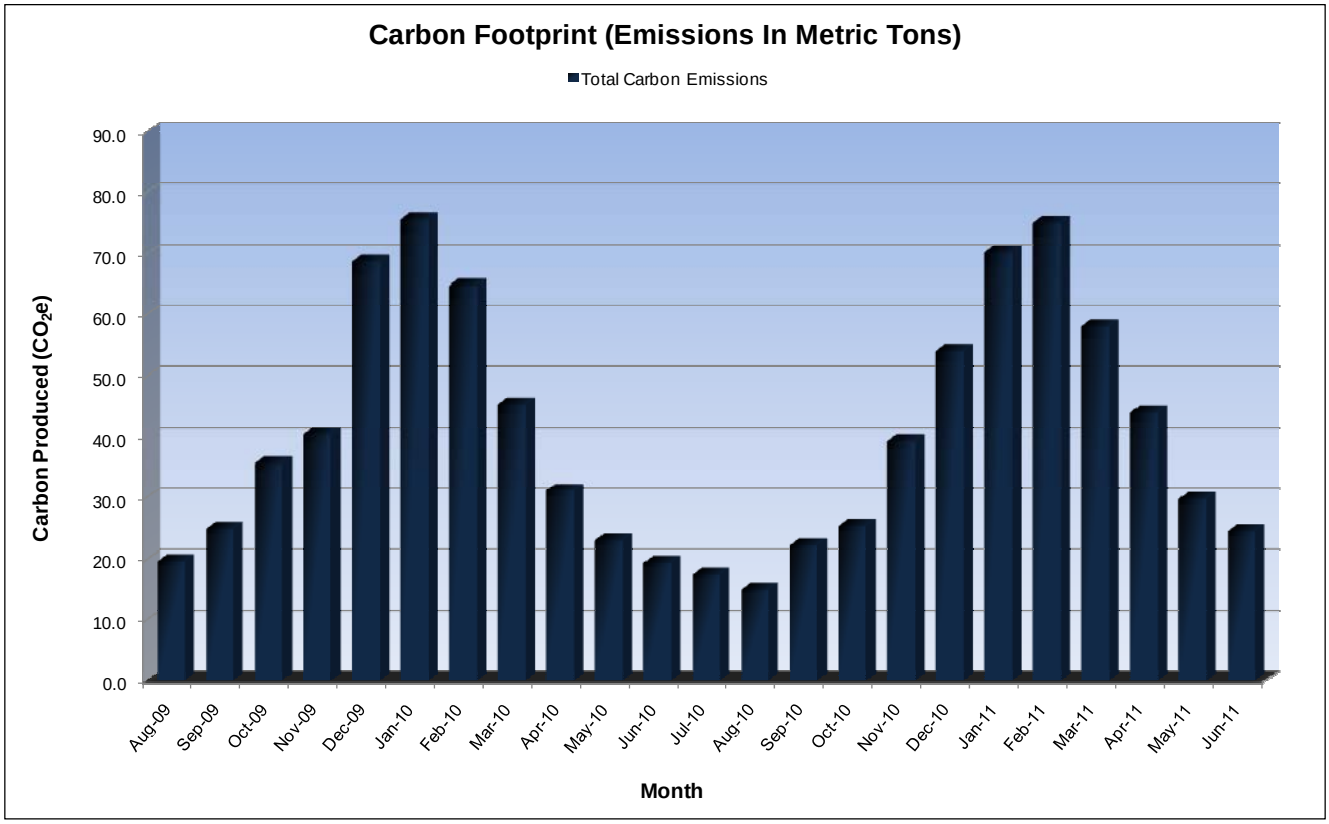


Figure 3. Monthly Greenhouse Gas Emissions for Rochester Middle School



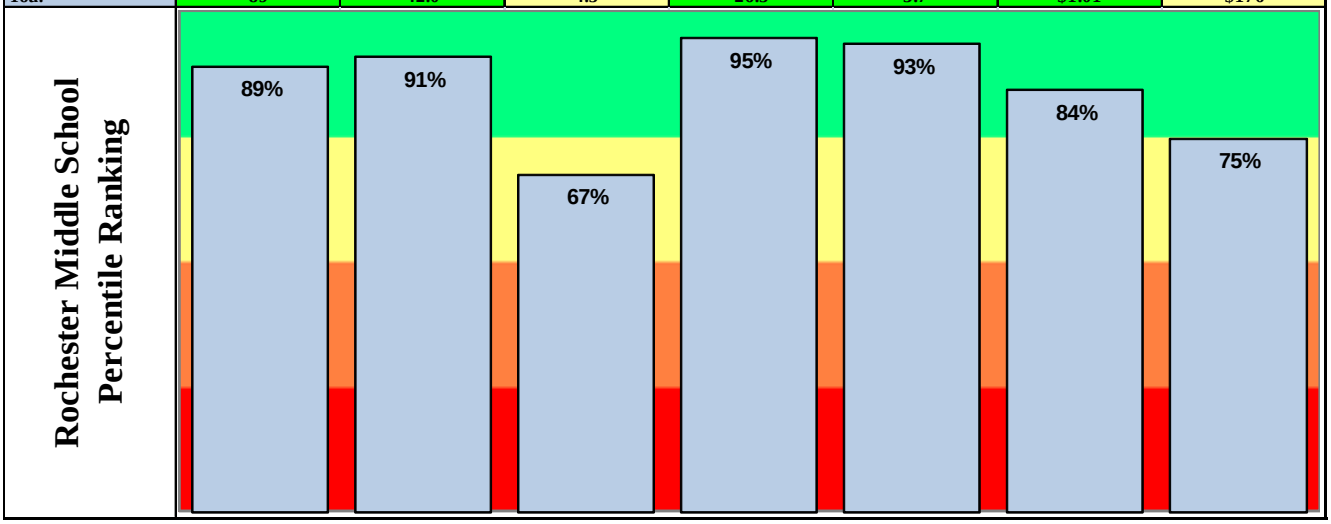
Benchmarking Data

To evaluate the energy and environmental performance of your school, the building data collected above has been compared against two different sets of school energy data: the U.S. Environmental Protection Agency's national data and New Hampshire specific state data. The results are illustrated in Figure 4 on the following page.

This will allow you to assess your building's performance relative to other buildings designed and constructed to the same codes and standards, operating under the same regulations and schedules and similar weather conditions. The indicators are calculated on a *per square foot* or *per student* basis, so you can compare your school to different sized schools.

Figure 4. EnergySmart Schools Benchmarks for Rochester Middle School

Schools	U.S. EPA Portfolio Manager Score	New Hampshire State Schools (Annual Data)					
		Total Energy Use (kBtu/sq.ft.)	Electric Use (kWh/sq.ft.)	Heating Fuel Use (kBtu/sq.ft.)	Weather Adjusted Heating Fuel Use (Btu/sq.ft./HDD)	Total Energy Cost ($/sq.ft.)	Total Energy Cost ($/student)
NH Average:	50	60.3	5.2	41.7	5.7	$1.42	$256
You:	89	42.0	4.5	26.5	3.7	$1.01	$176



Major Benchmark Indicators

1. Total Energy Use, kBtu/sq.ft.

This indicator shows how much total energy your school consumes each year. It includes the energy used for heating, cooling (if any), lights, cooking, computers, etc.

Your school's total energy use of 42.0 kBtu per square foot per year (kBtu/sq.ft.) is better than the New Hampshire K-12 schools state average of 60.3 kBtu/sq.ft. Your total energy use figure is lower than 91% of New Hampshire K-12 schools. The EnergySmart School Report is weather normalized so fuel consumption for heating takes the difference in climate between northern and southern New Hampshire into account.

This is a good indicator of how well, overall, your school is performing. However, it doesn't help you find ***where*** in your building to look for improvement opportunities. Multiple factors included on the following pages can help with that. Analysis of energy consumption for this program does not control for operational variations. An example is an improperly ventilated school may appear to have lower energy consumption. Ventilation systems that are not operating properly result in lower indoor air quality.

2. Electricity Data

Most electric utilities use the following two factors to estimate your electricity bill – Electric Use and Electric Demand.

a. Electric Use, kWh/sq.ft.

This shows how well the building does with its lights, cooling/air conditioners and cafeteria systems (if any), and what's referred to as "plug load." Plug load is anything that plugs into a socket. The major plug loads are generally computers (including monitors, printers and copiers), refrigerators, coffee machines, fans, shop equipment and projectors. If electric consumption is much higher than average, but heating fuel use (see below) is average or better, then focus your efforts on the electric-powered elements.

New Hampshire schools state average electric use is 5.2 kWh per square foot. Your school's electric consumption of 4.5 kWh per square foot this year is lower than 67% of New Hampshire schools benchmarked through the New Hampshire EnergySmart Schools Program.

b. Electric Demand, Watts/sq.ft.

Demand is a measure of the maximum electric draw in kW that your building places on the grid and is measured by adding up the kW draw for a 15 minute period. To give an analogy, if electricity usage is the amount of water going through a hose in gallons, electric demand would be how fast that water flows expressed in gallons per minute. Whichever 15 minute period during your monthly billing cycle places the highest kW demand on the grid is the demand factor applied to your bill. The best way to improve this demand factor is to stagger the times when your electrical systems draw at their maximum or reduce unnecessary electric load altogether.

The average electric demand for New Hampshire schools is 1.9 watts per square foot. Your school's electric demand is 1.5 watts per square foot and is lower than 82% of New Hampshire Schools benchmarked through the New Hampshire EnergySmart Schools Program.

3. Heating Fuel Use, kBtu/sq.ft.

Reviewing these indicators is relatively straightforward. If your school's heating fuel use is much higher than average, an audit of your heating system along with your building envelope - doors, windows, roof - is recommended. This factor is 'fuel-neutral' as it works for either fuel oil or natural gas heating systems.

New Hampshire K-12 schools state average heating fuel use is 41.7 kBtu/sq.ft. or 5.7 Btu/sq.ft./HDD. Your school's heating fuel use of 26.5 kBtu/sq.ft. per year is lower than 95% of other New Hampshire schools in the database. Your school's weather adjusted heating fuel use of 3.7 Btu/sq.ft./HDD is lower than 93% of other New Hampshire schools benchmarked through the New Hampshire EnergySmart Schools Program.

4. Energy Cost, $/sq.ft. & $/student

Cost is the bottom line. These numbers help you understand, in terms of budget, the gain through energy efficiency improvements. New Hampshire K-12 schools state averages $1.42/sq.ft. and $256/student.

Your school's annual energy cost of $1.01 per square foot is lower than 84% of other New Hampshire benchmarked schools. Your school's cost expressed on a per student basis of $176 is lower than 75% of other New Hampshire schools benchmarked through the New Hampshire EnergySmart Schools Program.

5. U.S. EPA *Portfolio Manager* Score

Portfolio Manager is a benchmarking model based on a national set of data from K-12 schools. It is provided by the U.S. Environmental Protection Agency's ENERGY STAR® Program. The impact of factors outside of your control (such as location, occupancy and operating hours) are removed, providing a 1-100 ranking of a school's energy performance relative to the national school building market. A score of 50 represents the national average and a score of 100 is best. Schools that achieve a score of 75 or higher are eligible for EPA's ENERGY STAR® Building Label, the national symbol for protecting the environment through energy efficiency. Districts can achieve ENERGY STAR® Leader Awards in recognition if their buildings, on average, improve by 10%, 20%, 30%, etc. over their baseline year of reported energy use or if the district's overall weighted average *Portfolio Manager* Score is at least a 75.

Your school's *Portfolio Manager* Score of 89 places it higher than 89% of K-12 schools nationwide. As noted above, this rating potentially qualifies your school for the prestigious ENERGY STAR® Label for Buildings.

III. Potential Energy Saving Opportunities

Based on the preceding analysis of your school's energy performance, implementation of the following recommendations can help you save energy and money. The first step is to look at reducing electrical lighting and HVAC consumption (burners, circulators and fans) which typically account for 67% of a building's electric consumption.

- **Perform an Energy Audit on the Building**

An energy audit involves a comprehensive analysis of the building's general characteristics, its energy use and allocation of that use amongst the facility's energy end uses. The goal is to identify sources of potential energy savings. Your auditor should develop a list of recommendations that will result in substantial energy and operational cost savings. These may include, building envelope improvement and mechanical systems, lighting upgrades, equipment replacement and installation of lighting and HVAC control mechanisms, among others.

A good audit should include information specific to each recommendation which *at least* includes approximate annual energy unit and cost savings, demand reduction, installation cost, lifetime cost savings and information related to cost-effectiveness. This will help to prioritize the recommendations based on their energy efficiency and shortest payback.

The recommendations provided in an energy audit report may reduce facility energy bills by 20% or more in addition to improving occupant health and comfort. Following this report, an energy audit is the next step in realizing the full potential of energy savings opportunities.

- **Request Retro-Commissioning**

Retro-commissioning is a detailed process applied to existing facilities aimed at correcting many of the degradations and inefficiencies that are indicative of older and/or poorly performing buildings. Many older buildings tend to be less comfortable and operate less efficiently when not properly commissioned. Retro-commissioning includes a detailed energy audit and focuses on not only potential energy savings but also the interaction of the building's equipments and mechanical systems with an eye toward restoring it to optimal performance.

In contrast to an energy audit, this optimization focuses on operational improvements to existing equipment, rather than replacement. Apart from energy savings, other improvements and benefits include substantial operation and maintenance (O&M) cost savings, improved air quality, occupant comfort, health and safety, equipment controls, and improved system interactivity.

In addition to providing recommendations, retro-commissioning includes implementation of the recommended improvements and hence the cost for retro-commissioning is higher than an audit. However, when the costs of improvements are added to the energy audit cost, prices may be comparable. If high O&M costs or occupant health, comfort and safety are concerns in addition to reduction in energy use, retro-commissioning may be a suitable strategy.

- **Upgrade Lighting Systems**

Lighting typically accounts for 30-60% of all energy consumed in school buildings. Additionally, the electrical energy consumed by lights during the summer creates heat and increases cooling costs.

Rochester Middle School's electricity consumption is slightly lower (better) compared to other schools in the State. Upgraded lighting systems in high consumption areas like classrooms, gymnasiums, libraries, offices, etc. can reduce costs even further, improve the lighting quality and increase occupant comfort and productivity.

Over-lit Spaces: Light levels should be recorded in classrooms and hallways to ensure they are not over-lit, 40-50 foot candles are adequate light levels for an instructional space. If classroom light levels are much higher than 50 foot candles, Rochester Middle School should consider de-lamping classrooms or installing dimming ballasts, which dim the lights when outdoor light levels are adequate. In over-lit hallway spaces photo sensors can be installed to turn lights off completely when light levels exceed a pre-set threshold.

In over-lit spaces a T8 to Super T8 lighting retro-fit can reduce the number of light fixtures needed. Super T8 lamps use between 4 and 7 Watts less electricity than standard T8 lamps, but they produce more light per Watt. In some cases this increase in light per Watt can allow for the removal of an entire lamp, saving 32 Watts. The room characteristics must be factored in before this type of retro-fit. The shape of the space, ceiling height, color of the walls, etc. all need to be taken into account when exploring a de-lamping project. We recommend that before retro-fitting the entire facility, begin by changing one classroom and monitor the comfort level of the occupants at Rochester Middle School.

Another proven energy reduction measure with a short payback period is to identify any areas where your school may still be using metal halide lighting. Typically metal halide lights are found in gymnasiums or cafeteria areas, many districts have been very satisfied by replacing these lights with high bay T5 lighting fixtures. In addition to the reduced operational wattage, high bay T5 lights turn on instantly, as opposed to metal halide fixtures which have an extended warm up period. The long warm up period associated with metal halides typically leads to the lights being left on all day, at 250 to 400 watts a fixture; the costs begin to add up. Adding occupancy sensors to high bay T5 fixtures further reduces the payback period.

Occupancy Sensors: We recommend that you explore the use of occupancy sensors to ensure that lights are turned off in unoccupied spaces. Lights controlled by occupancy sensors typically run a third of the time when compared with manually controlled lighting. Reduced runtime leads to decreases in both energy usage and operation and maintenance costs. Additionally, a study conducted in Massachusetts found that controlling the security lighting with occupancy sensors reduced vandalism; neighbors and police recognized something wrong when the lights were on in a building that was typically dark and investigated.

To summarize and add a few ways in which Rochester Middle School may be able to conserve energy and cost through lighting upgrades is to:

- Design light quantity and quality for the task and occupants' needs in that area.
- Maximize lamp and ballast efficiency.
- Activate the power saving features on office equipment such as copiers, printers and fax machines and ensure that they are turned off at the end of the day.
- Use automatic controls to turn lights off or dim lights in unoccupied spaces.
- Establish a maintenance schedule for group re-lamping and fixture cleaning.
- Replace T12 fixtures with the most efficient fixtures which may include T8/super T8/T5 fixtures.
- Replace incandescent lighting with compact fluorescent technology.

- Replace incandescent exit lighting which consumes 30 Watts with LED type exit lights with 1.5 Watts consumption. LED units last up to 10 years, which is a maintenance advantage.
- Install daylight sensors in areas with significant natural light.
- Install occupancy sensors in areas that are often unoccupied.
- Lighting retrofits reduce maintenance costs associated with lighting that is close to end of life.
- Establish a regular cleaning schedule particularly for areas where student safety of low light levels may be a concern, such as shop classes.
- Look to make lamp and fixture selection as uniform as possible to reduce maintenance and inventory overhead.
- Educate students and staff to turn off lights when rooms are unoccupied.

Lighting upgrades seek to reduce the connected electrical load (kW) and energy consumption (kWh) of lighting equipment. Lighting controls can also significantly reduce operating hours and costs by turning off lighting when spaces are unoccupied or sufficiently lit by natural light.

- **Install NEMA Premium Motors and VFDs**

Commercial and industrial electric motor-driven systems consume approximately 23% of all electricity in the U.S., making it the single largest category contributor to electric use in the country. With very high operating hours, the annual energy cost to run a system is more than its installation cost. Even a small increase in the efficiency of an electric motor can result in substantial energy cost savings. Typical opportunities for motor upgrades in schools include: ventilation fans, and heating and cooling system pumps and fans.

Motors with efficiency up to 90% are available to replace the older ones with efficiency less than 75%. Although standards for efficiency of new equipment are set by the Energy Policy Act, motor efficiency can be further increased by selecting Premium Efficiency motors as specified by the National Electrical Manufacturers Association (NEMA). This can cut the electric motor system demand by as much as 18%.

Savings can be increased further by optimizing system performance through the use of variable frequency drives (VFDs). When system load is known to vary substantially, these flow control systems can be utilized to match system output to system demand, significantly reducing energy usage during partial load hours. By employing high-efficiency motors and VFDs, facility owners can improve environmental conditions, utilize better control of motor-driven processes, and reduce waste output.

- **Install Demand Control Ventilation**

Demand control ventilation (DCV) monitors indoor air CO_2 content as a result of occupancy production levels and uses this data to regulate the amount of outdoor air that is permitted for ventilation. In order to ensure adequate air quality, standard ventilation systems permit outside air based on estimated occupancy levels in CFM, cubic feet per minute/occupant. However, during low occupancy hours, the space may become over ventilated due to decreased CO_2 levels and unnecessary ventilation results in wasted energy. DCV reduces unnecessary outdoor air intake by regulating ventilation based on actual CO_2 levels, saving energy. DCV is most suited for areas where occupancy levels are known to fluctuate considerably such as auditoriums, cafeterias, and gymnasiums.

Install Energy Recovery Ventilators. According to energy recovery equipment manufacturer's typical paybacks are less than 5 years for schools without cooling. The keys to success with ventilation retrofits are going with fewer larger units with long run hours as opposed to several small units with limited run time. Equipment with moisture recovery capabilities would cut humidity up to 50% during the cooling season.

- **Improve/Replace Inefficient Heating Systems**

Replacing an old boiler that is < 70% efficient with a modern 85-90% efficient natural gas-fired furnace alone will reduce heating costs by 15-20%. This combined with additional system improvements and installation of advanced HVAC control mechanisms can result in up to 20%+ heating load reduction.

Because of the high capital cost of new heating systems, some financial analysis should be performed to assess the cost-effectiveness of immediate replacement. If the current system is fairly new, replacement may not be immediately justifiable from a financial standpoint. However, as is the case with cooling systems, early replacement may prove to be a more cost-effective solution than waiting until existing systems fail or reach the end of their estimated useful life.

- **Improve/Replace Inefficient Air Conditioning Systems**

The useful life of a rooftop A/C unit is generally 12-18 years. However, depending on the efficiency, early replacement of outdated, inefficient, split, or packaged rooftop air conditioning units with new A/C systems that are 15% more efficient than 10-15 year old equipments can considerably reduce annual energy consumption. The energy cost savings and maintenance savings offset the high installation cost of a more efficient system. Installing thermostats and/or economizers on new or existing A/C systems will further reduce the cooling demand.

Economizers provide "free" cooling by using controllable dampers that bring in outside air to cool the space when the outdoor temperature or enthalpy is below the building's return air conditions. Although they require operation by a well calibrated and maintained control system, economizers have impressive energy-saving capabilities.

Install Occupancy Controlled/Programmable Thermostats

Combining efficient HVAC equipment with occupancy controlled and programmable thermostats can save a facility up to 10% of its annual heating and cooling costs:

- Areas with unpredictable occupancy on a daily/weekly basis - gym, bathrooms, outdoors: Use an *occupancy controlled thermostat* - a thermostat paired with a sensor and/or door detector to identify movement/occupancy. If occupancy is sensed by the sensor, the thermostat goes into an occupied mode (i.e. programmed set point). If a pre-programmed time frame elapses (i.e. 30 minutes) and no occupancy is sensed during that time, the thermostat goes into an unoccupied mode (e.g., setback set point or off) until occupancy is sensed again. This reduces the overall time the heating or cooling system is running, saving energy.

- Areas with predictable occupancy: e.g.: classrooms, cafeteria, offices: A *programmable thermostat* is recommended. This device is programmed on a schedule to reduce the heating or cooling output of the facility's HVAC systems in relation to its predetermined occupancy schedule. In this way, the thermostat acts to set-back or set-up the facility temperature during unoccupied hours, and re-establish a comfortable facility temperature during business hours. By employing programmable thermostat technology, the heating and cooling system demand coincides with occupancy level, reducing energy usage.

- **Install Vending Misers on Vending Machines**

Vending misers for refrigerated and non-refrigerated vending machines is an often overlooked source of potential savings. Uncontrolled, vending machine lights remain on 24/7, consuming a constant amount of energy year round. By controlling these lights with an occupancy sensor, energy consumption attributed to vending machines can be reduced considerably, in many cases, by as much as 50% and can save up to $150 per machine per year.

In the case of refrigerated vending machines, electric demand can be further reduced by controlling the machines' refrigeration systems. In a manner similar to programmable thermostats, vending misers for refrigerated machines act on a pre-set occupancy schedule to allow a marginal increase in operating temperature during non-business hours. Although products in the machine are delivered to the customer at the same temperature as in an uncontrolled vending machine, products are not being cooled unnecessarily when the machine is not in use, significantly reducing the machine's energy consumption. Because of the relatively low vending miser installation cost and high operating hours of vending machines, this improvement is typically cost-effective with a very short payback period.

- **Install ENERGY STAR® Rated Equipment / Plug Load Control**

Plug loads (computers, televisions, coffee makers, etc.) account for, on average, about 10% of total energy consumption. One of the easiest and most cost-effective energy saving strategies is the reduction of electric usage through installation of efficient appliances and the control of plug loads. In addition to utilizing ENERGY STAR® qualified appliances, greater savings can be realized through the various devices available that control every day plug loads.

By connecting non-critical loads (coffee makers, fans, microwave ovens, etc.) to an occupancy or timer controlled power strip, significant energy savings can be achieved. These savings result not only from the neglect of the user to turn the device off manually, but also from reduction of "phantom load". Phantom load is the small but constant energy draw from many plug-in devices when not in use. By connecting certain appliances to an occupancy controlled power strip, phantom load can be eliminated by cutting power supply to those devices. When replacing or ordering new equipment, emphasize ENERGY STAR® devices when they are available. Also, purchase controlled power strips and connect appropriate devices to those strips to reduce unnecessary consumption due to phantom load and appliances left on. The EPA offers free computer power management software which has saved some districts as much as $75 per computer per year, the software can be found at http://www.energystar.gov/index.cfm?c=power_mgt.pr_power_mgt_low_carbon_join.

IV. Resources:

The State of New Hampshire along with the utility companies offer multiple programs designed to improve the energy efficiency of schools through financial incentives and technical support, including:

Northeast Energy Efficiency Partnerships:

- **Northeast Collaborative for High Performance Schools (NE-CHPS)**
  NE-CHPS is a set of building and design standards for all schools from pre-K through community colleges tailored specifically for NH state code requirements, the New England climate, and the environmental priorities of the region. NH Department of Education offers up to a 3% re-imbursement for New Construction School projects. To learn more about NE-CHPS and incentive programs please visit: http://neep.org/public-policy/hpse/hpse-nechps.

New Hampshire Public Utilities Commission:

- **New Hampshire Pay for Performance**
  This program addresses the energy efficiency improvement needs of the commercial and industrial sector. The Program is implemented through a network of qualified Program Partners. Incentives will be paid out on the following three payment schedule: Incentive #1: Is based on the area of conditioned space in square feet. Incentive #2: Per/kWh saved and Per/MMBTU saved based on projected savings and paid at construction completion. Incentive #3: Per/kWh saved and Per/MMBTU saved based on actual energy savings performance one year post construction. Total performance incentives (#2 and #3) will be capped at $200,000 or 50% of project cost on a per project basis. For more information visit http://nhp4p.com.

- **New Hampshire Public Utilities Commission's Renewable Energy Rebates**
  The Sustainable Energy Division provides an incentive program for solar electric (photovoltaic or PV) arrays and solar thermal systems for domestic hot water, space and process heat, with a capacity of 100 kW or equivalent thermal output or less. The rebate for PV systems as follows: $1.00 per Watt, capped at 25% of the costs of the system or $50,000, whichever is less. For solar hot water (SHW) systems, the base rebate is $0.07 per rated or modeled kBtu/year, capped at 25% of the cost of the facility or $50,000, whichever is less, as a one-time incentive payment. http://www.puc.state.nh.us/Sustainable%20Energy/RenewableEnergyRebates-CI.html.

New Hampshire Community Development Finance Authority:

- **New Hampshire Community Development Finance Authority Revolving Loan Fund**
  The Enterprise Energy Fund is a low-interest loan and grant program available to businesses and nonprofit organizations to help finance energy improvements and renewable energy projects in their buildings. The loans will range from $10,000 to $500,000. Larger amounts will be considered on a case by case basis. The program is available to finance improvements to the overall energy-efficiency performance of buildings owned by businesses and nonprofits, thereby lowering their overall energy costs and the associated carbon emissions. More information about the program can be found on their website www.nhcdfa.org. These activities may include:

  - Improvements to the building's envelope, including air sealing and insulation in the walls, attics and foundations;
  - Improvements to HVAC equipment and air exchange;
  - Installation of renewable energy systems;
  - Improvements to lighting, equipment, and other electrical systems; and
  - Conduction of comprehensive, fuel-blind energy audits.

Public Service of New Hampshire (PSNH):

- **Commercial (Electric) Energy Efficiency Incentive Programs**
  This program targets any commercial/industrial member building a new facility, undergoing a major renovation, or replacing failed (end-of-life) equipment. The program offers prescriptive and custom rebates for lighting and lighting controls, motors, VFDs, HVAC systems, chillers and custom projects. http://www.psnh.com/SaveEnergyMoney/For-Business/Energy-Saving-Programs-and-Incentives.aspx

- **SmartSTART**
  The SmartSTART (Savings Through Affordable Retrofit Technologies) advantage is simple - pay nothing out of pocket to have energy efficiency products and services installed in your building. The Smart Start program is limited to PSNH's municipal customers only and includes schools. The program is available on a first-come, first served basis to projects which have been pre-qualified by PSNH. The cost of the improvements is fronted by PSNH which is then repaid over time by the municipality or school using the savings generated by the products themselves! This program is for lighting and lighting controls, air sealing, insulation and other verifiable energy savings measures which have sufficient kilowatt-hour savings. For more information on this program visit:
  http://www.psnh.com/SaveEnergyMoney/For-Business/Municipal-Smart-Start-Program.aspx

- **Schools Program**
  For major renovation or equipment replacement projects, this program offers prescriptive and custom rebates for energy efficient lighting, motors, HVAC, chillers, and variable frequency drives to towns or cities that install energy efficient equipment at their schools. Financial incentives are available for qualifying energy efficient equipment. Technical assistance is also offered through the Schools Program. http://www.psnh.com/SaveEnergyMoney/Large-Power/Schools-Program.aspx

Unitil:

- **Commercial and Industrial Energy Efficiency Programs**
  Subject to program qualifications and availability of funding - Unitil offers different programs for its commercial, industrial, and institutional customers in New Hampshire: the Small Business Energy Efficiency Program, the Small Commercial and Industrial Program, the Large Commercial and Industrial Program, the Large Commercial and Industrial (C&I) Retrofit Program, and the Large C&I New Construction Program. Rebates are available for various technologies including water heaters, lighting, lighting controls/sensors, chillers, furnaces, boilers, central air conditioners, compressed air, programmable thermostats, energy management systems/building controls, motors, motor VFDs, processing and manufacturing equipment, LED exit signs, commercial cooking and refrigeration equipment. http://www.unitil.com/.

Clean Air – Cool Planet:

- **Community Energy Efficiency**
  CA-CP works with communities throughout the Northeast to find solutions to climate change and build constituencies for effective climate policies and actions. Much of their work focuses on successful models for energy efficiency and renewable energy planning. They advise and partner with citizens, educators, faith groups, small businesses, municipal governments, and other local leaders. They explore cost-effective opportunities that exist for communities to reduce their emissions as well as their vulnerability to climate impacts. One such example is CA-CP's partnership with the University of NH, NH Sustainable Energy Association and UNH Cooperative Extension to create www.myenergyplan.net, a groundbreaking suite of web and outreach tools for individual action used by households, schools and community groups around the northeast. http://www.cleanair-coolplanet.org/for_communities/index.php.

Environmental Protection Agency (EPA):

- **ENERGY STAR Challenge for Schools**
  EPA is challenging school administrators and building managers to improve energy efficiency throughout their facilities. More than 500 school districts across the country are helping to fight climate change by committing to reducing their energy use with help from ENERGY STAR. Schools that take the ENERGY STAR Challenge can use energy tracking tools, technical guidance, case studies and other ENERGY STAR tools and resources to help them improve their energy efficiency. More information can be found at:
  http://yosemite.epa.gov/opa/admpress.nsf/d985312f6895893b852574ac005f1e40/d74f768ecfa9e11f8525762500522260!OpenDocument

For additional assistance in helping you save money and improve school conditions, please call TRC at (603) 766-1913 or (877) 442-9181.

NEW HAMPSHIRE ENERGYSMART SCHOOLS PROGRAM

Energy Benchmarking Report for:

Richard Creteau Regional Technology Center

Rochester, NH

Period: ***July 1, 2010*** through ***June 30, 2011***

PREPARED BY:

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I. Introduction

The Sustainable Energy Division of the New Hampshire Public Utilities Commission, with support from the New Hampshire Department of Education has sponsored TRC to develop the New Hampshire ***EnergySmart Schools Program*** to support New Hampshire K-12 public and private schools in the pursuit of energy efficiency and sustainability initiatives.

Energy efficiency has become an increasingly important issue for schools due to tightening budgets and rising energy costs. Since 2003, the prices of natural gas, fuel oil and electricity have increased by 123%, 107% and 32% respectively. Schools that have participated in energy benchmarking programs have shown a decrease in overall energy use by approximately 22% through the adoption of energy efficiency measures.

Tracking and documenting the energy use and associated carbon emissions in the state's K-12 schools will allow New Hampshire to account for the impact of its energy efficiency and renewable energy programs and determine which have the greatest effect. The analysis in this report, provided by the ***EnergySmart Schools Program*** is designed to help you:

- Understand the energy consumption and cost trends at each of your school buildings.
- Learn how your buildings are performing compared to other schools locally and nationally.
- Identify opportunities for improving operations and reducing costs.
- Take advantage of resources to implement efficiency improvements and save money.

The analysis was based on the information provided on the *Building Data Request Form* submitted, which included building descriptions, energy suppliers and other information. The building's utility bills were also used to assess its electricity and heating fuel consumption for the year(s) provided.

The energy performance for your school has been compared to national data for similar school facilities through EPA's ENERGY STAR® Portfolio Manager. Also shown are the five major benchmarks used to analyze building performance, which include: electricity use; heating fuel use; weather-normalized heating fuel use; total cost; and total cost per student, all of which have been normalized for comparison by square footage and weather. As part of the program's focus on sustainability, your school's carbon footprint is also presented.

II. Benchmarking Analysis and Review Results

Building and energy usage of your school was analyzed to assess the basic nature of your energy consumption and utility costs. The Building Data Summary table shown below summarizes this information.

Table 1: Building Data Summary for Richard Creteau Technology Center

Building Data			
District	SAU 54 Rochester School Department	**School Name**	Richard Creteau Regional Technology Center
City	Rochester	**Zip Code**	03867
Year Built	1990	**Floor Area (sq.ft.)**	88,000
Number of Students	400	**Number of PCs**	323
Weekly Operating Hours	60	**Months School Used**	12
Cooking?	YES	**% AC**	30
Pool Size?	N/A	**Months Pool Used**	0

Utility Data			
Data End Point	6/30/2011	**Total Cost ($)**	107,960
Electric Provider	PSNH	**Natural Gas Provider**	Unitil
Electricity Usage (kWh)	546,800	**Electricity Cost ($)**	77,845
Natural Gas Usage (therms)	29,735	**Natural Gas Cost ($)**	30,115
Fuel Oil Usage (gal)	0	**Fuel Oil Cost ($)**	0
Other Fuel Usage (gal)	0	**Other Fuel Cost ($)**	0

Energy Indicators			
EPA Score	81	**Electric Usage (kWh/sq.ft.)**	6.2
Heating Fuel Usage (kBtu/sq.ft.)	33.8	**Weather Adjusted Heating Usage Btu/sq.ft./HDD)**	4.7
Site Energy (kBtu/sq.ft.)	55.0	**Source Energy (kBtu/sq.ft.)**	106

Environmental Impact Indicators			
Greenhouse Gas Emissions			
Last Year Heating Fuel CO_2e (Mt)	158.1	**Last Year Total CO_2e (Mt)**	327.8
Last Year Electricity CO_2e (Mt)	169.7	**CO_2e Efficiency Savings Over Previous Year**	-30.4
EPA Target Score			
Target Score	Reached	**Site Energy Reduction Needed (kBtu/sq.ft.)**	N/A - Reached

Figures 1a, 1b, 2a and 2b display the energy use, demand and cost data tracked on a monthly basis. This demonstrates the energy consumption of your building over the course of the year. As a part of the program's focus on sustainability, your school's carbon footprint was also measured and is presented in Figure 3.

Figure 1a. Monthly Electric Use & Max Demand for Richard Creteau Tech Center

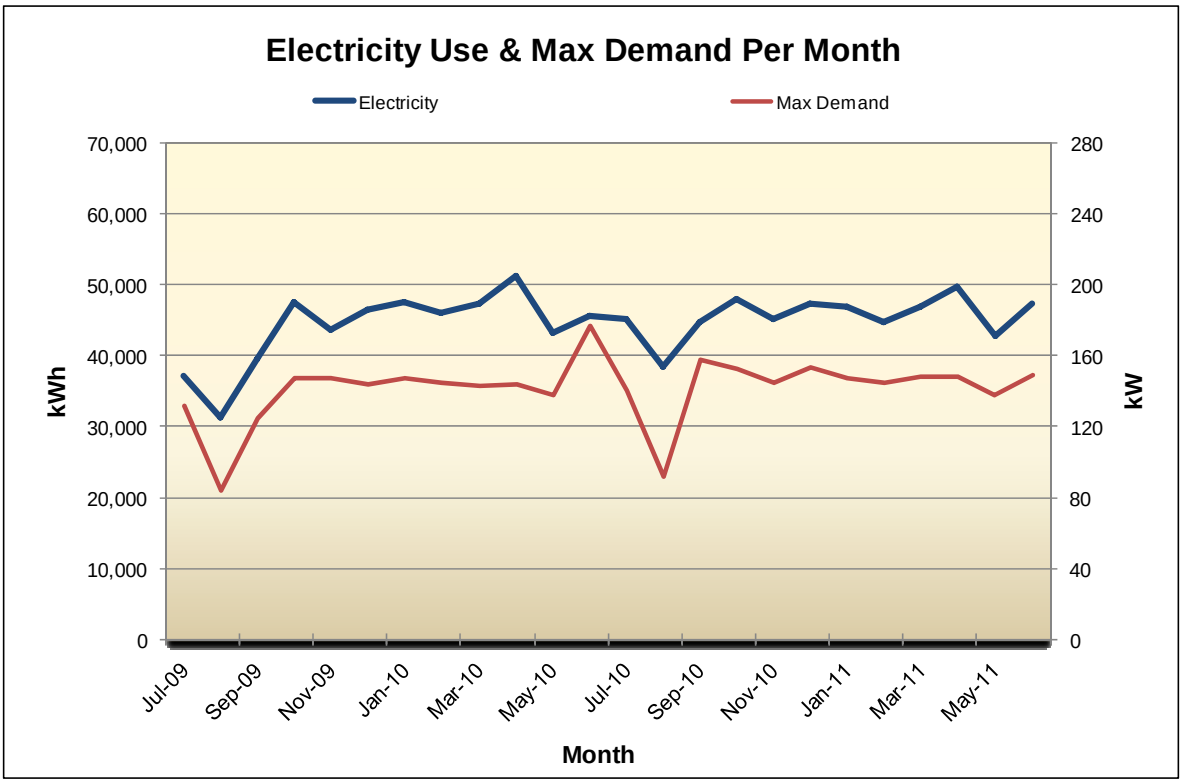
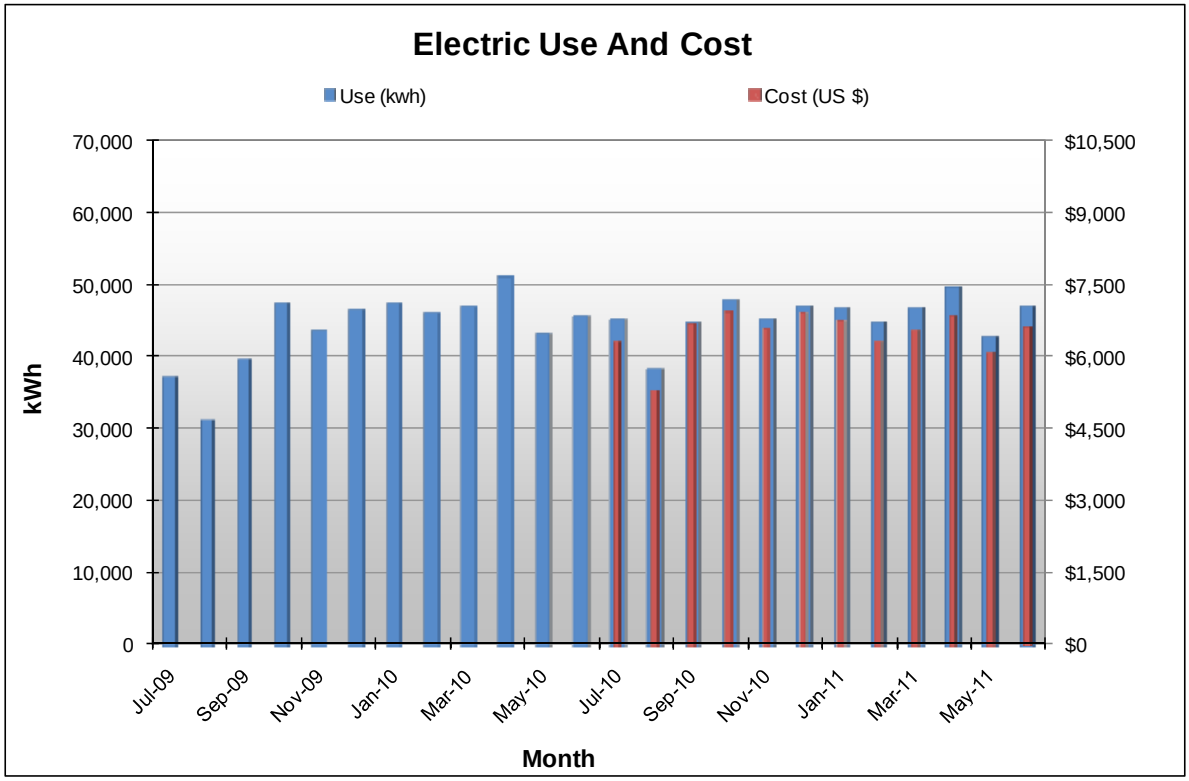


Figure 1b. Monthly Electric Use vs. Cost for Richard Creteau Tech Center



Note: Electric Cost was only available for the most recent 12 month period.

Figure 2a. Monthly Natural Gas Use for Richard Creteau Tech Center

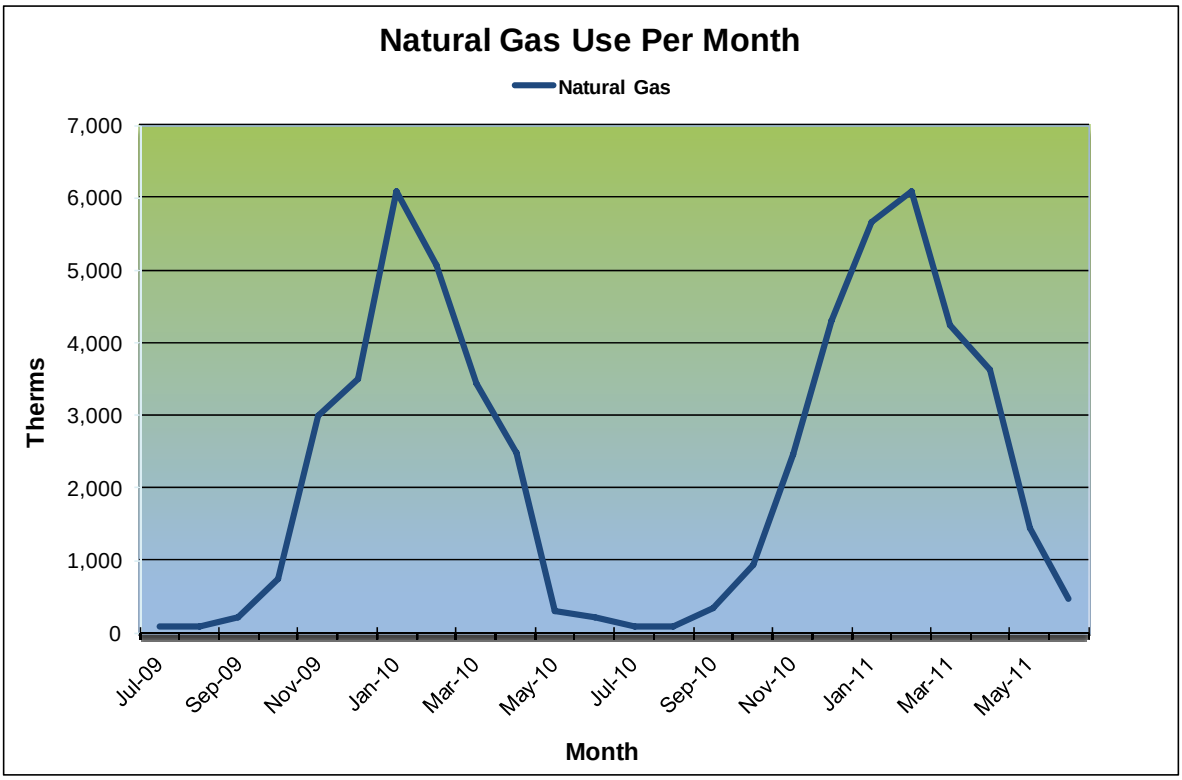


Figure 2b. Monthly Natural Gas Use vs Cost for Richard Creteau Tech Center

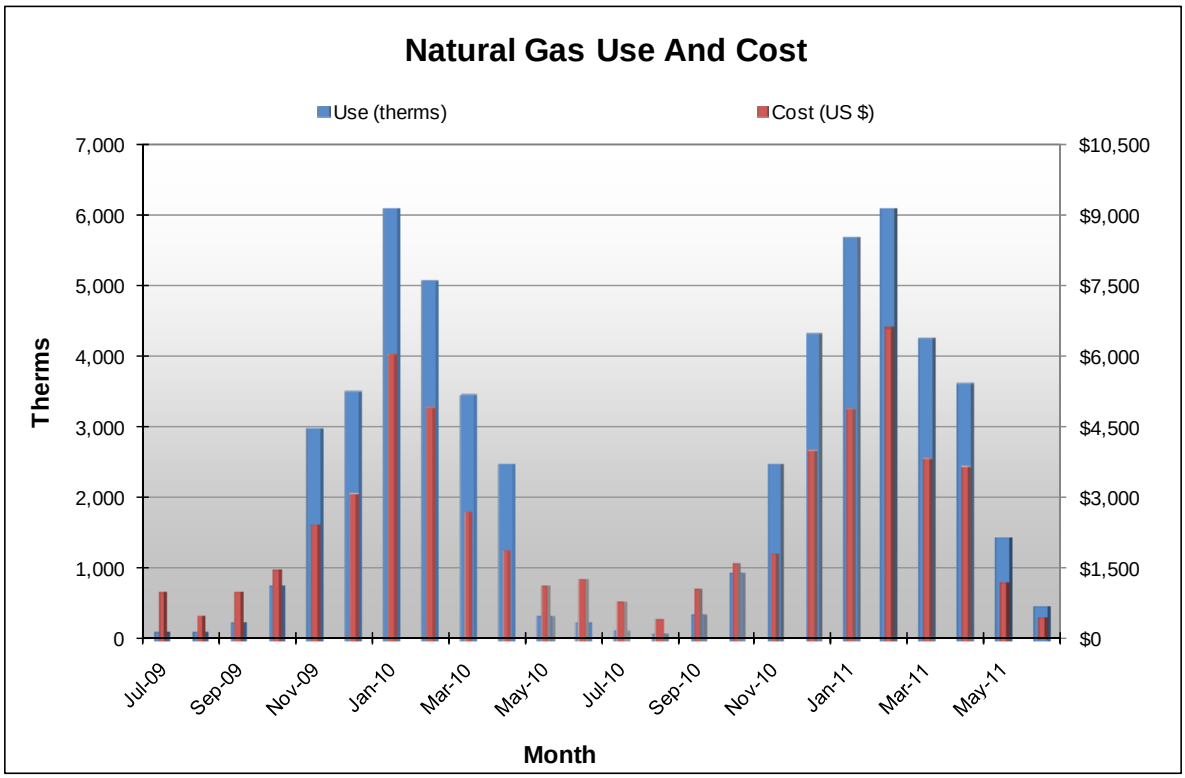
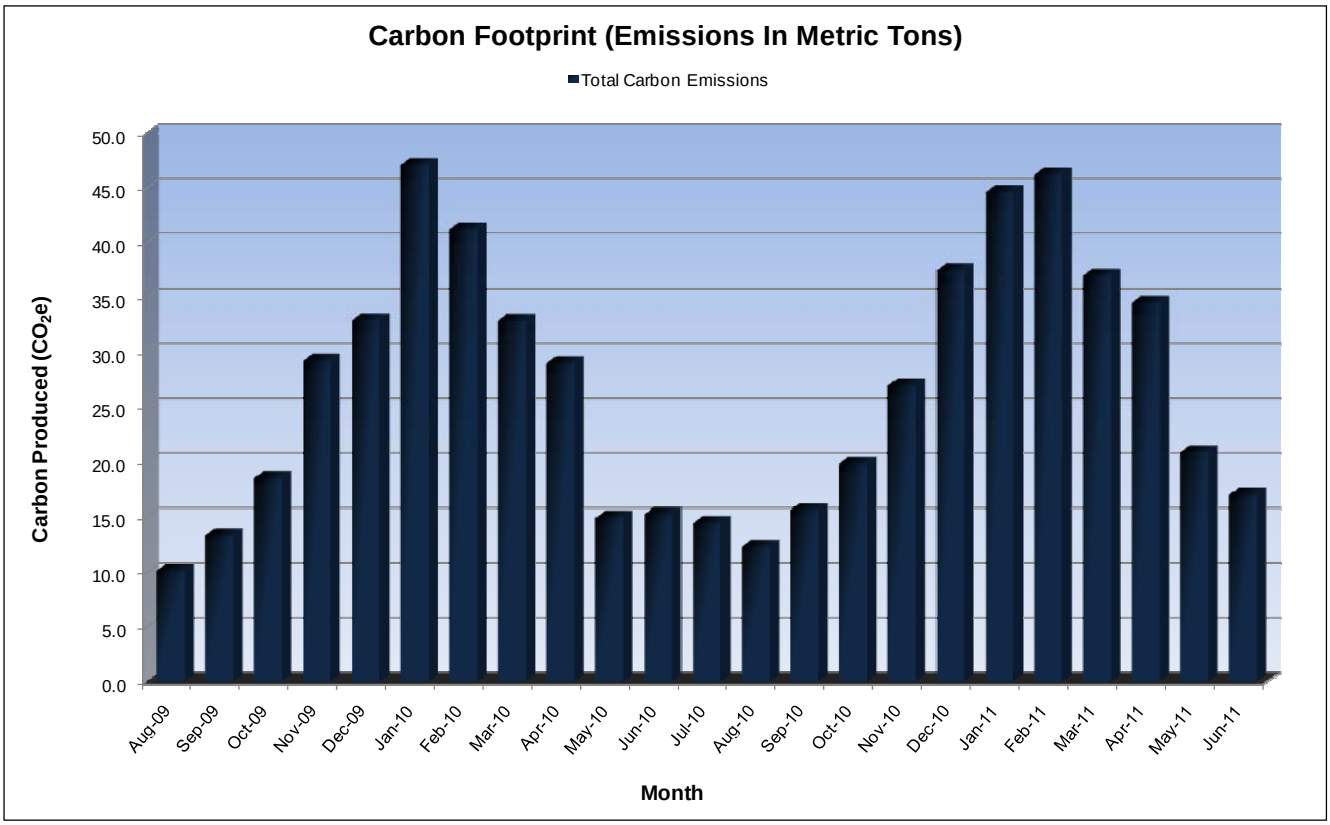


Figure 3. Monthly Greenhouse Gas Emissions for Richard Creteau Tech Center



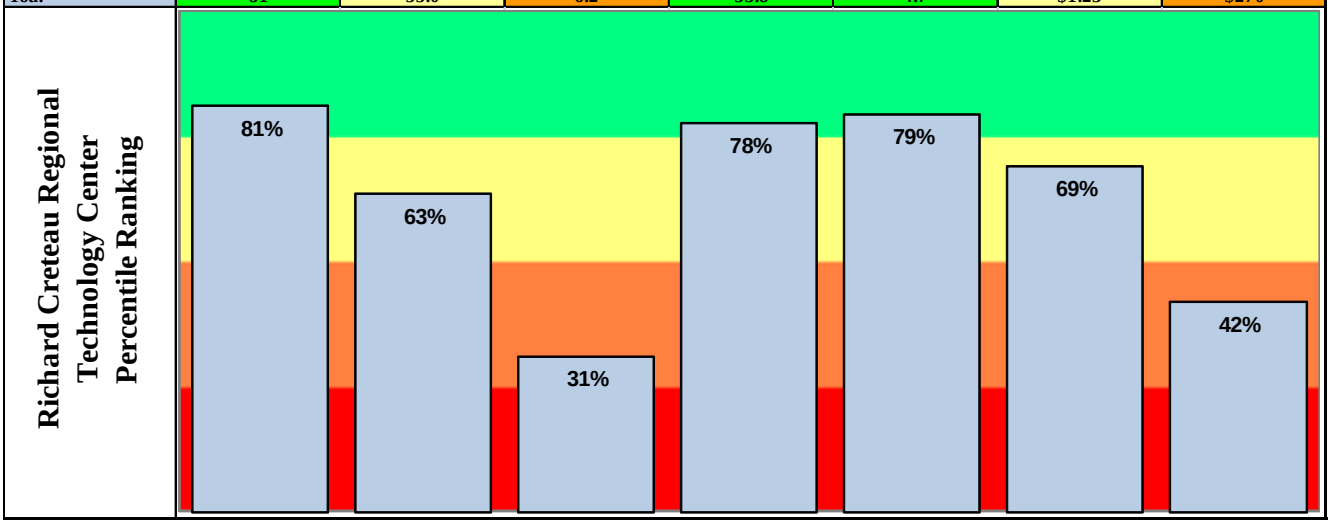
Benchmarking Data

To evaluate the energy and environmental performance of your school, the building data collected above has been compared against two different sets of school energy data: the U.S. Environmental Protection Agency's national data and New Hampshire specific state data. The results are illustrated in Figure 4 on the following page.

This will allow you to assess your building's performance relative to other buildings designed and constructed to the same codes and standards, operating under the same regulations and schedules and similar weather conditions. The indicators are calculated on a *per square foot* or *per student* basis, so you can compare your school to different sized schools.

Figure 4. EnergySmart Schools Benchmarks for Richard Creteau Tech Center

Schools	U.S. EPA Portfolio Manager Score	New Hampshire State Schools (Annual Data)					
		Total Energy Use (kBtu/sq.ft.)	Electric Use (kWh/sq.ft.)	Heating Fuel Use (kBtu/sq.ft.)	Weather Adjusted Heating Fuel Use (Btu/sq.ft./HDD)	Total Energy Cost ($/sq.ft.)	Total Energy Cost ($/student)
NH Average:	50	60.3	5.2	41.7	5.7	$1.42	$256
You:	81	55.0	6.2	33.8	4.7	$1.23	$270



Major Benchmark Indicators

1. Total Energy Use, kBtu/sq.ft.

This indicator shows how much total energy your school consumes each year. It includes the energy used for heating, cooling (if any), lights, cooking, computers, etc.

Your school's total energy use of 55.0 kBtu per square foot per year (kBtu/sq.ft.) is better than the New Hampshire K-12 schools state average of 60.3 kBtu/sq.ft. Your total energy use figure is lower than 63% of New Hampshire K-12 schools. The EnergySmart School Report is weather normalized so fuel consumption for heating takes the difference in climate between northern and southern New Hampshire into account.

This is a good indicator of how well, overall, your school is performing. However, it doesn't help you find ***where*** in your building to look for improvement opportunities. Multiple factors included on the following pages can help with that. Analysis of energy consumption for this program does not control for operational variations. An example is an improperly ventilated school may appear to have lower energy consumption. Ventilation systems that are not operating properly result in lower indoor air quality.

2. Electricity Data

Most electric utilities use the following two factors to estimate your electricity bill – Electric Use and Electric Demand.

a. Electric Use, kWh/sq.ft.

This shows how well the building does with its lights, cooling/air conditioners and cafeteria systems (if any), and what's referred to as "plug load." Plug load is anything that plugs into a socket. The major plug loads are generally computers (including monitors, printers and copiers), refrigerators, coffee machines, fans, shop equipment and projectors. If electric consumption is much higher than average, but heating fuel use (see below) is average or better, then focus your efforts on the electric-powered elements.

New Hampshire schools state average electric use is 5.2 kWh per square foot. Your school's electric consumption of 6.2 kWh per square foot this year is higher than 69% of New Hampshire schools benchmarked through the New Hampshire EnergySmart Schools Program.

b. Electric Demand, Watts/sq.ft.

Demand is a measure of the maximum electric draw in kW that your building places on the grid and is measured by adding up the kW draw for a 15 minute period. To give an analogy, if electricity usage is the amount of water going through a hose in gallons, electric demand would be how fast that water flows expressed in gallons per minute. Whichever 15 minute period during your monthly billing cycle places the highest kW demand on the grid is the demand factor applied to your bill. The best way to improve this demand factor is to stagger the times when your electrical systems draw at their maximum or reduce unnecessary electric load altogether.

The average electric demand for New Hampshire schools is 1.9 watts per square foot. Your school's electric demand is 1.8 watts per square foot and is lower than 58% of New Hampshire Schools benchmarked through the New Hampshire EnergySmart Schools Program.

3. Heating Fuel Use, kBtu/sq.ft.

Reviewing these indicators is relatively straightforward. If your school's heating fuel use is much higher than average, an audit of your heating system along with your building envelope - doors, windows, roof - is recommended. This factor is 'fuel-neutral' as it works for either fuel oil or natural gas heating systems.

New Hampshire K-12 schools state average heating fuel use is 41.7 kBtu/sq.ft. or 5.7 Btu/sq.ft./HDD. Your school's heating fuel use of 33.8 kBtu/sq.ft. per year is lower than 78% of other New Hampshire schools in the database. Your school's weather adjusted heating fuel use of 4.7 Btu/sq.ft./HDD is lower than 79% of other New Hampshire schools benchmarked through the New Hampshire EnergySmart Schools Program.

4. Energy Cost, $/sq.ft. & $/student

Cost is the bottom line. These numbers help you understand, in terms of budget, the gain through energy efficiency improvements. New Hampshire K-12 schools state averages $1.42/sq.ft. and $256/student.

Your school's annual energy cost of $1.23 per square foot is lower than 69% of other New Hampshire benchmarked schools. Your school's cost expressed on a per student basis of $270 is higher than 58% of other New Hampshire schools benchmarked through the New Hampshire EnergySmart Schools Program.

5. U.S. EPA *Portfolio Manager* Score

Portfolio Manager is a benchmarking model based on a national set of data from K-12 schools. It is provided by the U.S. Environmental Protection Agency's ENERGY STAR® Program. The impact of factors outside of your control (such as location, occupancy and operating hours) are removed, providing a 1-100 ranking of a school's energy performance relative to the national school building market. A score of 50 represents the national average and a score of 100 is best. Schools that achieve a score of 75 or higher are eligible for EPA's ENERGY STAR® Building Label, the national symbol for protecting the environment through energy efficiency. Districts can achieve ENERGY STAR® Leader Awards in recognition if their buildings, on average, improve by 10%, 20%, 30%, etc. over their baseline year of reported energy use or if the district's overall weighted average *Portfolio Manager* Score is at least a 75.

Your school's *Portfolio Manager* Score of 81 places it higher than 81% of K-12 schools nationwide. As noted above, this rating potentially qualifies your school for the prestigious ENERGY STAR® Label for Buildings.

III. Potential Energy Saving Opportunities

Based on the preceding analysis of your school's energy performance, implementation of the following recommendations can help you save energy and money. The first step is to look at reducing electrical lighting and HVAC consumption (burners, circulators and fans) which typically account for 67% of a building's electric consumption.

- **Perform an Energy Audit on the Building**

An energy audit involves a comprehensive analysis of the building's general characteristics, its energy use and allocation of that use amongst the facility's energy end uses. The goal is to identify sources of potential energy savings. Your auditor should develop a list of recommendations that will result in substantial energy and operational cost savings. These may include, building envelope improvement and mechanical systems, lighting upgrades, equipment replacement and installation of lighting and HVAC control mechanisms, among others.

A good audit should include information specific to each recommendation which *at least* includes approximate annual energy unit and cost savings, demand reduction, installation cost, lifetime cost savings and information related to cost-effectiveness. This will help to prioritize the recommendations based on their energy efficiency and shortest payback.

The recommendations provided in an energy audit report may reduce facility energy bills by 20% or more in addition to improving occupant health and comfort. Following this report, an energy audit is the next step in realizing the full potential of energy savings opportunities.

- **Request Retro-Commissioning**

Retro-commissioning is a detailed process applied to existing facilities aimed at correcting many of the degradations and inefficiencies that are indicative of older and/or poorly performing buildings. Many older buildings tend to be less comfortable and operate less efficiently when not properly commissioned. Retro-commissioning includes a detailed energy audit and focuses on not only potential energy savings but also the interaction of the building's equipments and mechanical systems with an eye toward restoring it to optimal performance.

In contrast to an energy audit, this optimization focuses on operational improvements to existing equipment, rather than replacement. Apart from energy savings, other improvements and benefits include substantial operation and maintenance (O&M) cost savings, improved air quality, occupant comfort, health and safety, equipment controls, and improved system interactivity.

In addition to providing recommendations, retro-commissioning includes implementation of the recommended improvements and hence the cost for retro-commissioning is higher than an audit. However, when the costs of improvements are added to the energy audit cost, prices may be comparable. If high O&M costs or occupant health, comfort and safety are concerns in addition to reduction in energy use, retro-commissioning may be a suitable strategy.

- **Upgrade Lighting Systems**

Lighting typically accounts for 30-60% of all energy consumed in school buildings. Additionally, the electrical energy consumed by lights during the summer creates heat and increases cooling costs.

Richard Creteau Regional Technology Center's electricity consumption is high compared to other schools in the State. Upgraded lighting systems in high consumption areas like classrooms, gymnasiums, libraries, offices, etc. can reduce these costs, improve the lighting quality and increase occupant comfort and productivity.

Over-lit Spaces: Light levels should be recorded in classrooms and hallways to ensure they are not over-lit, 40-50 foot candles are adequate light levels for an instructional space. If classroom light levels are much higher than 50 foot candles, Richard Creteau Regional Technology Center should consider de-lamping classrooms or installing dimming ballasts, which dim the lights when outdoor light levels are adequate. In over-lit hallway spaces photo sensors can be installed to turn lights off completely when light levels exceed a pre-set threshold.

In over-lit spaces a T8 to Super T8 lighting retro-fit can reduce the number of light fixtures needed. Super T8 lamps use between 4 and 7 Watts less electricity than standard T8 lamps, but they produce more light per Watt. In some cases this increase in light per Watt can allow for the removal of an entire lamp, saving 32 Watts. The room characteristics must be factored in before this type of retro-fit. The shape of the space, ceiling height, color of the walls, etc. all need to be taken into account when exploring a de-lamping project. We recommend that before retro-fitting the entire facility, begin by changing one classroom and monitor the comfort level of the occupants at Richard Creteau Regional Technology Center.

Another proven energy reduction measure with a short payback period is to identify any areas where your school may still be using metal halide lighting. Typically metal halide lights are found in gymnasiums or cafeteria areas, many districts have been very satisfied by replacing these lights with high bay T5 lighting fixtures. In addition to the reduced operational wattage, high bay T5 lights turn on instantly, as opposed to metal halide fixtures which have an extended warm up period. The long warm up period associated with metal halides typically leads to the lights being left on all day, at 250 to 400 watts a fixture; the costs begin to add up. Adding occupancy sensors to high bay T5 fixtures further reduces the payback period.

Occupancy Sensors: We recommend that you explore the use of occupancy sensors to ensure that lights are turned off in unoccupied spaces. Lights controlled by occupancy sensors typically run a third of the time when compared with manually controlled lighting. Reduced runtime leads to decreases in both energy usage and operation and maintenance costs. Additionally, a study conducted in Massachusetts found that controlling the security lighting with occupancy sensors reduced vandalism; neighbors and police recognized something wrong when the lights were on in a building that was typically dark and investigated.

To summarize and add a few ways in which Richard Creteau Regional Technology Center may be able to conserve energy and cost through lighting upgrades is to:

- Design light quantity and quality for the task and occupants' needs in that area.
- Maximize lamp and ballast efficiency.
- Activate the power saving features on office equipment such as copiers, printers and fax machines and ensure that they are turned off at the end of the day.
- Use automatic controls to turn lights off or dim lights in unoccupied spaces.
- Establish a maintenance schedule for group re-lamping and fixture cleaning.
- Replace T12 fixtures with the most efficient fixtures which may include T8/super T8/T5 fixtures.
- Replace incandescent lighting with compact fluorescent technology.

- Replace incandescent exit lighting which consumes 30 Watts with LED type exit lights with 1.5 Watts consumption. LED units last up to 10 years, which is a maintenance advantage.
- Install daylight sensors in areas with significant natural light.
- Install occupancy sensors in areas that are often unoccupied.
- Lighting retrofits reduce maintenance costs associated with lighting that is close to end of life.
- Establish a regular cleaning schedule particularly for areas where student safety of low light levels may be a concern, such as shop classes.
- Look to make lamp and fixture selection as uniform as possible to reduce maintenance and inventory overhead.
- Educate students and staff to turn off lights when rooms are unoccupied.

Lighting upgrades seek to reduce the connected electrical load (kW) and energy consumption (kWh) of lighting equipment. Lighting controls can also significantly reduce operating hours and costs by turning off lighting when spaces are unoccupied or sufficiently lit by natural light.

- **Install NEMA Premium Motors and VFDs**

Commercial and industrial electric motor-driven systems consume approximately 23% of all electricity in the U.S., making it the single largest category contributor to electric use in the country. With very high operating hours, the annual energy cost to run a system is more than its installation cost. Even a small increase in the efficiency of an electric motor can result in substantial energy cost savings. Typical opportunities for motor upgrades in schools include: ventilation fans, and heating and cooling system pumps and fans.

Motors with efficiency up to 90% are available to replace the older ones with efficiency less than 75%. Although standards for efficiency of new equipment are set by the Energy Policy Act, motor efficiency can be further increased by selecting Premium Efficiency motors as specified by the National Electrical Manufacturers Association (NEMA). This can cut the electric motor system demand by as much as 18%.

Savings can be increased further by optimizing system performance through the use of variable frequency drives (VFDs). When system load is known to vary substantially, these flow control systems can be utilized to match system output to system demand, significantly reducing energy usage during partial load hours. By employing high-efficiency motors and VFDs, facility owners can improve environmental conditions, utilize better control of motor-driven processes, and reduce waste output.

- **Install Demand Control Ventilation**

Demand control ventilation (DCV) monitors indoor air CO_2 content as a result of occupancy production levels and uses this data to regulate the amount of outdoor air that is permitted for ventilation. In order to ensure adequate air quality, standard ventilation systems permit outside air based on estimated occupancy levels in CFM, cubic feet per minute/occupant. However, during low occupancy hours, the space may become over ventilated due to decreased CO_2 levels and unnecessary ventilation results in wasted energy. DCV reduces unnecessary outdoor air intake by regulating ventilation based on actual CO_2 levels, saving energy. DCV is most suited for areas where occupancy levels are known to fluctuate considerably such as auditoriums, cafeterias, and gymnasiums.

Install Energy Recovery Ventilators. According to energy recovery equipment manufacturer's typical paybacks are less than 5 years for schools without cooling. The keys to success with ventilation retrofits are going with fewer larger units with long run hours as opposed to several small units with limited run time. Equipment with moisture recovery capabilities would cut humidity up to 50% during the cooling season.

- **Improve/Replace Inefficient Heating Systems**

Replacing an old boiler that is < 70% efficient with a modern 85-90% efficient natural gas-fired furnace alone will reduce heating costs by 15-20%. This combined with additional system improvements and installation of advanced HVAC control mechanisms can result in up to 20%+ heating load reduction.

Because of the high capital cost of new heating systems, some financial analysis should be performed to assess the cost-effectiveness of immediate replacement. If the current system is fairly new, replacement may not be immediately justifiable from a financial standpoint. However, as is the case with cooling systems, early replacement may prove to be a more cost-effective solution than waiting until existing systems fail or reach the end of their estimated useful life.

- **Improve/Replace Inefficient Air Conditioning Systems**

The useful life of a rooftop A/C unit is generally 12-18 years. However, depending on the efficiency, early replacement of outdated, inefficient, split, or packaged rooftop air conditioning units with new A/C systems that are 15% more efficient than 10-15 year old equipments can considerably reduce annual energy consumption. The energy cost savings and maintenance savings offset the high installation cost of a more efficient system. Installing thermostats and/or economizers on new or existing A/C systems will further reduce the cooling demand.

Economizers provide "free" cooling by using controllable dampers that bring in outside air to cool the space when the outdoor temperature or enthalpy is below the building's return air conditions. Although they require operation by a well calibrated and maintained control system, economizers have impressive energy-saving capabilities.

Install Occupancy Controlled/Programmable Thermostats

Combining efficient HVAC equipment with occupancy controlled and programmable thermostats can save a facility up to 10% of its annual heating and cooling costs:

- Areas with unpredictable occupancy on a daily/weekly basis - gym, bathrooms, outdoors: Use an *occupancy controlled thermostat* - a thermostat paired with a sensor and/or door detector to identify movement/occupancy. If occupancy is sensed by the sensor, the thermostat goes into an occupied mode (i.e. programmed set point). If a pre-programmed time frame elapses (i.e. 30 minutes) and no occupancy is sensed during that time, the thermostat goes into an unoccupied mode (e.g., setback set point or off) until occupancy is sensed again. This reduces the overall time the heating or cooling system is running, saving energy.

- Areas with predictable occupancy: e.g.: classrooms, cafeteria, offices: A *programmable thermostat* is recommended. This device is programmed on a schedule to reduce the heating or cooling output of the facility's HVAC systems in relation to its predetermined occupancy schedule. In this way, the thermostat acts to set-back or set-up the facility temperature during unoccupied hours, and re-establish a comfortable facility temperature during business hours. By employing programmable thermostat technology, the heating and cooling system demand coincides with occupancy level, reducing energy usage.

- **Install Vending Misers on Vending Machines**

Vending misers for refrigerated and non-refrigerated vending machines is an often overlooked source of potential savings. Uncontrolled, vending machine lights remain on 24/7, consuming a constant amount of energy year round. By controlling these lights with an occupancy sensor, energy consumption attributed to vending machines can be reduced considerably, in many cases, by as much as 50% and can save up to $150 per machine per year.

In the case of refrigerated vending machines, electric demand can be further reduced by controlling the machines' refrigeration systems. In a manner similar to programmable thermostats, vending misers for refrigerated machines act on a pre-set occupancy schedule to allow a marginal increase in operating temperature during non-business hours. Although products in the machine are delivered to the customer at the same temperature as in an uncontrolled vending machine, products are not being cooled unnecessarily when the machine is not in use, significantly reducing the machine's energy consumption. Because of the relatively low vending miser installation cost and high operating hours of vending machines, this improvement is typically cost-effective with a very short payback period.

- **Install ENERGY STAR® Rated Equipment / Plug Load Control**

Plug loads (computers, televisions, coffee makers, etc.) account for, on average, about 10% of total energy consumption. One of the easiest and most cost-effective energy saving strategies is the reduction of electric usage through installation of efficient appliances and the control of plug loads. In addition to utilizing ENERGY STAR® qualified appliances, greater savings can be realized through the various devices available that control every day plug loads.

By connecting non-critical loads (coffee makers, fans, microwave ovens, etc.) to an occupancy or timer controlled power strip, significant energy savings can be achieved. These savings result not only from the neglect of the user to turn the device off manually, but also from reduction of "phantom load". Phantom load is the small but constant energy draw from many plug-in devices when not in use. By connecting certain appliances to an occupancy controlled power strip, phantom load can be eliminated by cutting power supply to those devices. When replacing or ordering new equipment, emphasize ENERGY STAR® devices when they are available. Also, purchase controlled power strips and connect appropriate devices to those strips to reduce unnecessary consumption due to phantom load and appliances left on. The EPA offers free computer power management software which has saved some districts as much as $75 per computer per year, the software can be found at http://www.energystar.gov/index.cfm?c=power_mgt.pr_power_mgt_low_carbon_join.

IV. Resources:

The State of New Hampshire along with the utility companies offer multiple programs designed to improve the energy efficiency of schools through financial incentives and technical support, including:

Northeast Energy Efficiency Partnerships:

- **Northeast Collaborative for High Performance Schools (NE-CHPS)**
  NE-CHPS is a set of building and design standards for all schools from pre-K through community colleges tailored specifically for NH state code requirements, the New England climate, and the environmental priorities of the region. NH Department of Education offers up to a 3% re-imbursement for New Construction School projects. To learn more about NE-CHPS and incentive programs please visit: http://neep.org/public-policy/hpse/hpse-nechps.

New Hampshire Public Utilities Commission:

- **New Hampshire Pay for Performance**
  This program addresses the energy efficiency improvement needs of the commercial and industrial sector. The Program is implemented through a network of qualified Program Partners. Incentives will be paid out on the following three payment schedule: Incentive #1: Is based on the area of conditioned space in square feet. Incentive #2: Per/kWh saved and Per/MMBTU saved based on projected savings and paid at construction completion. Incentive #3: Per/kWh saved and Per/MMBTU saved based on actual energy savings performance one year post construction. Total performance incentives (#2 and #3) will be capped at $200,000 or 50% of project cost on a per project basis. For more information visit http://nhp4p.com.

- **New Hampshire Public Utilities Commission's Renewable Energy Rebates**
  The Sustainable Energy Division provides an incentive program for solar electric (photovoltaic or PV) arrays and solar thermal systems for domestic hot water, space and process heat, with a capacity of 100 kW or equivalent thermal output or less. The rebate for PV systems as follows: $1.00 per Watt, capped at 25% of the costs of the system or $50,000, whichever is less. For solar hot water (SHW) systems, the base rebate is $0.07 per rated or modeled kBtu/year, capped at 25% of the cost of the facility or $50,000, whichever is less, as a one-time incentive payment. http://www.puc.state.nh.us/Sustainable%20Energy/RenewableEnergyRebates-CI.html.

New Hampshire Community Development Finance Authority:

- **New Hampshire Community Development Finance Authority Revolving Loan Fund**
  The Enterprise Energy Fund is a low-interest loan and grant program available to businesses and nonprofit organizations to help finance energy improvements and renewable energy projects in their buildings. The loans will range from $10,000 to $500,000. Larger amounts will be considered on a case by case basis. The program is available to finance improvements to the overall energy-efficiency performance of buildings owned by businesses and nonprofits, thereby lowering their overall energy costs and the associated carbon emissions. More information about the program can be found on their website www.nhcdfa.org. These activities may include:

  - Improvements to the building's envelope, including air sealing and insulation in the walls, attics and foundations;
  - Improvements to HVAC equipment and air exchange;
  - Installation of renewable energy systems;
  - Improvements to lighting, equipment, and other electrical systems; and
  - Conduction of comprehensive, fuel-blind energy audits.

Public Service of New Hampshire (PSNH):

- **Commercial (Electric) Energy Efficiency Incentive Programs**
  This program targets any commercial/industrial member building a new facility, undergoing a major renovation, or replacing failed (end-of-life) equipment. The program offers prescriptive and custom rebates for lighting and lighting controls, motors, VFDs, HVAC systems, chillers and custom projects. http://www.psnh.com/SaveEnergyMoney/For-Business/Energy-Saving-Programs-and-Incentives.aspx

- **SmartSTART**
  The SmartSTART (Savings Through Affordable Retrofit Technologies) advantage is simple - pay nothing out of pocket to have energy efficiency products and services installed in your building. The Smart Start program is limited to PSNH's municipal customers only and includes schools. The program is available on a first-come, first served basis to projects which have been pre-qualified by PSNH. The cost of the improvements is fronted by PSNH which is then repaid over time by the municipality or school using the savings generated by the products themselves! This program is for lighting and lighting controls, air sealing, insulation and other verifiable energy savings measures which have sufficient kilowatt-hour savings. For more information on this program visit:
  http://www.psnh.com/SaveEnergyMoney/For-Business/Municipal-Smart-Start-Program.aspx

- **Schools Program**
  For major renovation or equipment replacement projects, this program offers prescriptive and custom rebates for energy efficient lighting, motors, HVAC, chillers, and variable frequency drives to towns or cities that install energy efficient equipment at their schools. Financial incentives are available for qualifying energy efficient equipment. Technical assistance is also offered through the Schools Program. http://www.psnh.com/SaveEnergyMoney/Large-Power/Schools-Program.aspx

Unitil:

- **Commercial and Industrial Energy Efficiency Programs**
  Subject to program qualifications and availability of funding - Unitil offers different programs for its commercial, industrial, and institutional customers in New Hampshire: the Small Business Energy Efficiency Program, the Small Commercial and Industrial Program, the Large Commercial and Industrial Program, the Large Commercial and Industrial (C&I) Retrofit Program, and the Large C&I New Construction Program. Rebates are available for various technologies including water heaters, lighting, lighting controls/sensors, chillers, furnaces, boilers, central air conditioners, compressed air, programmable thermostats, energy management systems/building controls, motors, motor VFDs, processing and manufacturing equipment, LED exit signs, commercial cooking and refrigeration equipment. http://www.unitil.com/.

Clean Air – Cool Planet:

- **Community Energy Efficiency**
  CA-CP works with communities throughout the Northeast to find solutions to climate change and build constituencies for effective climate policies and actions. Much of their work focuses on successful models for energy efficiency and renewable energy planning. They advise and partner with citizens, educators, faith groups, small businesses, municipal governments, and other local leaders. They explore cost-effective opportunities that exist for communities to reduce their emissions as well as their vulnerability to climate impacts. One such example is CA-CP's partnership with the University of NH, NH Sustainable Energy Association and UNH Cooperative Extension to create www.myenergyplan.net, a groundbreaking suite of web and outreach tools for individual action used by households, schools and community groups around the northeast. http://www.cleanair-coolplanet.org/for_communities/index.php.

Environmental Protection Agency (EPA):

- **ENERGY STAR Challenge for Schools**
  EPA is challenging school administrators and building managers to improve energy efficiency throughout their facilities. More than 500 school districts across the country are helping to fight climate change by committing to reducing their energy use with help from ENERGY STAR. Schools that take the ENERGY STAR Challenge can use energy tracking tools, technical guidance, case studies and other ENERGY STAR tools and resources to help them improve their energy efficiency. More information can be found at:
  http://yosemite.epa.gov/opa/admpress.nsf/d985312f6895893b852574ac005f1e40/d74f768ecfa9e11f8525762500522260!OpenDocument

For additional assistance in helping you save money and improve school conditions, please call TRC at (603) 766-1913 or (877) 442-9181.

NEW HAMPSHIRE ENERGYSMART SCHOOLS PROGRAM

Energy Benchmarking Report for:

Nancy Loud Elementary School

East Rochester, NH

Period: ***July 1, 2010*** through ***June 30, 2011***

PREPARED BY:

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Table of Contents

I. Introduction

The Sustainable Energy Division of the New Hampshire Public Utilities Commission, with support from the New Hampshire Department of Education has sponsored TRC to develop the New Hampshire ***EnergySmart Schools Program*** to support New Hampshire K-12 public and private schools in the pursuit of energy efficiency and sustainability initiatives.

Energy efficiency has become an increasingly important issue for schools due to tightening budgets and rising energy costs. Since 2003, the prices of natural gas, fuel oil and electricity have increased by 123%, 107% and 32% respectively. Schools that have participated in energy benchmarking programs have shown a decrease in overall energy use by approximately 22% through the adoption of energy efficiency measures.

Tracking and documenting the energy use and associated carbon emissions in the state's K-12 schools will allow New Hampshire to account for the impact of its energy efficiency and renewable energy programs and determine which have the greatest effect. The analysis in this report, provided by the ***EnergySmart Schools Program*** is designed to help you:

- Understand the energy consumption and cost trends at each of your school buildings.
- Learn how your buildings are performing compared to other schools locally and nationally.
- Identify opportunities for improving operations and reducing costs.
- Take advantage of resources to implement efficiency improvements and save money.

The analysis was based on the information provided on the *Building Data Request Form* submitted, which included building descriptions, energy suppliers and other information. The building's utility bills were also used to assess its electricity and heating fuel consumption for the year(s) provided.

The energy performance for your school has been compared to national data for similar school facilities through EPA's ENERGY STAR® Portfolio Manager. Also shown are the five major benchmarks used to analyze building performance, which include: electricity use; heating fuel use; weather-normalized heating fuel use; total cost; and total cost per student, all of which have been normalized for comparison by square footage and weather. As part of the program's focus on sustainability, your school's carbon footprint is also presented.

II. Benchmarking Analysis and Review Results

Building and energy usage of your school was analyzed to assess the basic nature of your energy consumption and utility costs. The Building Data Summary table shown below summarizes this information.

Table 1: Building Data Summary for Nancy Loud Elementary School

Building Data			
District	SAU 54 Rochester School Department	**School Name**	Nancy Loud Elementary School
City	East Rochester	**Zip Code**	03868
Year Built	1980	**Floor Area (sq.ft.)**	16,000
Number of Students	92	**Number of PCs**	21
Weekly Operating Hours	60	**Months School Used**	12
Cooking?	YES	**% AC**	0
Pool Size?	N/A	**Months Pool Used**	0

Utility Data			
Data End Point	6/30/2011	**Total Cost ($)**	21,675
Electric Provider	PSNH	**Natural Gas Provider**	N/A
Electricity Usage (kWh)	54,060	**Electricity Cost ($)**	8,256
Natural Gas Usage (therms)	0	**Natural Gas Cost ($)**	0
Fuel Oil Usage (gal)	6,509	**Fuel Oil Cost ($)**	13,419
Other Fuel Usage (gal)	0	**Other Fuel Cost ($)**	0

Energy Indicators			
EPA Score	79	**Electric Usage (kWh/sq.ft.)**	3.4
Heating Fuel Usage (kBtu/sq.ft.)	56.4	**Weather Adjusted Heating Usage Btu/sq.ft./HDD)**	7.8
Site Energy (kBtu/sq.ft.)	67.9	**Source Energy (kBtu/sq.ft.)**	96

Environmental Impact Indicators			
Greenhouse Gas Emissions			
Last Year Heating Fuel CO_2e (Mt)	66.4	**Last Year Total CO_2e (Mt)**	83.2
Last Year Electricity CO_2e (Mt)	16.8	**CO_2e Efficiency Savings Over Previous Year (Mt)**	-5.9
EPA Target Score			
Target Score	Reached	**Site Energy Reduction Needed (kBtu/sq.ft.)**	N/A - Reached

Figures 1a, 1b, 2a and 2b display the energy use, demand and cost data tracked on a monthly basis. This demonstrates the energy consumption of your building over the course of the year. As a part of the program's focus on sustainability, your school's carbon footprint was also measured and is presented in Figure 3.

Figure 1a. Monthly Electric Use & Max Demand for Nancy Loud Elementary

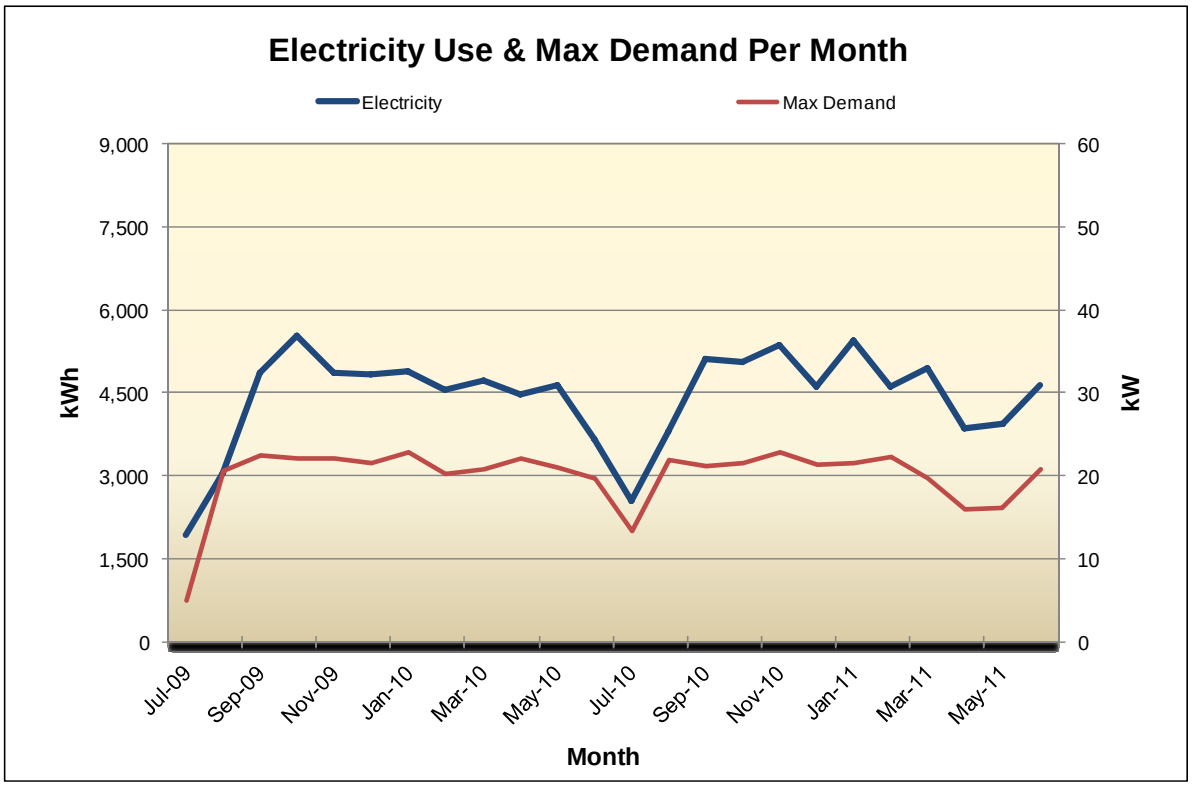


Figure 1b. Monthly Electric Use vs. Cost for Nancy Loud Elementary

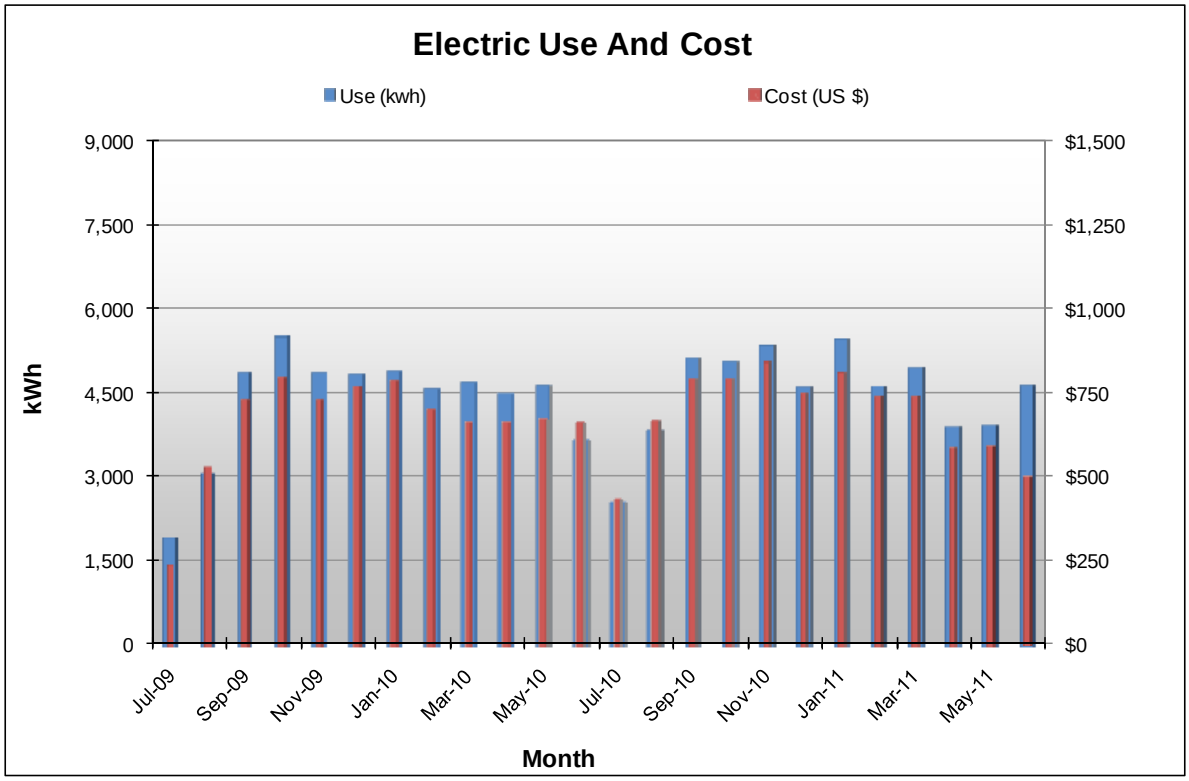


Figure 2a. Monthly Heating Fuel Use for Nancy Loud Elementary

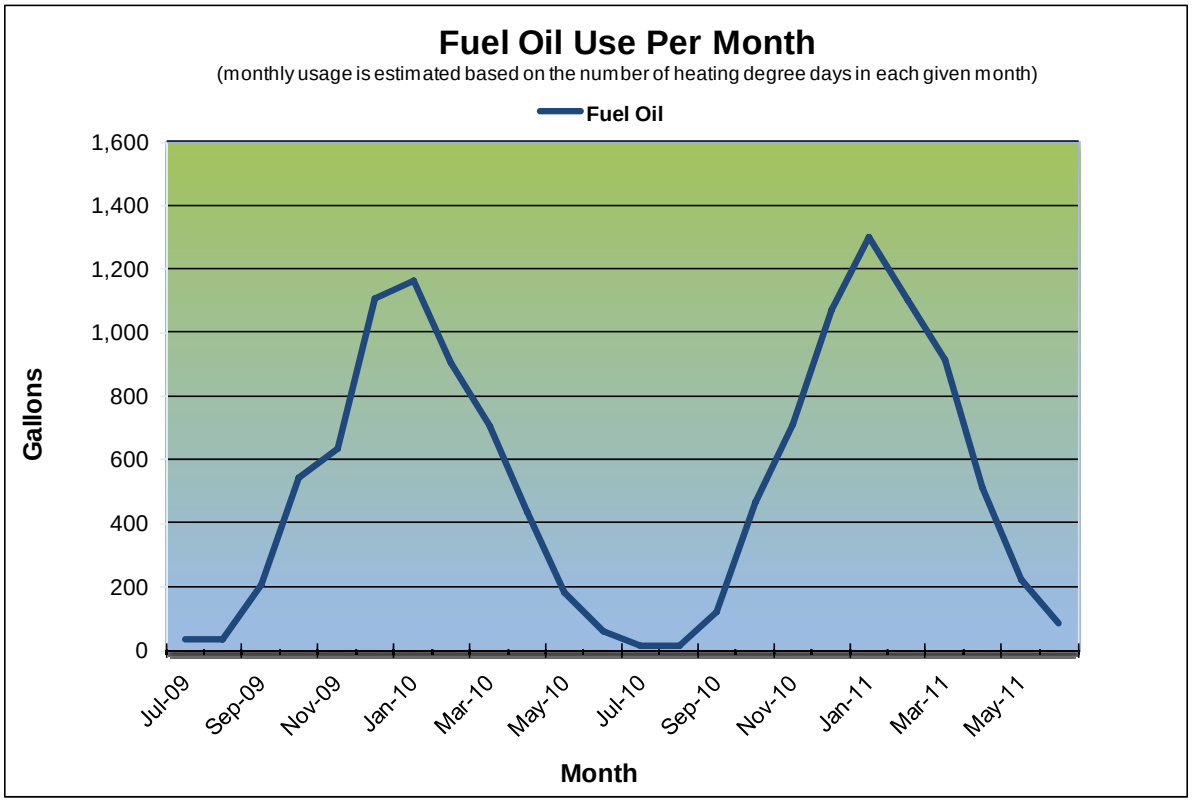


Figure 2b. Monthly Heating Fuel Use vs Cost for Nancy Loud Elementary

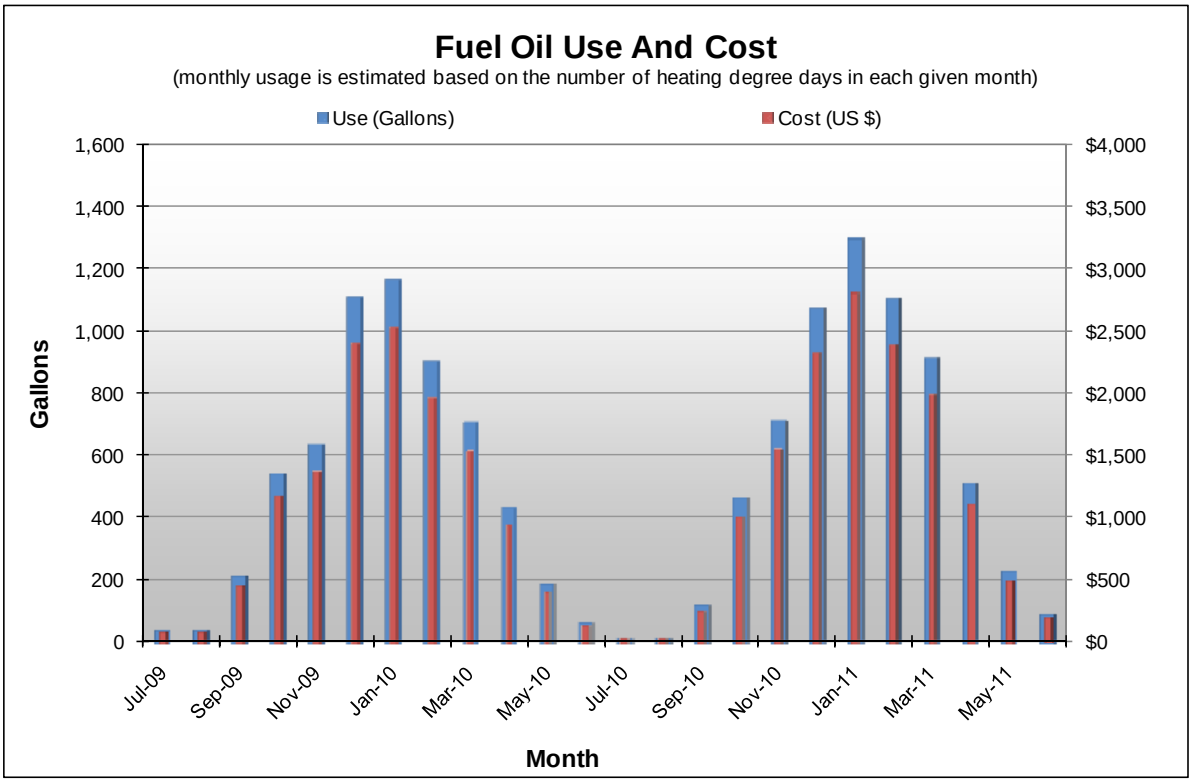
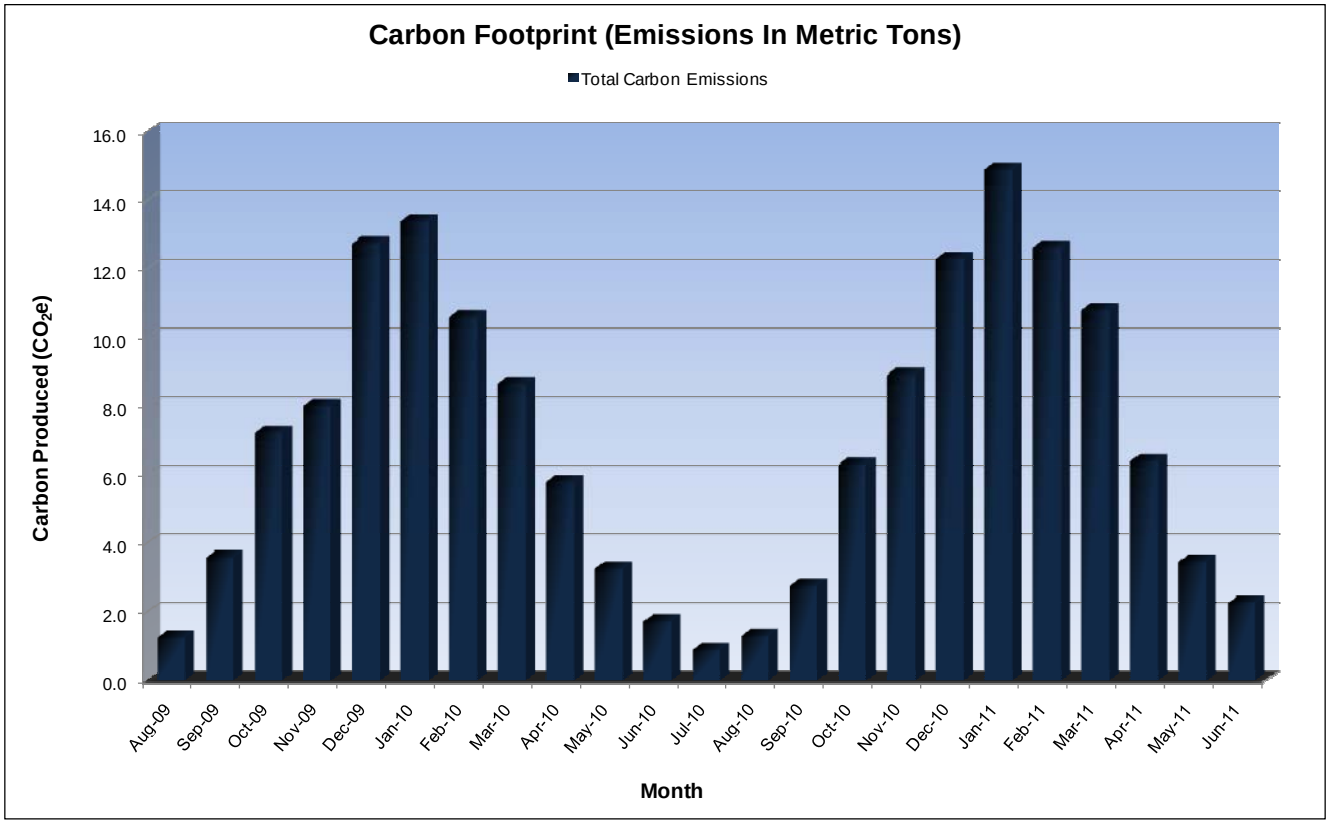


Figure 3. Monthly Greenhouse Gas Emissions for Nancy Loud Elementary



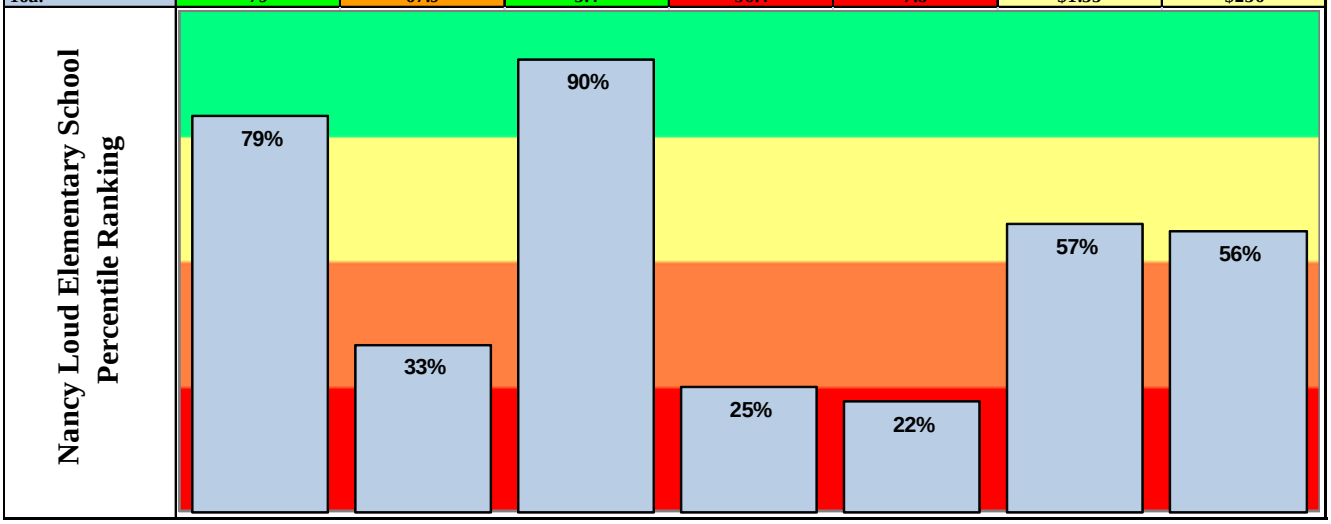
Benchmarking Data

To evaluate the energy and environmental performance of your school, the building data collected above has been compared against two different sets of school energy data: the U.S. Environmental Protection Agency's national data and New Hampshire specific state data. The results are illustrated in Figure 4 on the following page.

This will allow you to assess your building's performance relative to other buildings designed and constructed to the same codes and standards, operating under the same regulations and schedules and similar weather conditions. The indicators are calculated on a *per square foot* or *per student* basis, so you can compare your school to different sized schools.

Figure 4. EnergySmart Schools Benchmarks for Nancy Loud Elementary School

Schools	U.S. EPA Portfolio Manager Score	New Hampshire State Schools (Annual Data)					
		Total Energy Use (kBtu/sq.ft.)	Electric Use (kWh/sq.ft.)	Heating Fuel Use (kBtu/sq.ft.)	Weather Adjusted Heating Fuel Use (Btu/sq.ft./HDD)	Total Energy Cost ($/sq.ft.)	Total Energy Cost ($/student)
NH Average:	50	60.3	5.2	41.7	5.7	$1.42	$256
You:	79	67.9	3.4	56.4	7.8	$1.35	$236



Major Benchmark Indicators

1. Total Energy Use, kBtu/sq.ft.

This indicator shows how much total energy your school consumes each year. It includes the energy used for heating, cooling (if any), lights, cooking, computers, etc.

Your school's total energy use of 67.9 kBtu per square foot per year (kBtu/sq.ft.) is higher (worse) than the New Hampshire K-12 schools state average of 60.3 kBtu/sq.ft. Your total energy use figure is higher than 67% of New Hampshire K-12 schools. The EnergySmart School Report is weather normalized so fuel consumption for heating takes the difference in climate between northern and southern New Hampshire into account.

This is a good indicator of how well, overall, your school is performing. However, it doesn't help you find ***where*** in your building to look for improvement opportunities. Multiple factors included on the following pages can help with that. Analysis of energy consumption for this program does not control for operational variations. An example is an improperly ventilated school may appear to have lower energy consumption. Ventilation systems that are not operating properly result in lower indoor air quality.

2. Electricity Data

Most electric utilities use the following two factors to estimate your electricity bill – Electric Use and Electric Demand.

a. Electric Use, kWh/sq.ft.

This shows how well the building does with its lights, cooling/air conditioners and cafeteria systems (if any), and what's referred to as "plug load." Plug load is anything that plugs into a socket. The major plug loads are generally computers (including monitors, printers and copiers), refrigerators, coffee machines, fans, shop equipment and projectors. If electric consumption is much higher than average, but heating fuel use (see below) is average or better, then focus your efforts on the electric-powered elements.

New Hampshire schools state average electric use is 5.2 kWh per square foot. Your school's electric consumption of 3.4 kWh per square foot this year is lower than 90% of New Hampshire schools benchmarked through the New Hampshire EnergySmart Schools Program.

b. Electric Demand, Watts/sq.ft.

Demand is a measure of the maximum electric draw in kW that your building places on the grid and is measured by adding up the kW draw for a 15 minute period. To give an analogy, if electricity usage is the amount of water going through a hose in gallons, electric demand would be how fast that water flows expressed in gallons per minute. Whichever 15 minute period during your monthly billing cycle places the highest kW demand on the grid is the demand factor applied to your bill. The best way to improve this demand factor is to stagger the times when your electrical systems draw at their maximum or reduce unnecessary electric load altogether.

The average electric demand for New Hampshire schools is 1.9 watts per square foot. Your school's electric demand is 1.4 watts per square foot and is lower than 86% of New Hampshire Schools benchmarked through the New Hampshire EnergySmart Schools Program.

3. Heating Fuel Use, kBtu/sq.ft.

Reviewing these indicators is relatively straightforward. If your school's heating fuel use is much higher than average, an audit of your heating system along with your building envelope - doors, windows, roof - is recommended. This factor is 'fuel-neutral' as it works for either fuel oil or natural gas heating systems.

New Hampshire K-12 schools state average heating fuel use is 41.7 kBtu/sq.ft. or 5.7 Btu/sq.ft./HDD. Your school's heating fuel use of 56.4 kBtu/sq.ft. per year is higher than 75% of other New Hampshire schools in the database. Your school's weather adjusted heating fuel use of 7.8 Btu/sq.ft./HDD is higher than 78% of other New Hampshire schools benchmarked through the New Hampshire EnergySmart Schools Program.

4. Energy Cost, $/sq.ft. & $/student

Cost is the bottom line. These numbers help you understand, in terms of budget, the gain through energy efficiency improvements. New Hampshire K-12 schools state averages $1.42/sq.ft. and $256/student.

Your school's annual energy cost of $1.35 per square foot is lower than 57% of other New Hampshire benchmarked schools. Your school's cost expressed on a per student basis of $236 is lower than 56% of other New Hampshire schools benchmarked through the New Hampshire EnergySmart Schools Program.

5. U.S. EPA *Portfolio Manager* Score

Portfolio Manager is a benchmarking model based on a national set of data from K-12 schools. It is provided by the U.S. Environmental Protection Agency's ENERGY STAR® Program. The impact of factors outside of your control (such as location, occupancy and operating hours) are removed, providing a 1-100 ranking of a school's energy performance relative to the national school building market. A score of 50 represents the national average and a score of 100 is best. Schools that achieve a score of 75 or higher are eligible for EPA's ENERGY STAR® Building Label, the national symbol for protecting the environment through energy efficiency. Districts can achieve ENERGY STAR® Leader Awards in recognition if their buildings, on average, improve by 10%, 20%, 30%, etc. over their baseline year of reported energy use or if the district's overall weighted average *Portfolio Manager* Score is at least a 75.

Your school's *Portfolio Manager* Score of 79 places it higher than 79% of K-12 schools nationwide. As noted above, this rating potentially qualifies your school for the prestigious ENERGY STAR® Label for Buildings.

III. Potential Energy Saving Opportunities

Based on the preceding analysis of your school's energy performance, implementation of the following recommendations can help you save energy and money. The first step is to look at reducing electrical lighting and HVAC consumption (burners, circulators and fans) which typically account for 67% of a building's electric consumption.

- **Perform an Energy Audit on the Building**

An energy audit involves a comprehensive analysis of the building's general characteristics, its energy use and allocation of that use amongst the facility's energy end uses. The goal is to identify sources of potential energy savings. Your auditor should develop a list of recommendations that will result in substantial energy and operational cost savings. These may include, building envelope improvement and mechanical systems, lighting upgrades, equipment replacement and installation of lighting and HVAC control mechanisms, among others.

A good audit should include information specific to each recommendation which *at least* includes approximate annual energy unit and cost savings, demand reduction, installation cost, lifetime cost savings and information related to cost-effectiveness. This will help to prioritize the recommendations based on their energy efficiency and shortest payback.

The recommendations provided in an energy audit report may reduce facility energy bills by 20% or more in addition to improving occupant health and comfort. Following this report, an energy audit is the next step in realizing the full potential of energy savings opportunities.

- **Request Retro-Commissioning**

Retro-commissioning is a detailed process applied to existing facilities aimed at correcting many of the degradations and inefficiencies that are indicative of older and/or poorly performing buildings. Many older buildings tend to be less comfortable and operate less efficiently when not properly commissioned. Retro-commissioning includes a detailed energy audit and focuses on not only potential energy savings but also the interaction of the building's equipments and mechanical systems with an eye toward restoring it to optimal performance.

In contrast to an energy audit, this optimization focuses on operational improvements to existing equipment, rather than replacement. Apart from energy savings, other improvements and benefits include substantial operation and maintenance (O&M) cost savings, improved air quality, occupant comfort, health and safety, equipment controls, and improved system interactivity.

In addition to providing recommendations, retro-commissioning includes implementation of the recommended improvements and hence the cost for retro-commissioning is higher than an audit. However, when the costs of improvements are added to the energy audit cost, prices may be comparable. If high O&M costs or occupant health, comfort and safety are concerns in addition to reduction in energy use, retro-commissioning may be a suitable strategy.

- **Upgrade Lighting Systems**

Lighting typically accounts for 30-60% of all energy consumed in school buildings. Additionally, the electrical energy consumed by lights during the summer creates heat and increases cooling costs.

Nancy Loud Elementary School's electricity consumption is high compared to other schools in the State. Upgraded lighting systems in high consumption areas like classrooms, gymnasiums, libraries, offices, etc. can reduce these costs, improve the lighting quality and increase occupant comfort and productivity.

Over-lit Spaces: Light levels should be recorded in classrooms and hallways to ensure they are not over-lit, 40-50 foot candles are adequate light levels for an instructional space. If classroom light levels are much higher than 50 foot candles, Nancy Loud Elementary School should consider de-lamping classrooms or installing dimming ballasts, which dim the lights when outdoor light levels are adequate. In over-lit hallway spaces photo sensors can be installed to turn lights off completely when light levels exceed a pre-set threshold.

In over-lit spaces a T8 to Super T8 lighting retro-fit can reduce the number of light fixtures needed. Super T8 lamps use between 4 and 7 Watts less electricity than standard T8 lamps, but they produce more light per Watt. In some cases this increase in light per Watt can allow for the removal of an entire lamp, saving 32 Watts. The room characteristics must be factored in before this type of retro-fit. The shape of the space, ceiling height, color of the walls, etc. all need to be taken into account when exploring a de-lamping project. We recommend that before retro-fitting the entire facility, begin by changing one classroom and monitor the comfort level of the occupants at Nancy Loud Elementary School.

Another proven energy reduction measure with a short payback period is to identify any areas where your school may still be using metal halide lighting. Typically metal halide lights are found in gymnasiums or cafeteria areas, many districts have been very satisfied by replacing these lights with high bay T5 lighting fixtures. In addition to the reduced operational wattage, high bay T5 lights turn on instantly, as opposed to metal halide fixtures which have an extended warm up period. The long warm up period associated with metal halides typically leads to the lights being left on all day, at 250 to 400 watts a fixture; the costs begin to add up. Adding occupancy sensors to high bay T5 fixtures further reduces the payback period.

Occupancy Sensors: We recommend that you explore the use of occupancy sensors to ensure that lights are turned off in unoccupied spaces. Lights controlled by occupancy sensors typically run a third of the time when compared with manually controlled lighting. Reduced runtime leads to decreases in both energy usage and operation and maintenance costs. Additionally, a study conducted in Massachusetts found that controlling the security lighting with occupancy sensors reduced vandalism; neighbors and police recognized something wrong when the lights were on in a building that was typically dark and investigated.

To summarize and add a few ways in which Nancy Loud Elementary School may be able to conserve energy and cost through lighting upgrades is to:

- Design light quantity and quality for the task and occupants' needs in that area.
- Maximize lamp and ballast efficiency.
- Activate the power saving features on office equipment such as copiers, printers and fax machines and ensure that they are turned off at the end of the day.
- Use automatic controls to turn lights off or dim lights in unoccupied spaces.
- Establish a maintenance schedule for group re-lamping and fixture cleaning.
- Replace T12 fixtures with the most efficient fixtures which may include T8/super T8/T5 fixtures.
- Replace incandescent lighting with compact fluorescent technology.

- Replace incandescent exit lighting which consumes 30 Watts with LED type exit lights with 1.5 Watts consumption. LED units last up to 10 years, which is a maintenance advantage.
- Install daylight sensors in areas with significant natural light.
- Install occupancy sensors in areas that are often unoccupied.
- Lighting retrofits reduce maintenance costs associated with lighting that is close to end of life.
- Establish a regular cleaning schedule particularly for areas where student safety of low light levels may be a concern, such as shop classes.
- Look to make lamp and fixture selection as uniform as possible to reduce maintenance and inventory overhead.
- Educate students and staff to turn off lights when rooms are unoccupied.

Lighting upgrades seek to reduce the connected electrical load (kW) and energy consumption (kWh) of lighting equipment. Lighting controls can also significantly reduce operating hours and costs by turning off lighting when spaces are unoccupied or sufficiently lit by natural light.

- **Install NEMA Premium Motors and VFDs**

Commercial and industrial electric motor-driven systems consume approximately 23% of all electricity in the U.S., making it the single largest category contributor to electric use in the country. With very high operating hours, the annual energy cost to run a system is more than its installation cost. Even a small increase in the efficiency of an electric motor can result in substantial energy cost savings. Typical opportunities for motor upgrades in schools include: ventilation fans, and heating and cooling system pumps and fans.

Motors with efficiency up to 90% are available to replace the older ones with efficiency less than 75%. Although standards for efficiency of new equipment are set by the Energy Policy Act, motor efficiency can be further increased by selecting Premium Efficiency motors as specified by the National Electrical Manufacturers Association (NEMA). This can cut the electric motor system demand by as much as 18%.

Savings can be increased further by optimizing system performance through the use of variable frequency drives (VFDs). When system load is known to vary substantially, these flow control systems can be utilized to match system output to system demand, significantly reducing energy usage during partial load hours. By employing high-efficiency motors and VFDs, facility owners can improve environmental conditions, utilize better control of motor-driven processes, and reduce waste output.

- **Install Demand Control Ventilation**

Demand control ventilation (DCV) monitors indoor air CO_2 content as a result of occupancy production levels and uses this data to regulate the amount of outdoor air that is permitted for ventilation. In order to ensure adequate air quality, standard ventilation systems permit outside air based on estimated occupancy levels in CFM, cubic feet per minute/occupant. However, during low occupancy hours, the space may become over ventilated due to decreased CO_2 levels and unnecessary ventilation results in wasted energy. DCV reduces unnecessary outdoor air intake by regulating ventilation based on actual CO_2 levels, saving energy. DCV is most suited for areas where occupancy levels are known to fluctuate considerably such as auditoriums, cafeterias, and gymnasiums.

Install Energy Recovery Ventilators. According to energy recovery equipment manufacturer's typical paybacks are less than 5 years for schools without cooling. The keys to success with ventilation retrofits are going with fewer larger units with long run hours as opposed to several small units with limited run time. Equipment with moisture recovery capabilities would cut humidity up to 50% during the cooling season.

- **Improve/Replace Inefficient Heating Systems**

Replacing an old boiler that is < 70% efficient with a modern 85-90% efficient natural gas-fired furnace alone will reduce heating costs by 15-20%. This combined with additional system improvements and installation of advanced HVAC control mechanisms can result in up to 20%+ heating load reduction.

Because of the high capital cost of new heating systems, some financial analysis should be performed to assess the cost-effectiveness of immediate replacement. If the current system is fairly new, replacement may not be immediately justifiable from a financial standpoint. However, as is the case with cooling systems, early replacement may prove to be a more cost-effective solution than waiting until existing systems fail or reach the end of their estimated useful life.

- **Improve/Replace Inefficient Air Conditioning Systems**

The useful life of a rooftop A/C unit is generally 12-18 years. However, depending on the efficiency, early replacement of outdated, inefficient, split, or packaged rooftop air conditioning units with new A/C systems that are 15% more efficient than 10-15 year old equipments can considerably reduce annual energy consumption. The energy cost savings and maintenance savings offset the high installation cost of a more efficient system. Installing thermostats and/or economizers on new or existing A/C systems will further reduce the cooling demand.

Economizers provide "free" cooling by using controllable dampers that bring in outside air to cool the space when the outdoor temperature or enthalpy is below the building's return air conditions. Although they require operation by a well calibrated and maintained control system, economizers have impressive energy-saving capabilities.

Install Occupancy Controlled/Programmable Thermostats

Combining efficient HVAC equipment with occupancy controlled and programmable thermostats can save a facility up to 10% of its annual heating and cooling costs:

- Areas with unpredictable occupancy on a daily/weekly basis - gym, bathrooms, outdoors: Use an *occupancy controlled thermostat* - a thermostat paired with a sensor and/or door detector to identify movement/occupancy. If occupancy is sensed by the sensor, the thermostat goes into an occupied mode (i.e. programmed set point). If a pre-programmed time frame elapses (i.e. 30 minutes) and no occupancy is sensed during that time, the thermostat goes into an unoccupied mode (e.g., setback set point or off) until occupancy is sensed again. This reduces the overall time the heating or cooling system is running, saving energy.

- Areas with predictable occupancy: e.g.: classrooms, cafeteria, offices: A *programmable thermostat* is recommended. This device is programmed on a schedule to reduce the heating or cooling output of the facility's HVAC systems in relation to its predetermined occupancy schedule. In this way, the thermostat acts to set-back or set-up the facility temperature during unoccupied hours, and re-establish a comfortable facility temperature during business hours. By employing programmable thermostat technology, the heating and cooling system demand coincides with occupancy level, reducing energy usage.

- **Install Vending Misers on Vending Machines**

Vending misers for refrigerated and non-refrigerated vending machines is an often overlooked source of potential savings. Uncontrolled, vending machine lights remain on 24/7, consuming a constant amount of energy year round. By controlling these lights with an occupancy sensor, energy consumption attributed to vending machines can be reduced considerably, in many cases, by as much as 50% and can save up to $150 per machine per year.

In the case of refrigerated vending machines, electric demand can be further reduced by controlling the machines' refrigeration systems. In a manner similar to programmable thermostats, vending misers for refrigerated machines act on a pre-set occupancy schedule to allow a marginal increase in operating temperature during non-business hours. Although products in the machine are delivered to the customer at the same temperature as in an uncontrolled vending machine, products are not being cooled unnecessarily when the machine is not in use, significantly reducing the machine's energy consumption. Because of the relatively low vending miser installation cost and high operating hours of vending machines, this improvement is typically cost-effective with a very short payback period.

- **Install ENERGY STAR® Rated Equipment / Plug Load Control**

Plug loads (computers, televisions, coffee makers, etc.) account for, on average, about 10% of total energy consumption. One of the easiest and most cost-effective energy saving strategies is the reduction of electric usage through installation of efficient appliances and the control of plug loads. In addition to utilizing ENERGY STAR® qualified appliances, greater savings can be realized through the various devices available that control every day plug loads.

By connecting non-critical loads (coffee makers, fans, microwave ovens, etc.) to an occupancy or timer controlled power strip, significant energy savings can be achieved. These savings result not only from the neglect of the user to turn the device off manually, but also from reduction of "phantom load". Phantom load is the small but constant energy draw from many plug-in devices when not in use. By connecting certain appliances to an occupancy controlled power strip, phantom load can be eliminated by cutting power supply to those devices. When replacing or ordering new equipment, emphasize ENERGY STAR® devices when they are available. Also, purchase controlled power strips and connect appropriate devices to those strips to reduce unnecessary consumption due to phantom load and appliances left on. The EPA offers free computer power management software which has saved some districts as much as $75 per computer per year, the software can be found at http://www.energystar.gov/index.cfm?c=power_mgt.pr_power_mgt_low_carbon_join.

IV. Resources:

The State of New Hampshire along with the utility companies offer multiple programs designed to improve the energy efficiency of schools through financial incentives and technical support, including:

Northeast Energy Efficiency Partnerships:

- **Northeast Collaborative for High Performance Schools (NE-CHPS)**
  NE-CHPS is a set of building and design standards for all schools from pre-K through community colleges tailored specifically for NH state code requirements, the New England climate, and the environmental priorities of the region. NH Department of Education offers up to a 3% re-imbursement for New Construction School projects. To learn more about NE-CHPS and incentive programs please visit: http://neep.org/public-policy/hpse/hpse-nechps.

New Hampshire Public Utilities Commission:

- **New Hampshire Pay for Performance**
  This program addresses the energy efficiency improvement needs of the commercial and industrial sector. The Program is implemented through a network of qualified Program Partners. Incentives will be paid out on the following three payment schedule: Incentive #1: Is based on the area of conditioned space in square feet. Incentive #2: Per/kWh saved and Per/MMBTU saved based on projected savings and paid at construction completion. Incentive #3: Per/kWh saved and Per/MMBTU saved based on actual energy savings performance one year post construction. Total performance incentives (#2 and #3) will be capped at $200,000 or 50% of project cost on a per project basis. For more information visit http://nhp4p.com.

- **New Hampshire Public Utilities Commission's Renewable Energy Rebates**
  The Sustainable Energy Division provides an incentive program for solar electric (photovoltaic or PV) arrays and solar thermal systems for domestic hot water, space and process heat, with a capacity of 100 kW or equivalent thermal output or less. The rebate for PV systems as follows: $1.00 per Watt, capped at 25% of the costs of the system or $50,000, whichever is less. For solar hot water (SHW) systems, the base rebate is $0.07 per rated or modeled kBtu/year, capped at 25% of the cost of the facility or $50,000, whichever is less, as a one-time incentive payment. http://www.puc.state.nh.us/Sustainable%20Energy/RenewableEnergyRebates-CI.html.

New Hampshire Community Development Finance Authority:

- **New Hampshire Community Development Finance Authority Revolving Loan Fund**
  The Enterprise Energy Fund is a low-interest loan and grant program available to businesses and nonprofit organizations to help finance energy improvements and renewable energy projects in their buildings. The loans will range from $10,000 to $500,000. Larger amounts will be considered on a case by case basis. The program is available to finance improvements to the overall energy-efficiency performance of buildings owned by businesses and nonprofits, thereby lowering their overall energy costs and the associated carbon emissions. More information about the program can be found on their website www.nhcdfa.org. These activities may include:

  - Improvements to the building's envelope, including air sealing and insulation in the walls, attics and foundations;
  - Improvements to HVAC equipment and air exchange;
  - Installation of renewable energy systems;
  - Improvements to lighting, equipment, and other electrical systems; and
  - Conduction of comprehensive, fuel-blind energy audits.

Public Service of New Hampshire (PSNH):

- **Commercial (Electric) Energy Efficiency Incentive Programs**
  This program targets any commercial/industrial member building a new facility, undergoing a major renovation, or replacing failed (end-of-life) equipment. The program offers prescriptive and custom rebates for lighting and lighting controls, motors, VFDs, HVAC systems, chillers and custom projects. http://www.psnh.com/SaveEnergyMoney/For-Business/Energy-Saving-Programs-and-Incentives.aspx

- **SmartSTART**
  The SmartSTART (Savings Through Affordable Retrofit Technologies) advantage is simple - pay nothing out of pocket to have energy efficiency products and services installed in your building. The Smart Start program is limited to PSNH's municipal customers only and includes schools. The program is available on a first-come, first served basis to projects which have been pre-qualified by PSNH. The cost of the improvements is fronted by PSNH which is then repaid over time by the municipality or school using the savings generated by the products themselves! This program is for lighting and lighting controls, air sealing, insulation and other verifiable energy savings measures which have sufficient kilowatt-hour savings. For more information on this program visit:
  http://www.psnh.com/SaveEnergyMoney/For-Business/Municipal-Smart-Start-Program.aspx

- **Schools Program**
  For major renovation or equipment replacement projects, this program offers prescriptive and custom rebates for energy efficient lighting, motors, HVAC, chillers, and variable frequency drives to towns or cities that install energy efficient equipment at their schools. Financial incentives are available for qualifying energy efficient equipment. Technical assistance is also offered through the Schools Program. http://www.psnh.com/SaveEnergyMoney/Large-Power/Schools-Program.aspx

Unitil:

- **Commercial and Industrial Energy Efficiency Programs**
  Subject to program qualifications and availability of funding - Unitil offers different programs for its commercial, industrial, and institutional customers in New Hampshire: the Small Business Energy Efficiency Program, the Small Commercial and Industrial Program, the Large Commercial and Industrial Program, the Large Commercial and Industrial (C&I) Retrofit Program, and the Large C&I New Construction Program. Rebates are available for various technologies including water heaters, lighting, lighting controls/sensors, chillers, furnaces, boilers, central air conditioners, compressed air, programmable thermostats, energy management systems/building controls, motors, motor VFDs, processing and manufacturing equipment, LED exit signs, commercial cooking and refrigeration equipment. http://www.unitil.com/.

Clean Air – Cool Planet:

- **Community Energy Efficiency**
  CA-CP works with communities throughout the Northeast to find solutions to climate change and build constituencies for effective climate policies and actions. Much of their work focuses on successful models for energy efficiency and renewable energy planning. They advise and partner with citizens, educators, faith groups, small businesses, municipal governments, and other local leaders. They explore cost-effective opportunities that exist for communities to reduce their emissions as well as their vulnerability to climate impacts. One such example is CA-CP's partnership with the University of NH, NH Sustainable Energy Association and UNH Cooperative Extension to create www.myenergyplan.net, a groundbreaking suite of web and outreach tools for individual action used by households, schools and community groups around the northeast. http://www.cleanair-coolplanet.org/for_communities/index.php.

Environmental Protection Agency (EPA):

- **ENERGY STAR Challenge for Schools**
  EPA is challenging school administrators and building managers to improve energy efficiency throughout their facilities. More than 500 school districts across the country are helping to fight climate change by committing to reducing their energy use with help from ENERGY STAR. Schools that take the ENERGY STAR Challenge can use energy tracking tools, technical guidance, case studies and other ENERGY STAR tools and resources to help them improve their energy efficiency. More information can be found at:
  http://yosemite.epa.gov/opa/admpress.nsf/d985312f6895893b852574ac005f1e40/d74f768ecfa9e11f8525762500522260!OpenDocument

For additional assistance in helping you save money and improve school conditions, please call TRC at (603) 766-1913 or (877) 442-9181.

NEW HAMPSHIRE ENERGYSMART SCHOOLS PROGRAM

Energy Benchmarking Report for:

McClelland Elementary School

Rochester, NH

Period: ***July 1, 2010*** through ***June 30, 2011***

PREPARED BY:

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Table of Contents

I. Introduction

The Sustainable Energy Division of the New Hampshire Public Utilities Commission, with support from the New Hampshire Department of Education has sponsored TRC to develop the New Hampshire ***EnergySmart Schools Program*** to support New Hampshire K-12 public and private schools in the pursuit of energy efficiency and sustainability initiatives.

Energy efficiency has become an increasingly important issue for schools due to tightening budgets and rising energy costs. Since 2003, the prices of natural gas, fuel oil and electricity have increased by 123%, 107% and 32% respectively. Schools that have participated in energy benchmarking programs have shown a decrease in overall energy use by approximately 22% through the adoption of energy efficiency measures.

Tracking and documenting the energy use and associated carbon emissions in the state's K-12 schools will allow New Hampshire to account for the impact of its energy efficiency and renewable energy programs and determine which have the greatest effect. The analysis in this report, provided by the ***EnergySmart Schools Program*** is designed to help you:

- Understand the energy consumption and cost trends at each of your school buildings.
- Learn how your buildings are performing compared to other schools locally and nationally.
- Identify opportunities for improving operations and reducing costs.
- Take advantage of resources to implement efficiency improvements and save money.

The analysis was based on the information provided on the *Building Data Request Form* submitted, which included building descriptions, energy suppliers and other information. The building's utility bills were also used to assess its electricity and heating fuel consumption for the year(s) provided.

The energy performance for your school has been compared to national data for similar school facilities through EPA's ENERGY STAR® Portfolio Manager. Also shown are the five major benchmarks used to analyze building performance, which include: electricity use; heating fuel use; weather-normalized heating fuel use; total cost; and total cost per student, all of which have been normalized for comparison by square footage and weather. As part of the program's focus on sustainability, your school's carbon footprint is also presented.

II. Benchmarking Analysis and Review Results

Building and energy usage of your school was analyzed to assess the basic nature of your energy consumption and utility costs. The Building Data Summary table shown below summarizes this information.

Table 1: Building Data Summary for McClelland Elementary School

Building Data			
District	SAU 54 Rochester School Department	**School Name**	McClelland Elementary School
City	Rochester	**Zip Code**	03867
Year Built	1957	**Floor Area (sq.ft.)**	83,800
Number of Students	407	**Number of PCs**	66
Weekly Operating Hours	60	**Months School Used**	12
Cooking?	YES	**% AC**	10
Pool Size?	N/A	**Months Pool Used**	0

Utility Data			
Data End Point	6/30/2011	**Total Cost ($)**	58,033
Electric Provider	PSNH	**Natural Gas Provider**	Unitil
Electricity Usage (kWh)	219,840	**Electricity Cost ($)**	31,227
Natural Gas Usage (therms)	18,709	**Natural Gas Cost ($)**	26,806
Fuel Oil Usage (gal)	0	**Fuel Oil Cost ($)**	0
Other Fuel Usage (gal)	0	**Other Fuel Cost ($)**	0

Energy Indicators			
EPA Score	96	**Electric Usage (kWh/sq.ft.)**	2.6
Heating Fuel Usage (kBtu/sq.ft.)	22.3	**Weather Adjusted Heating Usage Btu/sq.ft./HDD)**	3.1
Site Energy (kBtu/sq.ft.)	31.3	**Source Energy (kBtu/sq.ft.)**	53

Environmental Impact Indicators			
Greenhouse Gas Emissions			
Last Year Heating Fuel CO_2e (Mt)	99.6	**Last Year Total CO_2e (Mt)**	167.7
Last Year Electricity CO_2e (Mt)	68.1	**CO_2e Efficiency Savings Over Previous Year**	-9.3
EPA Target Score			
Target Score	Reached	**Site Energy Reduction Needed (kBtu/sq.ft.)**	N/A - Reached

Figures 1a, 1b, 2a and 2b display the energy use, demand and cost data tracked on a monthly basis. This demonstrates the energy consumption of your building over the course of the year. As a part of the program's focus on sustainability, your school's carbon footprint was also measured and is presented in Figure 3.

Figure 1a. Monthly Electric Use & Max Demand for McClelland Elementary

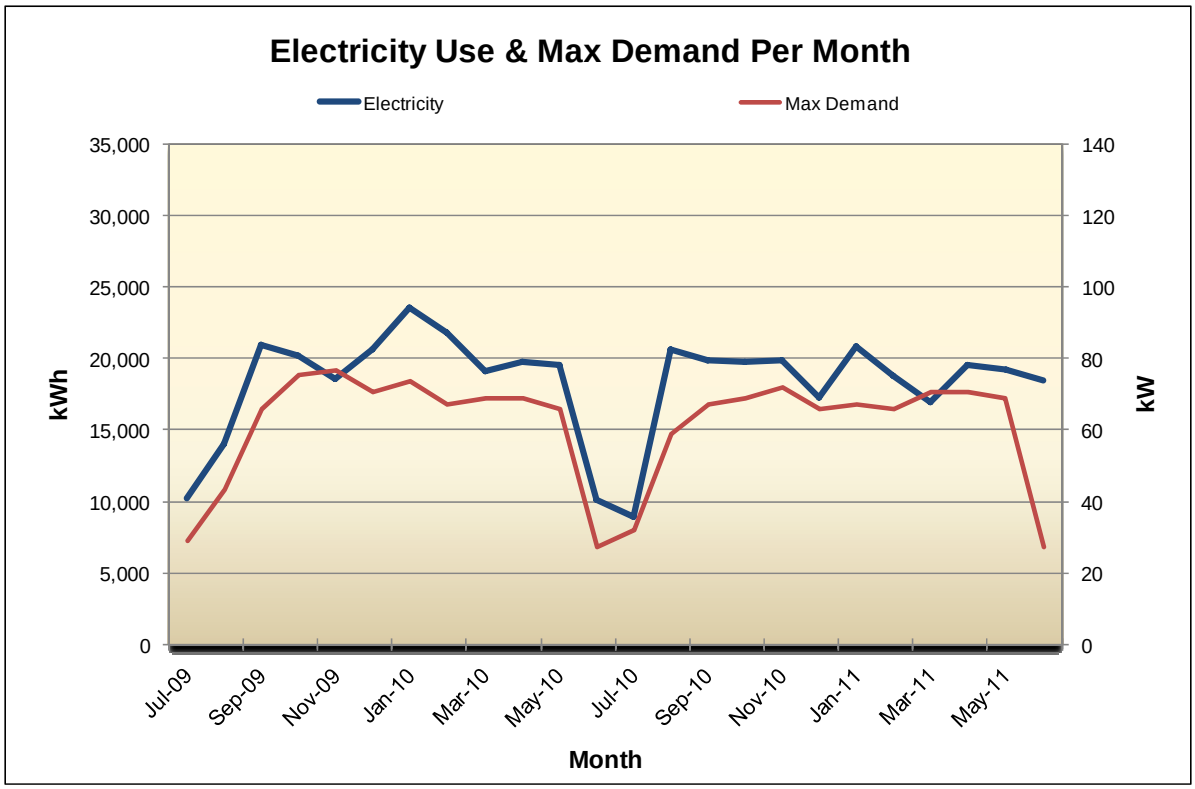


Figure 1b. Monthly Electric Use vs. Cost for McClelland Elementary

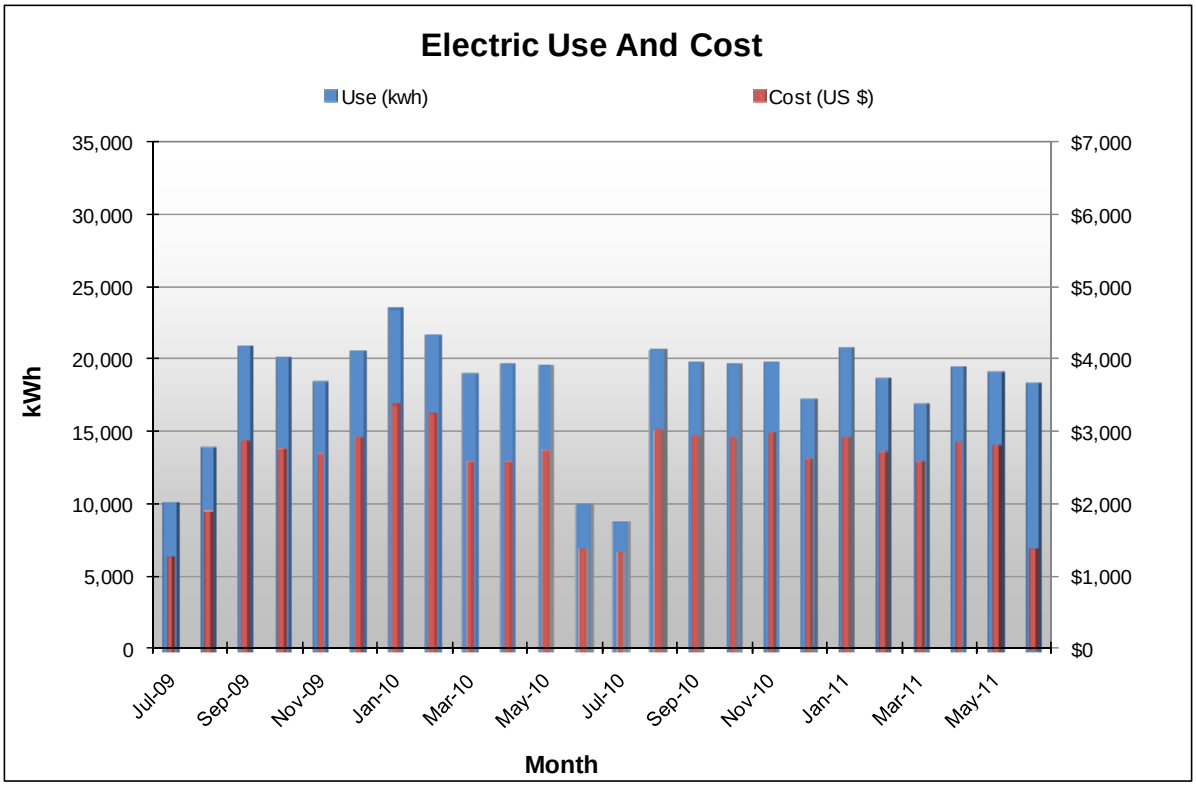


Figure 2a. Monthly Natural Gas Use for McClelland Elementary

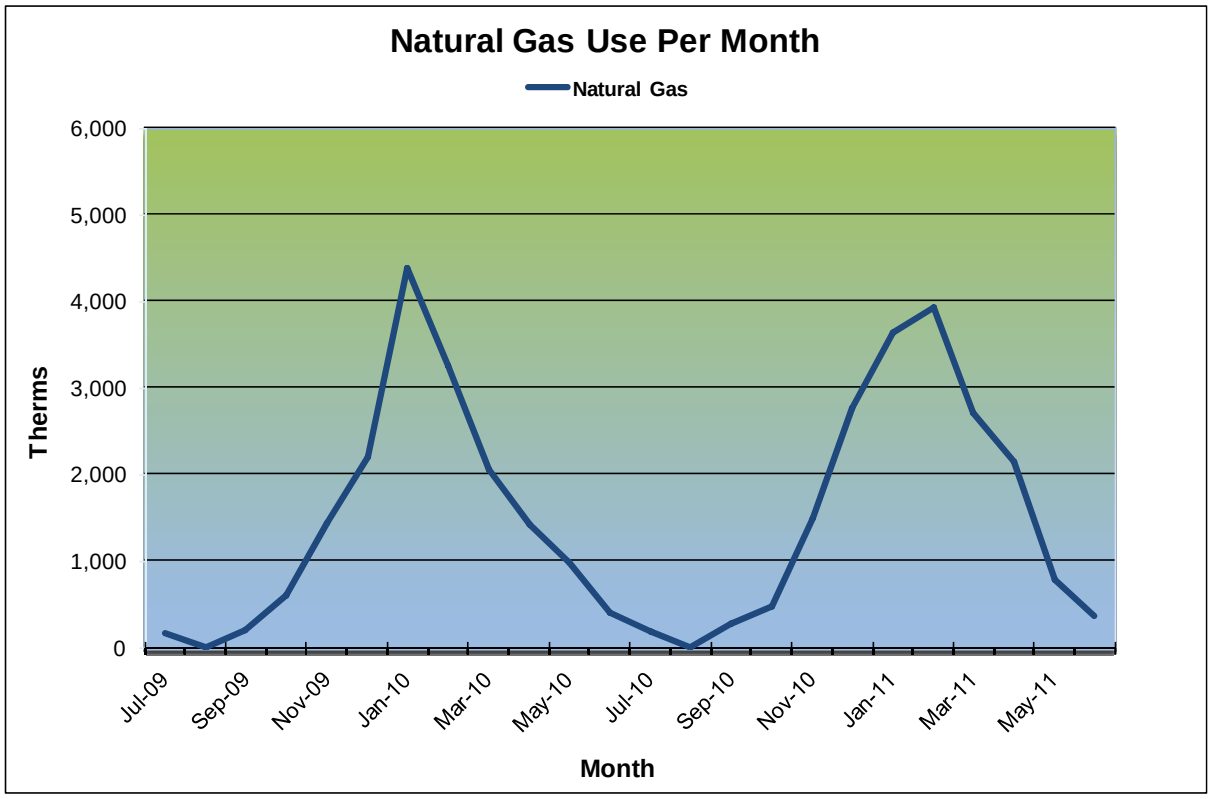


Figure 2b. Monthly Natural Gas Use vs Cost for McClelland Elementary

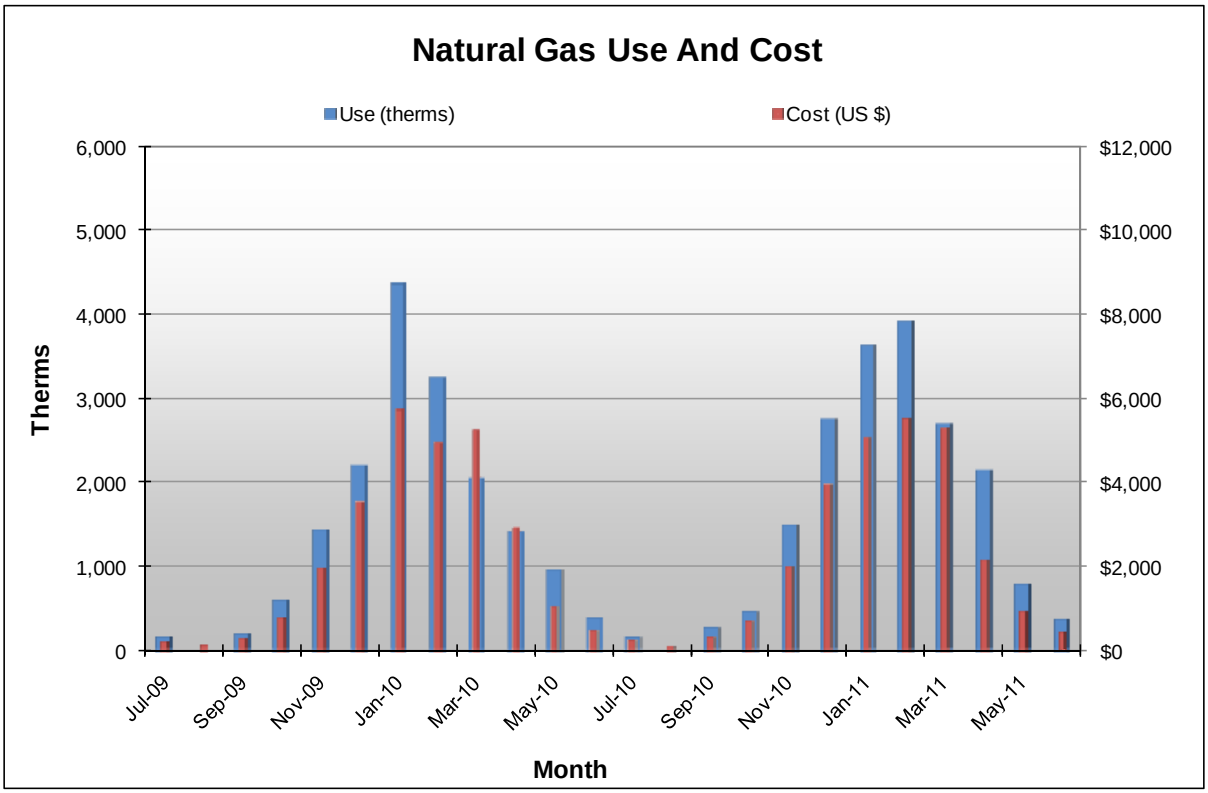
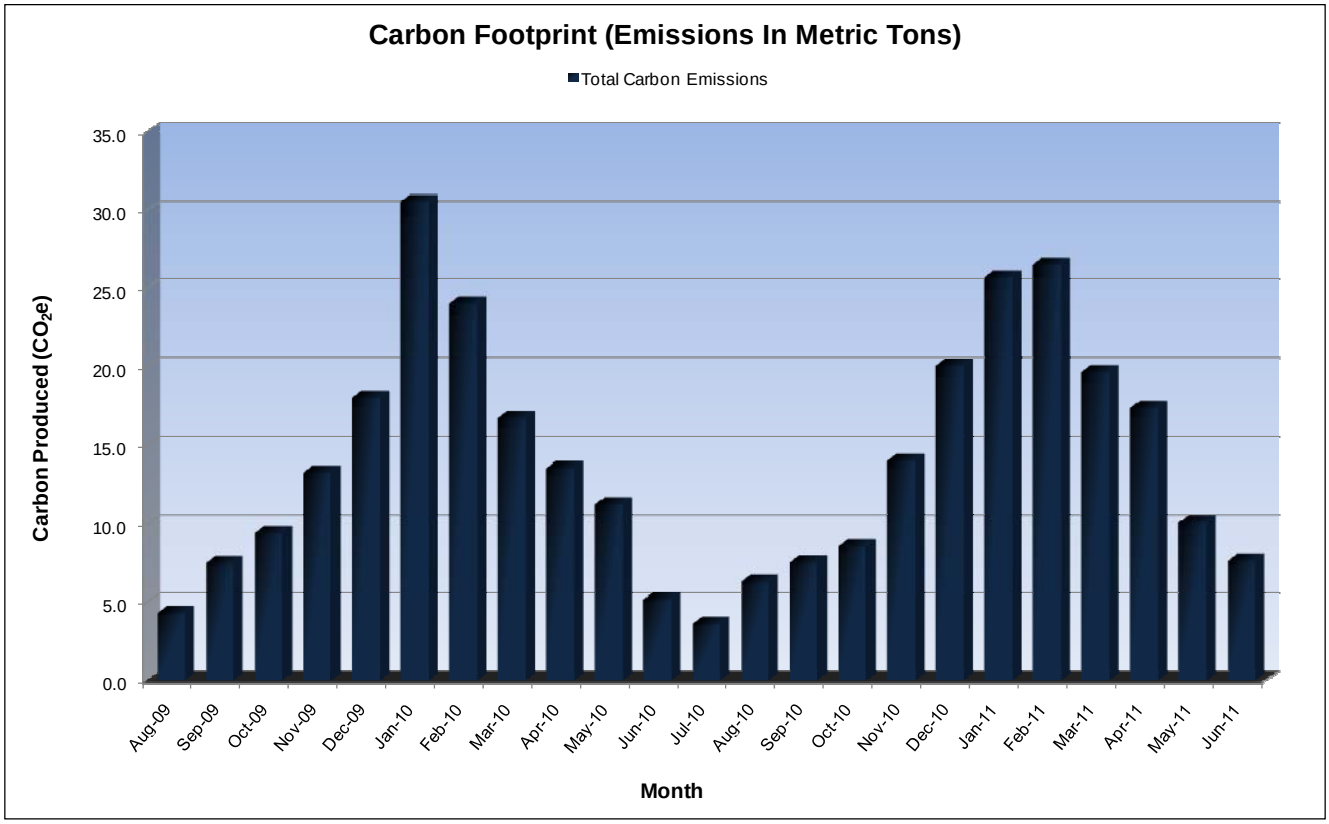


Figure 3. Monthly Greenhouse Gas Emissions for McClelland Elementary School



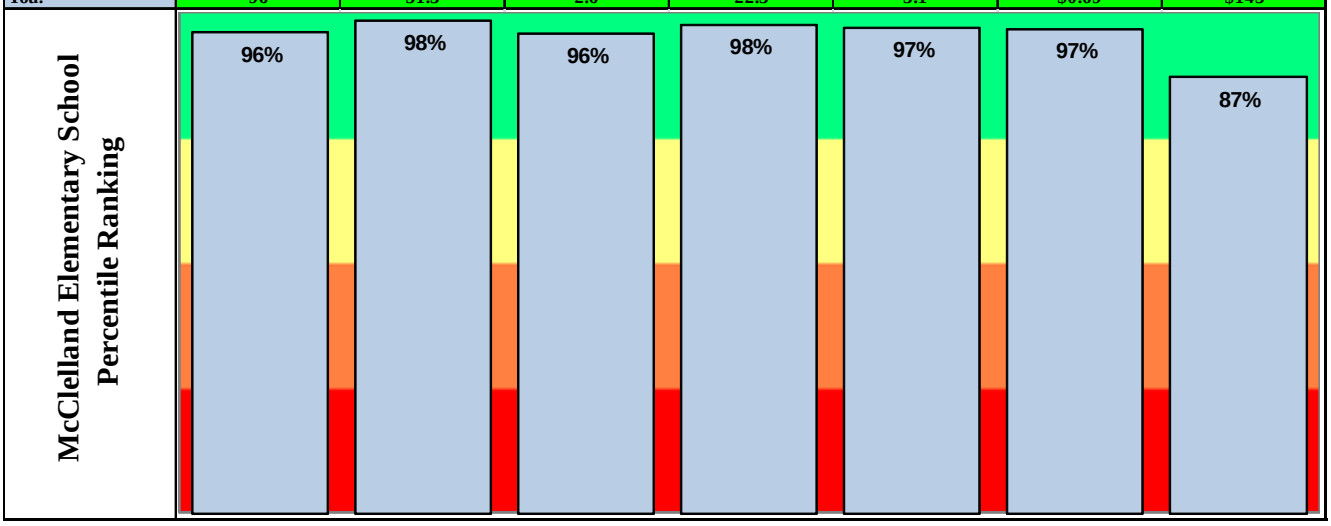
Benchmarking Data

To evaluate the energy and environmental performance of your school, the building data collected above has been compared against two different sets of school energy data: the U.S. Environmental Protection Agency's national data and New Hampshire specific state data. The results are illustrated in Figure 4 on the following page.

This will allow you to assess your building's performance relative to other buildings designed and constructed to the same codes and standards, operating under the same regulations and schedules and similar weather conditions. The indicators are calculated on a *per square foot* or *per student* basis, so you can compare your school to different sized schools.

Figure 4. EnergySmart Schools Benchmarks for McClelland Elementary School

Schools	U.S. EPA Portfolio Manager Score	New Hampshire State Schools (Annual Data)					
		Total Energy Use (kBtu/sq.ft.)	Electric Use (kWh/sq.ft.)	Heating Fuel Use (kBtu/sq.ft.)	Weather Adjusted Heating Fuel Use (Btu/sq.ft./HDD)	Total Energy Cost ($/sq.ft.)	Total Energy Cost ($/student)
NH Average:	50	60.3	5.2	41.7	5.7	$1.42	$256
You:	96	31.3	2.6	22.3	3.1	$0.69	$143



Major Benchmark Indicators

1. Total Energy Use, kBtu/sq.ft.

This indicator shows how much total energy your school consumes each year. It includes the energy used for heating, cooling (if any), lights, cooking, computers, etc.

Your school's total energy use of 31.3 kBtu per square foot per year (kBtu/sq.ft.) is significantly better than the New Hampshire K-12 schools state average of 60.3 kBtu/sq.ft. Your total energy use figure is lower than 98% of New Hampshire K-12 schools. The EnergySmart School Report is weather normalized so fuel consumption for heating takes the difference in climate between northern and southern New Hampshire into account.

This is a good indicator of how well, overall, your school is performing. However, it doesn't help you find ***where*** in your building to look for improvement opportunities. Multiple factors included on the following pages can help with that. Analysis of energy consumption for this program does not control for operational variations. An example is an improperly ventilated school may appear to have lower energy consumption. Ventilation systems that are not operating properly result in lower indoor air quality.

2. Electricity Data

Most electric utilities use the following two factors to estimate your electricity bill – Electric Use and Electric Demand.

a. Electric Use, kWh/sq.ft.

This shows how well the building does with its lights, cooling/air conditioners and cafeteria systems (if any), and what's referred to as "plug load." Plug load is anything that plugs into a socket. The major plug loads are generally computers (including monitors, printers and copiers), refrigerators, coffee machines, fans, shop equipment and projectors. If electric consumption is much higher than average, but heating fuel use (see below) is average or better, then focus your efforts on the electric-powered elements.

New Hampshire schools state average electric use is 5.2 kWh per square foot. Your school's electric consumption of 2.6 kWh per square foot this year is lower than 96% of New Hampshire schools benchmarked through the New Hampshire EnergySmart Schools Program.

b. Electric Demand, Watts/sq.ft.

Demand is a measure of the maximum electric draw in kW that your building places on the grid and is measured by adding up the kW draw for a 15 minute period. To give an analogy, if electricity usage is the amount of water going through a hose in gallons, electric demand would be how fast that water flows expressed in gallons per minute. Whichever 15 minute period during your monthly billing cycle places the highest kW demand on the grid is the demand factor applied to your bill. The best way to improve this demand factor is to stagger the times when your electrical systems draw at their maximum or reduce unnecessary electric load altogether.

The average electric demand for New Hampshire schools is 1.9 watts per square foot. Your school's electric demand is 0.86 watts per square foot and is lower than 98% of New Hampshire Schools benchmarked through the New Hampshire EnergySmart Schools Program.

3. Heating Fuel Use, kBtu/sq.ft.

Reviewing these indicators is relatively straightforward. If your school's heating fuel use is much higher than average, an audit of your heating system along with your building envelope - doors, windows, roof - is recommended. This factor is 'fuel-neutral' as it works for either fuel oil or natural gas heating systems.

New Hampshire K-12 schools state average heating fuel use is 41.7 kBtu/sq.ft. or 5.7 Btu/sq.ft./HDD. Your school's heating fuel use of 22.3 kBtu/sq.ft. per year is lower than 98% of other New Hampshire schools in the database. Your school's weather adjusted heating fuel use of 3.1 Btu/sq.ft./HDD is lower than 97% of other New Hampshire schools benchmarked through the New Hampshire EnergySmart Schools Program.

4. Energy Cost, $/sq.ft. & $/student

Cost is the bottom line. These numbers help you understand, in terms of budget, the gain through energy efficiency improvements. New Hampshire K-12 schools state averages $1.42/sq.ft. and $256/student.

Your school's annual energy cost of $0.69 per square foot is lower than 97% of other New Hampshire benchmarked schools. Your school's cost expressed on a per student basis of $143 is lower than 87% of other New Hampshire schools benchmarked through the New Hampshire EnergySmart Schools Program.

5. U.S. EPA *Portfolio Manager* Score

Portfolio Manager is a benchmarking model based on a national set of data from K-12 schools. It is provided by the U.S. Environmental Protection Agency's ENERGY STAR® Program. The impact of factors outside of your control (such as location, occupancy and operating hours) are removed, providing a 1-100 ranking of a school's energy performance relative to the national school building market. A score of 50 represents the national average and a score of 100 is best. Schools that achieve a score of 75 or higher are eligible for EPA's ENERGY STAR® Building Label, the national symbol for protecting the environment through energy efficiency. Districts can achieve ENERGY STAR® Leader Awards in recognition if their buildings, on average, improve by 10%, 20%, 30%, etc. over their baseline year of reported energy use or if the district's overall weighted average *Portfolio Manager* Score is at least a 75.

Your school's *Portfolio Manager* Score of 96 places it higher than 96% of K-12 schools nationwide. As noted above, this rating potentially qualifies your school for the prestigious ENERGY STAR® Label for Buildings.

III. Potential Energy Saving Opportunities

Based on the preceding analysis of your school's energy performance, implementation of the following recommendations can help you save energy and money. The first step is to look at reducing electrical lighting and HVAC consumption (burners, circulators and fans) which typically account for 67% of a building's electric consumption.

- **Perform an Energy Audit on the Building**

An energy audit involves a comprehensive analysis of the building's general characteristics, its energy use and allocation of that use amongst the facility's energy end uses. The goal is to identify sources of potential energy savings. Your auditor should develop a list of recommendations that will result in substantial energy and operational cost savings. These may include, building envelope improvement and mechanical systems, lighting upgrades, equipment replacement and installation of lighting and HVAC control mechanisms, among others.

A good audit should include information specific to each recommendation which *at least* includes approximate annual energy unit and cost savings, demand reduction, installation cost, lifetime cost savings and information related to cost-effectiveness. This will help to prioritize the recommendations based on their energy efficiency and shortest payback.

The recommendations provided in an energy audit report may reduce facility energy bills by 20% or more in addition to improving occupant health and comfort. Following this report, an energy audit is the next step in realizing the full potential of energy savings opportunities.

- **Request Retro-Commissioning**

Retro-commissioning is a detailed process applied to existing facilities aimed at correcting many of the degradations and inefficiencies that are indicative of older and/or poorly performing buildings. Many older buildings tend to be less comfortable and operate less efficiently when not properly commissioned. Retro-commissioning includes a detailed energy audit and focuses on not only potential energy savings but also the interaction of the building's equipments and mechanical systems with an eye toward restoring it to optimal performance.

In contrast to an energy audit, this optimization focuses on operational improvements to existing equipment, rather than replacement. Apart from energy savings, other improvements and benefits include substantial operation and maintenance (O&M) cost savings, improved air quality, occupant comfort, health and safety, equipment controls, and improved system interactivity.

In addition to providing recommendations, retro-commissioning includes implementation of the recommended improvements and hence the cost for retro-commissioning is higher than an audit. However, when the costs of improvements are added to the energy audit cost, prices may be comparable. If high O&M costs or occupant health, comfort and safety are concerns in addition to reduction in energy use, retro-commissioning may be a suitable strategy.

- **Upgrade Lighting Systems**

Lighting typically accounts for 30-60% of all energy consumed in school buildings. Additionally, the electrical energy consumed by lights during the summer creates heat and increases cooling costs.

McClelland Elementary School's electricity significantly low (better) compared to other schools in the State. Even so, upgraded lighting systems in high consumption areas like classrooms, gymnasiums, libraries, offices, etc. can reduce costs, improve the lighting quality and increase occupant comfort and productivity.

Over-lit Spaces: Light levels should be recorded in classrooms and hallways to ensure they are not over-lit, 40-50 foot candles are adequate light levels for an instructional space. If classroom light levels are much higher than 50 foot candles, McClelland Elementary School should consider de-lamping classrooms or installing dimming ballasts, which dim the lights when outdoor light levels are adequate. In over-lit hallway spaces photo sensors can be installed to turn lights off completely when light levels exceed a pre-set threshold.

In over-lit spaces a T8 to Super T8 lighting retro-fit can reduce the number of light fixtures needed. Super T8 lamps use between 4 and 7 Watts less electricity than standard T8 lamps, but they produce more light per Watt. In some cases this increase in light per Watt can allow for the removal of an entire lamp, saving 32 Watts. The room characteristics must be factored in before this type of retro-fit. The shape of the space, ceiling height, color of the walls, etc. all need to be taken into account when exploring a de-lamping project. We recommend that before retro-fitting the entire facility, begin by changing one classroom and monitor the comfort level of the occupants at McClelland Elementary School.

Another proven energy reduction measure with a short payback period is to identify any areas where your school may still be using metal halide lighting. Typically metal halide lights are found in gymnasiums or cafeteria areas, many districts have been very satisfied by replacing these lights with high bay T5 lighting fixtures. In addition to the reduced operational wattage, high bay T5 lights turn on instantly, as opposed to metal halide fixtures which have an extended warm up period. The long warm up period associated with metal halides typically leads to the lights being left on all day, at 250 to 400 watts a fixture; the costs begin to add up. Adding occupancy sensors to high bay T5 fixtures further reduces the payback period.

Occupancy Sensors: We recommend that you explore the use of occupancy sensors to ensure that lights are turned off in unoccupied spaces. Lights controlled by occupancy sensors typically run a third of the time when compared with manually controlled lighting. Reduced runtime leads to decreases in both energy usage and operation and maintenance costs. Additionally, a study conducted in Massachusetts found that controlling the security lighting with occupancy sensors reduced vandalism; neighbors and police recognized something wrong when the lights were on in a building that was typically dark and investigated.

To summarize and add a few ways in which McClelland Elementary School may be able to conserve energy and cost through lighting upgrades is to:

- Design light quantity and quality for the task and occupants' needs in that area.
- Maximize lamp and ballast efficiency.
- Activate the power saving features on office equipment such as copiers, printers and fax machines and ensure that they are turned off at the end of the day.
- Use automatic controls to turn lights off or dim lights in unoccupied spaces.
- Establish a maintenance schedule for group re-lamping and fixture cleaning.
- Replace T12 fixtures with the most efficient fixtures which may include T8/super T8/T5 fixtures.
- Replace incandescent lighting with compact fluorescent technology.

- Replace incandescent exit lighting which consumes 30 Watts with LED type exit lights with 1.5 Watts consumption. LED units last up to 10 years, which is a maintenance advantage.
- Install daylight sensors in areas with significant natural light.
- Install occupancy sensors in areas that are often unoccupied.
- Lighting retrofits reduce maintenance costs associated with lighting that is close to end of life.
- Establish a regular cleaning schedule particularly for areas where student safety of low light levels may be a concern, such as shop classes.
- Look to make lamp and fixture selection as uniform as possible to reduce maintenance and inventory overhead.
- Educate students and staff to turn off lights when rooms are unoccupied.

Lighting upgrades seek to reduce the connected electrical load (kW) and energy consumption (kWh) of lighting equipment. Lighting controls can also significantly reduce operating hours and costs by turning off lighting when spaces are unoccupied or sufficiently lit by natural light.

- **Install NEMA Premium Motors and VFDs**

Commercial and industrial electric motor-driven systems consume approximately 23% of all electricity in the U.S., making it the single largest category contributor to electric use in the country. With very high operating hours, the annual energy cost to run a system is more than its installation cost. Even a small increase in the efficiency of an electric motor can result in substantial energy cost savings. Typical opportunities for motor upgrades in schools include: ventilation fans, and heating and cooling system pumps and fans.

Motors with efficiency up to 90% are available to replace the older ones with efficiency less than 75%. Although standards for efficiency of new equipment are set by the Energy Policy Act, motor efficiency can be further increased by selecting Premium Efficiency motors as specified by the National Electrical Manufacturers Association (NEMA). This can cut the electric motor system demand by as much as 18%.

Savings can be increased further by optimizing system performance through the use of variable frequency drives (VFDs). When system load is known to vary substantially, these flow control systems can be utilized to match system output to system demand, significantly reducing energy usage during partial load hours. By employing high-efficiency motors and VFDs, facility owners can improve environmental conditions, utilize better control of motor-driven processes, and reduce waste output.

- **Install Demand Control Ventilation**

Demand control ventilation (DCV) monitors indoor air CO_2 content as a result of occupancy production levels and uses this data to regulate the amount of outdoor air that is permitted for ventilation. In order to ensure adequate air quality, standard ventilation systems permit outside air based on estimated occupancy levels in CFM, cubic feet per minute/occupant. However, during low occupancy hours, the space may become over ventilated due to decreased CO_2 levels and unnecessary ventilation results in wasted energy. DCV reduces unnecessary outdoor air intake by regulating ventilation based on actual CO_2 levels, saving energy. DCV is most suited for areas where occupancy levels are known to fluctuate considerably such as auditoriums, cafeterias, and gymnasiums.

Install Energy Recovery Ventilators. According to energy recovery equipment manufacturer's typical paybacks are less than 5 years for schools without cooling. The keys to success with ventilation retrofits are going with fewer larger units with long run hours as opposed to several small units with limited run time. Equipment with moisture recovery capabilities would cut humidity up to 50% during the cooling season.

- **Improve/Replace Inefficient Heating Systems**

Replacing an old boiler that is < 70% efficient with a modern 85-90% efficient natural gas-fired furnace alone will reduce heating costs by 15-20%. This combined with additional system improvements and installation of advanced HVAC control mechanisms can result in up to 20%+ heating load reduction.

Because of the high capital cost of new heating systems, some financial analysis should be performed to assess the cost-effectiveness of immediate replacement. If the current system is fairly new, replacement may not be immediately justifiable from a financial standpoint. However, as is the case with cooling systems, early replacement may prove to be a more cost-effective solution than waiting until existing systems fail or reach the end of their estimated useful life.

- **Improve/Replace Inefficient Air Conditioning Systems**

The useful life of a rooftop A/C unit is generally 12-18 years. However, depending on the efficiency, early replacement of outdated, inefficient, split, or packaged rooftop air conditioning units with new A/C systems that are 15% more efficient than 10-15 year old equipments can considerably reduce annual energy consumption. The energy cost savings and maintenance savings offset the high installation cost of a more efficient system. Installing thermostats and/or economizers on new or existing A/C systems will further reduce the cooling demand.

Economizers provide "free" cooling by using controllable dampers that bring in outside air to cool the space when the outdoor temperature or enthalpy is below the building's return air conditions. Although they require operation by a well calibrated and maintained control system, economizers have impressive energy-saving capabilities.

Install Occupancy Controlled/Programmable Thermostats

Combining efficient HVAC equipment with occupancy controlled and programmable thermostats can save a facility up to 10% of its annual heating and cooling costs:

- Areas with unpredictable occupancy on a daily/weekly basis - gym, bathrooms, outdoors: Use an *occupancy controlled thermostat* - a thermostat paired with a sensor and/or door detector to identify movement/occupancy. If occupancy is sensed by the sensor, the thermostat goes into an occupied mode (i.e. programmed set point). If a pre-programmed time frame elapses (i.e. 30 minutes) and no occupancy is sensed during that time, the thermostat goes into an unoccupied mode (e.g., setback set point or off) until occupancy is sensed again. This reduces the overall time the heating or cooling system is running, saving energy.

- Areas with predictable occupancy: e.g.: classrooms, cafeteria, offices: A *programmable thermostat* is recommended. This device is programmed on a schedule to reduce the heating or cooling output of the facility's HVAC systems in relation to its predetermined occupancy schedule. In this way, the thermostat acts to set-back or set-up the facility temperature during unoccupied hours, and re-establish a comfortable facility temperature during business hours. By employing programmable thermostat technology, the heating and cooling system demand coincides with occupancy level, reducing energy usage.

- **Install Vending Misers on Vending Machines**

Vending misers for refrigerated and non-refrigerated vending machines is an often overlooked source of potential savings. Uncontrolled, vending machine lights remain on 24/7, consuming a constant amount of energy year round. By controlling these lights with an occupancy sensor, energy consumption attributed to vending machines can be reduced considerably, in many cases, by as much as 50% and can save up to $150 per machine per year.

In the case of refrigerated vending machines, electric demand can be further reduced by controlling the machines' refrigeration systems. In a manner similar to programmable thermostats, vending misers for refrigerated machines act on a pre-set occupancy schedule to allow a marginal increase in operating temperature during non-business hours. Although products in the machine are delivered to the customer at the same temperature as in an uncontrolled vending machine, products are not being cooled unnecessarily when the machine is not in use, significantly reducing the machine's energy consumption. Because of the relatively low vending miser installation cost and high operating hours of vending machines, this improvement is typically cost-effective with a very short payback period.

- **Install ENERGY STAR® Rated Equipment / Plug Load Control**

Plug loads (computers, televisions, coffee makers, etc.) account for, on average, about 10% of total energy consumption. One of the easiest and most cost-effective energy saving strategies is the reduction of electric usage through installation of efficient appliances and the control of plug loads. In addition to utilizing ENERGY STAR® qualified appliances, greater savings can be realized through the various devices available that control every day plug loads.

By connecting non-critical loads (coffee makers, fans, microwave ovens, etc.) to an occupancy or timer controlled power strip, significant energy savings can be achieved. These savings result not only from the neglect of the user to turn the device off manually, but also from reduction of "phantom load". Phantom load is the small but constant energy draw from many plug-in devices when not in use. By connecting certain appliances to an occupancy controlled power strip, phantom load can be eliminated by cutting power supply to those devices. When replacing or ordering new equipment, emphasize ENERGY STAR® devices when they are available. Also, purchase controlled power strips and connect appropriate devices to those strips to reduce unnecessary consumption due to phantom load and appliances left on. The EPA offers free computer power management software which has saved some districts as much as $75 per computer per year, the software can be found at http://www.energystar.gov/index.cfm?c=power_mgt.pr_power_mgt_low_carbon_join.

IV. Resources:

The State of New Hampshire along with the utility companies offer multiple programs designed to improve the energy efficiency of schools through financial incentives and technical support, including:

Northeast Energy Efficiency Partnerships:

- **Northeast Collaborative for High Performance Schools (NE-CHPS)**
  NE-CHPS is a set of building and design standards for all schools from pre-K through community colleges tailored specifically for NH state code requirements, the New England climate, and the environmental priorities of the region. NH Department of Education offers up to a 3% re-imbursement for New Construction School projects. To learn more about NE-CHPS and incentive programs please visit: http://neep.org/public-policy/hpse/hpse-nechps.

New Hampshire Public Utilities Commission:

- **New Hampshire Pay for Performance**
  This program addresses the energy efficiency improvement needs of the commercial and industrial sector. The Program is implemented through a network of qualified Program Partners. Incentives will be paid out on the following three payment schedule: Incentive #1: Is based on the area of conditioned space in square feet. Incentive #2: Per/kWh saved and Per/MMBTU saved based on projected savings and paid at construction completion. Incentive #3: Per/kWh saved and Per/MMBTU saved based on actual energy savings performance one year post construction. Total performance incentives (#2 and #3) will be capped at $200,000 or 50% of project cost on a per project basis. For more information visit http://nhp4p.com.

- **New Hampshire Public Utilities Commission's Renewable Energy Rebates**
  The Sustainable Energy Division provides an incentive program for solar electric (photovoltaic or PV) arrays and solar thermal systems for domestic hot water, space and process heat, with a capacity of 100 kW or equivalent thermal output or less. The rebate for PV systems as follows: $1.00 per Watt, capped at 25% of the costs of the system or $50,000, whichever is less. For solar hot water (SHW) systems, the base rebate is $0.07 per rated or modeled kBtu/year, capped at 25% of the cost of the facility or $50,000, whichever is less, as a one-time incentive payment. http://www.puc.state.nh.us/Sustainable%20Energy/RenewableEnergyRebates-CI.html.

New Hampshire Community Development Finance Authority:

- **New Hampshire Community Development Finance Authority Revolving Loan Fund**
  The Enterprise Energy Fund is a low-interest loan and grant program available to businesses and nonprofit organizations to help finance energy improvements and renewable energy projects in their buildings. The loans will range from $10,000 to $500,000. Larger amounts will be considered on a case by case basis. The program is available to finance improvements to the overall energy-efficiency performance of buildings owned by businesses and nonprofits, thereby lowering their overall energy costs and the associated carbon emissions. More information about the program can be found on their website www.nhcdfa.org. These activities may include:

  - Improvements to the building's envelope, including air sealing and insulation in the walls, attics and foundations;
  - Improvements to HVAC equipment and air exchange;
  - Installation of renewable energy systems;
  - Improvements to lighting, equipment, and other electrical systems; and
  - Conduction of comprehensive, fuel-blind energy audits.

Public Service of New Hampshire (PSNH):

- **Commercial (Electric) Energy Efficiency Incentive Programs**
  This program targets any commercial/industrial member building a new facility, undergoing a major renovation, or replacing failed (end-of-life) equipment. The program offers prescriptive and custom rebates for lighting and lighting controls, motors, VFDs, HVAC systems, chillers and custom projects. http://www.psnh.com/SaveEnergyMoney/For-Business/Energy-Saving-Programs-and-Incentives.aspx

- **SmartSTART**
  The SmartSTART (Savings Through Affordable Retrofit Technologies) advantage is simple - pay nothing out of pocket to have energy efficiency products and services installed in your building. The Smart Start program is limited to PSNH's municipal customers only and includes schools. The program is available on a first-come, first served basis to projects which have been pre-qualified by PSNH. The cost of the improvements is fronted by PSNH which is then repaid over time by the municipality or school using the savings generated by the products themselves! This program is for lighting and lighting controls, air sealing, insulation and other verifiable energy savings measures which have sufficient kilowatt-hour savings. For more information on this program visit:
  http://www.psnh.com/SaveEnergyMoney/For-Business/Municipal-Smart-Start-Program.aspx

- **Schools Program**
  For major renovation or equipment replacement projects, this program offers prescriptive and custom rebates for energy efficient lighting, motors, HVAC, chillers, and variable frequency drives to towns or cities that install energy efficient equipment at their schools. Financial incentives are available for qualifying energy efficient equipment. Technical assistance is also offered through the Schools Program. http://www.psnh.com/SaveEnergyMoney/Large-Power/Schools-Program.aspx

Unitil:

- **Commercial and Industrial Energy Efficiency Programs**
  Subject to program qualifications and availability of funding - Unitil offers different programs for its commercial, industrial, and institutional customers in New Hampshire: the Small Business Energy Efficiency Program, the Small Commercial and Industrial Program, the Large Commercial and Industrial Program, the Large Commercial and Industrial (C&I) Retrofit Program, and the Large C&I New Construction Program. Rebates are available for various technologies including water heaters, lighting, lighting controls/sensors, chillers, furnaces, boilers, central air conditioners, compressed air, programmable thermostats, energy management systems/building controls, motors, motor VFDs, processing and manufacturing equipment, LED exit signs, commercial cooking and refrigeration equipment. http://www.unitil.com/.

Clean Air – Cool Planet:

- **Community Energy Efficiency**
  CA-CP works with communities throughout the Northeast to find solutions to climate change and build constituencies for effective climate policies and actions. Much of their work focuses on successful models for energy efficiency and renewable energy planning. They advise and partner with citizens, educators, faith groups, small businesses, municipal governments, and other local leaders. They explore cost-effective opportunities that exist for communities to reduce their emissions as well as their vulnerability to climate impacts. One such example is CA-CP's partnership with the University of NH, NH Sustainable Energy Association and UNH Cooperative Extension to create www.myenergyplan.net, a groundbreaking suite of web and outreach tools for individual action used by households, schools and community groups around the northeast. http://www.cleanair-coolplanet.org/for_communities/index.php.

Environmental Protection Agency (EPA):

- **ENERGY STAR Challenge for Schools**
  EPA is challenging school administrators and building managers to improve energy efficiency throughout their facilities. More than 500 school districts across the country are helping to fight climate change by committing to reducing their energy use with help from ENERGY STAR. Schools that take the ENERGY STAR Challenge can use energy tracking tools, technical guidance, case studies and other ENERGY STAR tools and resources to help them improve their energy efficiency. More information can be found at:
  http://yosemite.epa.gov/opa/admpress.nsf/d985312f6895893b852574ac005f1e40/d74f768ecfa9e11f8525762500522260!OpenDocument

For additional assistance in helping you save money and improve school conditions, please call TRC at (603) 766-1913 or (877) 442-9181.

NEW HAMPSHIRE ENERGYSMART SCHOOLS PROGRAM

Energy Benchmarking Report for:

Maple Street Elementary School

Rochester, NH

Period: ***July 1, 2010*** through ***June 30, 2011***

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Table of Contents

I. Introduction

The Sustainable Energy Division of the New Hampshire Public Utilities Commission, with support from the New Hampshire Department of Education has sponsored TRC to develop the New Hampshire ***EnergySmart Schools Program*** to support New Hampshire K-12 public and private schools in the pursuit of energy efficiency and sustainability initiatives.

Energy efficiency has become an increasingly important issue for schools due to tightening budgets and rising energy costs. Since 2003, the prices of natural gas, fuel oil and electricity have increased by 123%, 107% and 32% respectively. Schools that have participated in energy benchmarking programs have shown a decrease in overall energy use by approximately 22% through the adoption of energy efficiency measures.

Tracking and documenting the energy use and associated carbon emissions in the state's K-12 schools will allow New Hampshire to account for the impact of its energy efficiency and renewable energy programs and determine which have the greatest effect. The analysis in this report, provided by the ***EnergySmart Schools Program*** is designed to help you:

- Understand the energy consumption and cost trends at each of your school buildings.
- Learn how your buildings are performing compared to other schools locally and nationally.
- Identify opportunities for improving operations and reducing costs.
- Take advantage of resources to implement efficiency improvements and save money.

The analysis was based on the information provided on the *Building Data Request Form* submitted, which included building descriptions, energy suppliers and other information. The building's utility bills were also used to assess its electricity and heating fuel consumption for the year(s) provided.

The energy performance for your school has been compared to national data for similar school facilities through EPA's ENERGY STAR® Portfolio Manager. Also shown are the five major benchmarks used to analyze building performance, which include: electricity use; heating fuel use; weather-normalized heating fuel use; total cost; and total cost per student, all of which have been normalized for comparison by square footage and weather. As part of the program's focus on sustainability, your school's carbon footprint is also presented.

II. Benchmarking Analysis and Review Results

Building and energy usage of your school was analyzed to assess the basic nature of your energy consumption and utility costs. The Building Data Summary table shown below summarizes this information.

Table 1: Building Data Summary for Maple Street Elementary School

Building Data			
District	SAU 54 Rochester School Department	**School Name**	Maple Street Elementary School
City	Rochester	**Zip Code**	03867
Year Built	1928	**Floor Area (sq.ft.)**	16,000
Number of Students	68	**Number of PCs**	29
Weekly Operating Hours	60	**Months School Used**	12
Cooking?	YES	**% AC**	0
Pool Size?	N/A	**Months Pool Used**	0

Utility Data			
Data End Point	6/30/2011	**Total Cost ($)**	21,697
Electric Provider	PSNH	**Natural Gas Provider**	N/A
Electricity Usage (kWh)	73,920	**Electricity Cost ($)**	9,315
Natural Gas Usage (therms)	0	**Natural Gas Cost ($)**	0
Fuel Oil Usage (gal)	6,006	**Fuel Oil Cost ($)**	12,382
Other Fuel Usage (gal)	0	**Other Fuel Cost ($)**	0

Energy Indicators			
EPA Score	74	**Electric Usage (kWh/sq.ft.)**	4.6
Heating Fuel Usage (kBtu/sq.ft.)	52	**Weather Adjusted Heating Usage Btu/sq.ft./HDD)**	7.2
Site Energy (kBtu/sq.ft.)	68	**Source Energy (kBtu/sq.ft.)**	105

Environmental Impact Indicators			
Greenhouse Gas Emissions			
Last Year Heating Fuel CO_2e (Mt)	61.3	**Last Year Total CO_2e (Mt)**	84.2
Last Year Electricity CO_2e (Mt)	22.9	**CO_2e Efficiency Savings Over Previous Year (Mt)**	-19.2
EPA Target Score			
Target Score	75	**Site Energy Reduction Needed (kBtu/sq.ft.)**	0.5

Figures 1a, 1b, 2a and 2b display the energy use, demand and cost data tracked on a monthly basis. This demonstrates the energy consumption of your building over the course of the year. As a part of the program's focus on sustainability, your school's carbon footprint was also measured and is presented in Figure 3.

Figure 1a. Monthly Electric Use & Max Demand for Maple Street Elementary

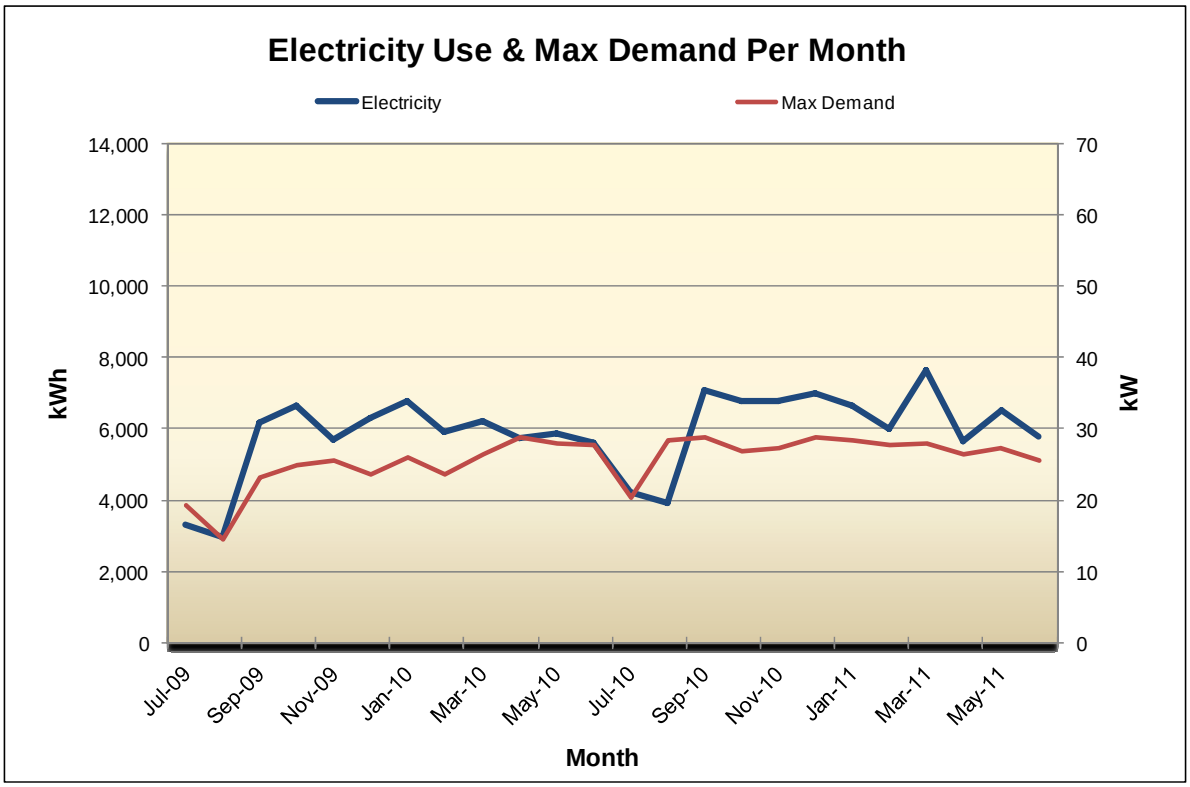
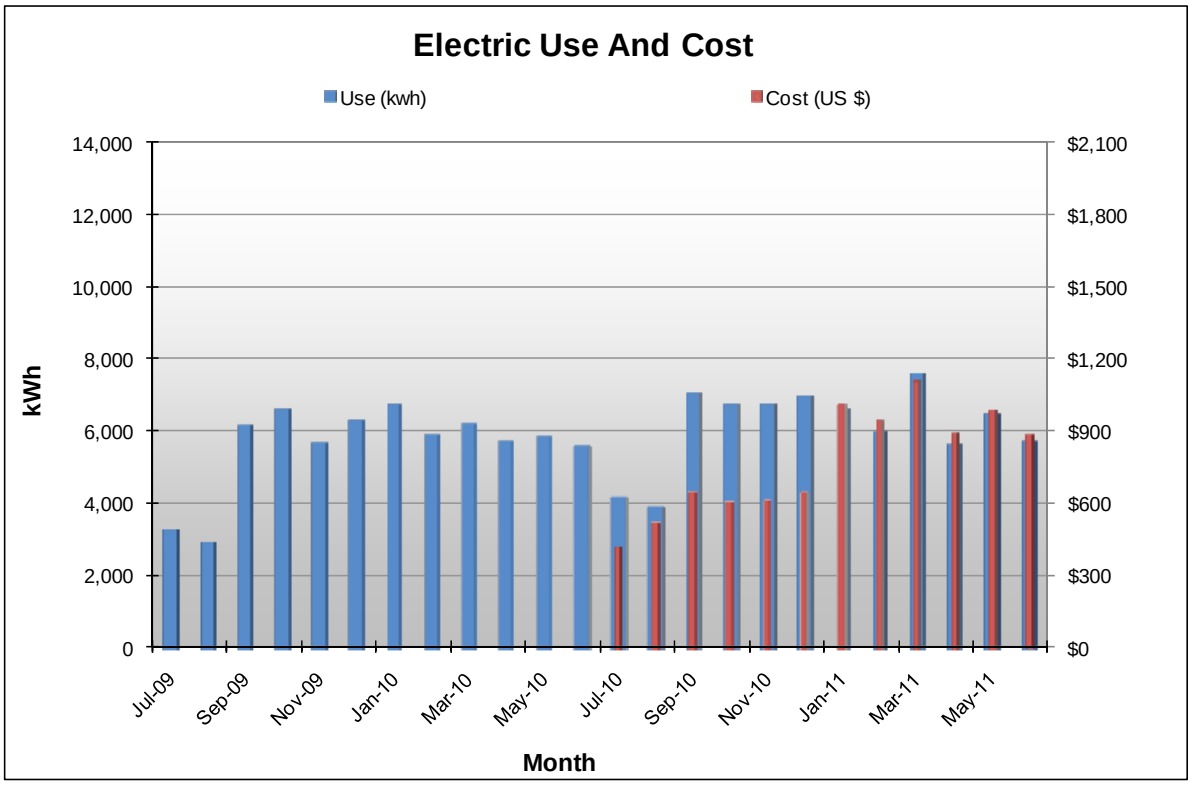


Figure 1b. Monthly Electric Use vs. Cost for Maple Street Elementary



Note: Electric Cost was only available for the most recent twelve month period.

Figure 2a. Monthly Heating Fuel Use for Maple Street Elementary

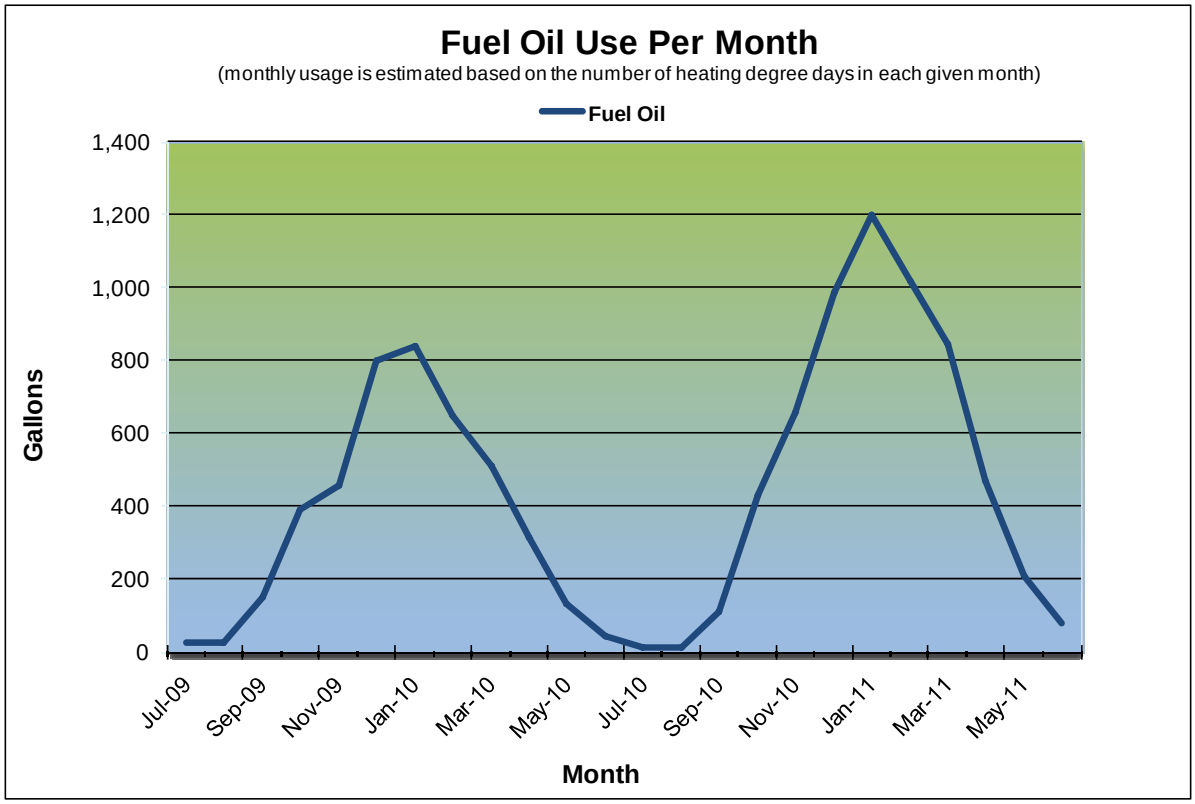


Figure 2b. Monthly Heating Fuel Use vs Cost for Maple Street Elementary

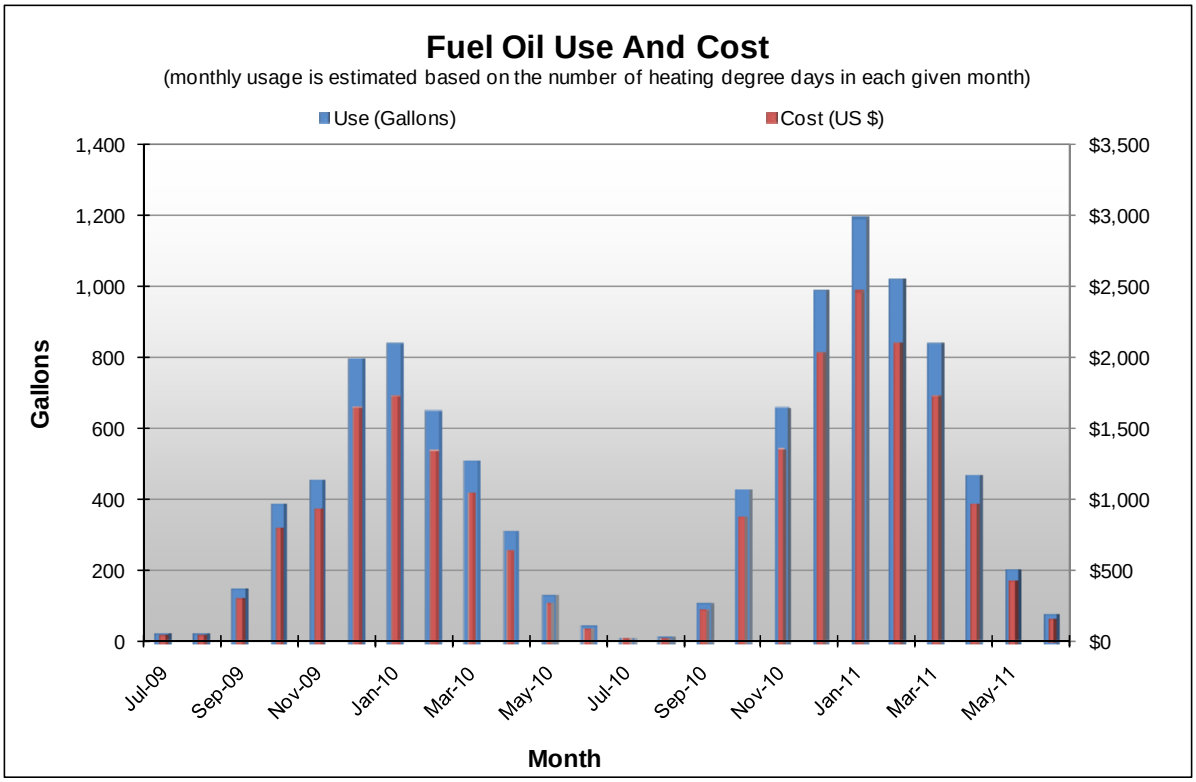
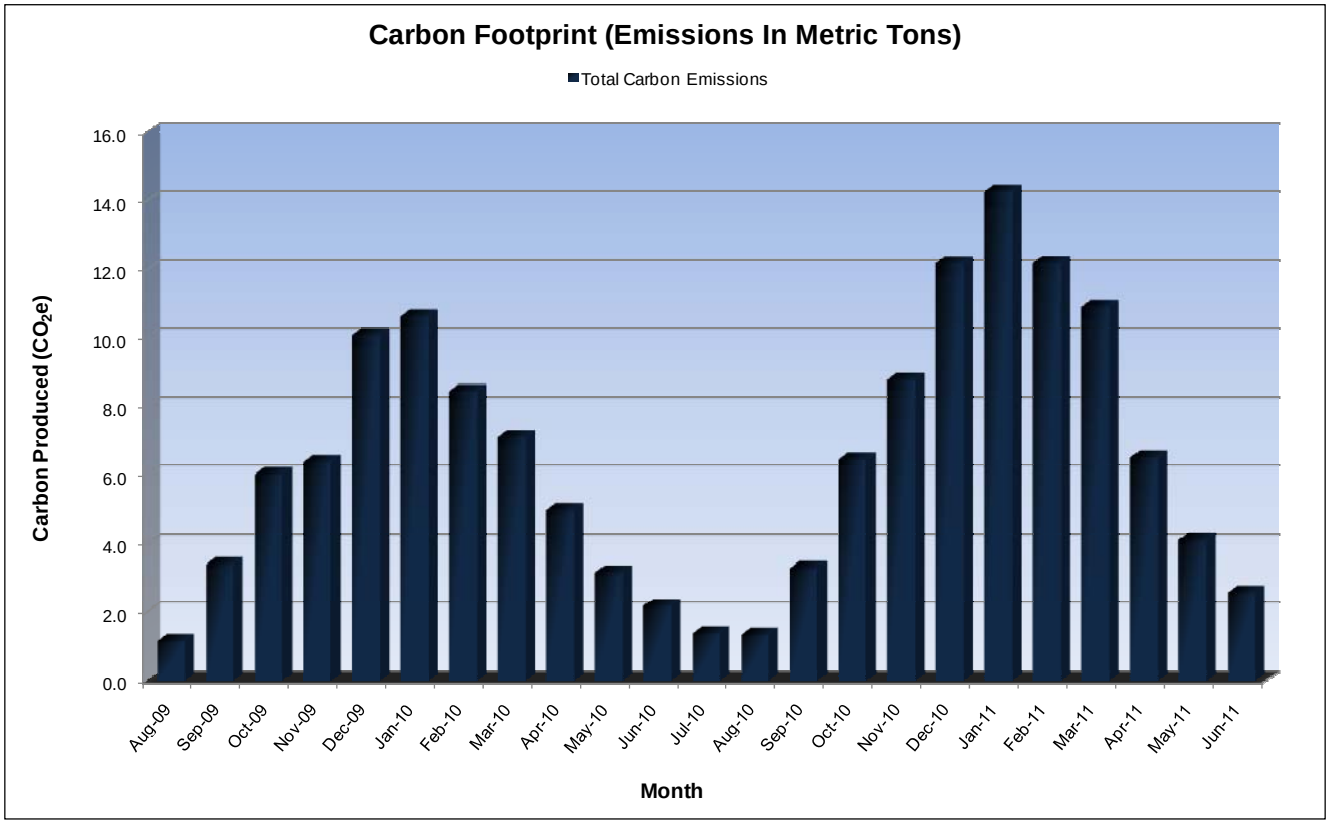


Figure 3. Monthly Greenhouse Gas Emissions for Maple Street Elementary



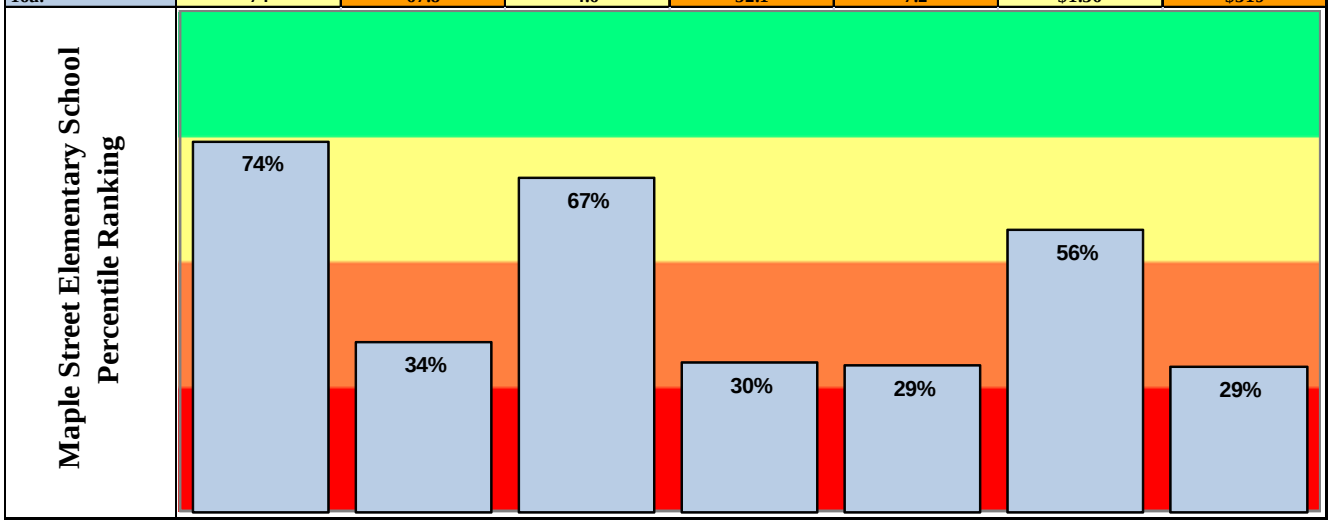
Benchmarking Data

To evaluate the energy and environmental performance of your school, the building data collected above has been compared against two different sets of school energy data: the U.S. Environmental Protection Agency's national data and New Hampshire specific state data. The results are illustrated in Figure 4 on the following page.

This will allow you to assess your building's performance relative to other buildings designed and constructed to the same codes and standards, operating under the same regulations and schedules and similar weather conditions. The indicators are calculated on a *per square foot* or *per student* basis, so you can compare your school to different sized schools.

Figure 4. EnergySmart Schools Benchmarks for Maple Street Elementary School

Schools	U.S. EPA Portfolio Manager Score	New Hampshire State Schools (Annual Data)					
		Total Energy Use (kBtu/sq.ft.)	Electric Use (kWh/sq.ft.)	Heating Fuel Use (kBtu/sq.ft.)	Weather Adjusted Heating Fuel Use (Btu/sq.ft./HDD)	Total Energy Cost ($/sq.ft.)	Total Energy Cost ($/student)
NH Average:	50	60.3	5.2	41.7	5.7	$1.42	$256
You:	74	67.8	4.6	52.1	7.2	$1.36	$319



Major Benchmark Indicators

1. Total Energy Use, kBtu/sq.ft.

This indicator shows how much total energy your school consumes each year. It includes the energy used for heating, cooling (if any), lights, cooking, computers, etc.

Your school's total energy use of 67.8 kBtu per square foot per year (kBtu/sq.ft.) is higher than the New Hampshire K-12 schools state average of 60.3 kBtu/sq.ft. Your total energy use figure is higher than 66% of New Hampshire K-12 schools. The EnergySmart School Report is weather normalized so fuel consumption for heating takes the difference in climate between northern and southern New Hampshire into account.

This is a good indicator of how well, overall, your school is performing. However, it doesn't help you find ***where*** in your building to look for improvement opportunities. Multiple factors included on the following pages can help with that. Analysis of energy consumption for this program does not control for operational variations. An example is an improperly ventilated school may appear to have lower energy consumption. Ventilation systems that are not operating properly result in lower indoor air quality.

2. Electricity Data

Most electric utilities use the following two factors to estimate your electricity bill – Electric Use and Electric Demand.

a. Electric Use, kWh/sq.ft.

This shows how well the building does with its lights, cooling/air conditioners and cafeteria systems (if any), and what's referred to as "plug load." Plug load is anything that plugs into a socket. The major plug loads are generally computers (including monitors, printers and copiers), refrigerators, coffee machines, fans, shop equipment and projectors. If electric consumption is much higher than average, but heating fuel use (see below) is average or better, then focus your efforts on the electric-powered elements.

New Hampshire schools state average electric use is 5.2 kWh per square foot. Your school's electric consumption of 4.6 kWh per square foot this year is lower than 67% of New Hampshire schools benchmarked through the New Hampshire EnergySmart Schools Program.

b. Electric Demand, Watts/sq.ft.

Demand is a measure of the maximum electric draw in kW that your building places on the grid and is measured by adding up the kW draw for a 15 minute period. To give an analogy, if electricity usage is the amount of water going through a hose in gallons, electric demand would be how fast that water flows expressed in gallons per minute. Whichever 15 minute period during your monthly billing cycle places the highest kW demand on the grid is the demand factor applied to your bill. The best way to improve this demand factor is to stagger the times when your electrical systems draw at their maximum or reduce unnecessary electric load altogether.

The average electric demand for New Hampshire schools is 1.9 watts per square foot. Your school's electric demand is 1.8 watts per square foot and is lower than 58% of New Hampshire Schools benchmarked through the New Hampshire EnergySmart Schools Program.

3. Heating Fuel Use, kBtu/sq.ft.

Reviewing these indicators is relatively straightforward. If your school's heating fuel use is much higher than average, an audit of your heating system along with your building envelope - doors, windows, roof - is recommended. This factor is 'fuel-neutral' as it works for either fuel oil or natural gas heating systems.

New Hampshire K-12 schools state average heating fuel use is 41.7 kBtu/sq.ft. or 5.7 Btu/sq.ft./HDD. Your school's heating fuel use of 52.1 kBtu/sq.ft. per year is higher than 70% of other New Hampshire schools in the database. Your school's weather adjusted heating fuel use of 7.2 Btu/sq.ft./HDD is higher than 71% of other New Hampshire schools benchmarked through the New Hampshire EnergySmart Schools Program.

4. Energy Cost, $/sq.ft. & $/student

Cost is the bottom line. These numbers help you understand, in terms of budget, the gain through energy efficiency improvements. New Hampshire K-12 schools state averages $1.42/sq.ft. and $256/student.

Your school's annual energy cost of $1.36 per square foot is lower than 56% of other New Hampshire benchmarked schools. Your school's cost expressed on a per student basis of $319 is higher than 71% of other New Hampshire schools benchmarked through the New Hampshire EnergySmart Schools Program.

5. U.S. EPA *Portfolio Manager* Score

Portfolio Manager is a benchmarking model based on a national set of data from K-12 schools. It is provided by the U.S. Environmental Protection Agency's ENERGY STAR® Program. The impact of factors outside of your control (such as location, occupancy and operating hours) are removed, providing a 1-100 ranking of a school's energy performance relative to the national school building market. A score of 50 represents the national average and a score of 100 is best. Schools that achieve a score of 75 or higher are eligible for EPA's ENERGY STAR® Building Label, the national symbol for protecting the environment through energy efficiency. Districts can achieve ENERGY STAR® Leader Awards in recognition if their buildings, on average, improve by 10%, 20%, 30%, etc. over their baseline year of reported energy use or if the district's overall weighted average *Portfolio Manager* Score is at least a 75.

Your school's *Portfolio Manager* Score of 74 places it higher than 74% of K-12 schools nationwide.

III. Potential Energy Saving Opportunities

Based on the preceding analysis of your school's energy performance, implementation of the following recommendations can help you save energy and money. The first step is to look at reducing electrical lighting and HVAC consumption (burners, circulators and fans) which typically account for 67% of a building's electric consumption.

- **Perform an Energy Audit on the Building**

An energy audit involves a comprehensive analysis of the building's general characteristics, its energy use and allocation of that use amongst the facility's energy end uses. The goal is to identify sources of potential energy savings. Your auditor should develop a list of recommendations that will result in substantial energy and operational cost savings. These may include, building envelope improvement and mechanical systems, lighting upgrades, equipment replacement and installation of lighting and HVAC control mechanisms, among others.

A good audit should include information specific to each recommendation which *at least* includes approximate annual energy unit and cost savings, demand reduction, installation cost, lifetime cost savings and information related to cost-effectiveness. This will help to prioritize the recommendations based on their energy efficiency and shortest payback.

The recommendations provided in an energy audit report may reduce facility energy bills by 20% or more in addition to improving occupant health and comfort. Following this report, an energy audit is the next step in realizing the full potential of energy savings opportunities.

- **Request Retro-Commissioning**

Retro-commissioning is a detailed process applied to existing facilities aimed at correcting many of the degradations and inefficiencies that are indicative of older and/or poorly performing buildings. Many older buildings tend to be less comfortable and operate less efficiently when not properly commissioned. Retro-commissioning includes a detailed energy audit and focuses on not only potential energy savings but also the interaction of the building's equipments and mechanical systems with an eye toward restoring it to optimal performance.

In contrast to an energy audit, this optimization focuses on operational improvements to existing equipment, rather than replacement. Apart from energy savings, other improvements and benefits include substantial operation and maintenance (O&M) cost savings, improved air quality, occupant comfort, health and safety, equipment controls, and improved system interactivity.

In addition to providing recommendations, retro-commissioning includes implementation of the recommended improvements and hence the cost for retro-commissioning is higher than an audit. However, when the costs of improvements are added to the energy audit cost, prices may be comparable. If high O&M costs or occupant health, comfort and safety are concerns in addition to reduction in energy use, retro-commissioning may be a suitable strategy.

- **Upgrade Lighting Systems**

Lighting typically accounts for 30-60% of all energy consumed in school buildings. Additionally, the electrical energy consumed by lights during the summer creates heat and increases cooling costs.

Maple Street Elementary School's electricity consumption is slightly lower than average compared to other schools in the State. Even so, upgraded lighting systems in high consumption areas like classrooms, gymnasiums, libraries, offices, etc. can reduce utility costs, improve the lighting quality and increase occupant comfort and productivity.

Over-lit Spaces: Light levels should be recorded in classrooms and hallways to ensure they are not over-lit, 40-50 foot candles are adequate light levels for an instructional space. If classroom light levels are much higher than 50 foot candles, Maple Street Elementary School should consider de-lamping classrooms or installing dimming ballasts, which dim the lights when outdoor light levels are adequate. In over-lit hallway spaces photo sensors can be installed to turn lights off completely when light levels exceed a pre-set threshold.

In over-lit spaces a T8 to Super T8 lighting retro-fit can reduce the number of light fixtures needed. Super T8 lamps use between 4 and 7 Watts less electricity than standard T8 lamps, but they produce more light per Watt. In some cases this increase in light per Watt can allow for the removal of an entire lamp, saving 32 Watts. The room characteristics must be factored in before this type of retro-fit. The shape of the space, ceiling height, color of the walls, etc. all need to be taken into account when exploring a de-lamping project. We recommend that before retro-fitting the entire facility, begin by changing one classroom and monitor the comfort level of the occupants at Maple Street Elementary School.

Another proven energy reduction measure with a short payback period is to identify any areas where your school may still be using metal halide lighting. Typically metal halide lights are found in gymnasiums or cafeteria areas, many districts have been very satisfied by replacing these lights with high bay T5 lighting fixtures. In addition to the reduced operational wattage, high bay T5 lights turn on instantly, as opposed to metal halide fixtures which have an extended warm up period. The long warm up period associated with metal halides typically leads to the lights being left on all day, at 250 to 400 watts a fixture; the costs begin to add up. Adding occupancy sensors to high bay T5 fixtures further reduces the payback period.

Occupancy Sensors: We recommend that you explore the use of occupancy sensors to ensure that lights are turned off in unoccupied spaces. Lights controlled by occupancy sensors typically run a third of the time when compared with manually controlled lighting. Reduced runtime leads to decreases in both energy usage and operation and maintenance costs. Additionally, a study conducted in Massachusetts found that controlling the security lighting with occupancy sensors reduced vandalism; neighbors and police recognized something wrong when the lights were on in a building that was typically dark and investigated.

To summarize and add a few ways in which Maple Street Elementary School may be able to conserve energy and cost through lighting upgrades is to:

- Design light quantity and quality for the task and occupants' needs in that area.
- Maximize lamp and ballast efficiency.
- Activate the power saving features on office equipment such as copiers, printers and fax machines and ensure that they are turned off at the end of the day.
- Use automatic controls to turn lights off or dim lights in unoccupied spaces.
- Establish a maintenance schedule for group re-lamping and fixture cleaning.
- Replace T12 fixtures with the most efficient fixtures which may include T8/super T8/T5 fixtures.
- Replace incandescent lighting with compact fluorescent technology.

- Replace incandescent exit lighting which consumes 30 Watts with LED type exit lights with 1.5 Watts consumption. LED units last up to 10 years, which is a maintenance advantage.
- Install daylight sensors in areas with significant natural light.
- Install occupancy sensors in areas that are often unoccupied.
- Lighting retrofits reduce maintenance costs associated with lighting that is close to end of life.
- Establish a regular cleaning schedule particularly for areas where student safety of low light levels may be a concern, such as shop classes.
- Look to make lamp and fixture selection as uniform as possible to reduce maintenance and inventory overhead.
- Educate students and staff to turn off lights when rooms are unoccupied.

Lighting upgrades seek to reduce the connected electrical load (kW) and energy consumption (kWh) of lighting equipment. Lighting controls can also significantly reduce operating hours and costs by turning off lighting when spaces are unoccupied or sufficiently lit by natural light.

- **Install NEMA Premium Motors and VFDs**

Commercial and industrial electric motor-driven systems consume approximately 23% of all electricity in the U.S., making it the single largest category contributor to electric use in the country. With very high operating hours, the annual energy cost to run a system is more than its installation cost. Even a small increase in the efficiency of an electric motor can result in substantial energy cost savings. Typical opportunities for motor upgrades in schools include: ventilation fans, and heating and cooling system pumps and fans.

Motors with efficiency up to 90% are available to replace the older ones with efficiency less than 75%. Although standards for efficiency of new equipment are set by the Energy Policy Act, motor efficiency can be further increased by selecting Premium Efficiency motors as specified by the National Electrical Manufacturers Association (NEMA). This can cut the electric motor system demand by as much as 18%.

Savings can be increased further by optimizing system performance through the use of variable frequency drives (VFDs). When system load is known to vary substantially, these flow control systems can be utilized to match system output to system demand, significantly reducing energy usage during partial load hours. By employing high-efficiency motors and VFDs, facility owners can improve environmental conditions, utilize better control of motor-driven processes, and reduce waste output.

- **Install Demand Control Ventilation**

Demand control ventilation (DCV) monitors indoor air CO_2 content as a result of occupancy production levels and uses this data to regulate the amount of outdoor air that is permitted for ventilation. In order to ensure adequate air quality, standard ventilation systems permit outside air based on estimated occupancy levels in CFM, cubic feet per minute/occupant. However, during low occupancy hours, the space may become over ventilated due to decreased CO_2 levels and unnecessary ventilation results in wasted energy. DCV reduces unnecessary outdoor air intake by regulating ventilation based on actual CO_2 levels, saving energy. DCV is most suited for areas where occupancy levels are known to fluctuate considerably such as auditoriums, cafeterias, and gymnasiums.

Install Energy Recovery Ventilators. According to energy recovery equipment manufacturer's typical paybacks are less than 5 years for schools without cooling. The keys to success with ventilation retrofits are going with fewer larger units with long run hours as opposed to several small units with limited run time. Equipment with moisture recovery capabilities would cut humidity up to 50% during the cooling season.

- **Improve/Replace Inefficient Heating Systems**

Replacing an old boiler that is < 70% efficient with a modern 85-90% efficient natural gas-fired furnace alone will reduce heating costs by 15-20%. This combined with additional system improvements and installation of advanced HVAC control mechanisms can result in up to 20%+ heating load reduction.

Because of the high capital cost of new heating systems, some financial analysis should be performed to assess the cost-effectiveness of immediate replacement. If the current system is fairly new, replacement may not be immediately justifiable from a financial standpoint. However, as is the case with cooling systems, early replacement may prove to be a more cost-effective solution than waiting until existing systems fail or reach the end of their estimated useful life.

- **Improve/Replace Inefficient Air Conditioning Systems**

The useful life of a rooftop A/C unit is generally 12-18 years. However, depending on the efficiency, early replacement of outdated, inefficient, split, or packaged rooftop air conditioning units with new A/C systems that are 15% more efficient than 10-15 year old equipments can considerably reduce annual energy consumption. The energy cost savings and maintenance savings offset the high installation cost of a more efficient system. Installing thermostats and/or economizers on new or existing A/C systems will further reduce the cooling demand.

Economizers provide "free" cooling by using controllable dampers that bring in outside air to cool the space when the outdoor temperature or enthalpy is below the building's return air conditions. Although they require operation by a well calibrated and maintained control system, economizers have impressive energy-saving capabilities.

Install Occupancy Controlled/Programmable Thermostats

Combining efficient HVAC equipment with occupancy controlled and programmable thermostats can save a facility up to 10% of its annual heating and cooling costs:

- Areas with unpredictable occupancy on a daily/weekly basis - gym, bathrooms, outdoors: Use an *occupancy controlled thermostat* - a thermostat paired with a sensor and/or door detector to identify movement/occupancy. If occupancy is sensed by the sensor, the thermostat goes into an occupied mode (i.e. programmed set point). If a pre-programmed time frame elapses (i.e. 30 minutes) and no occupancy is sensed during that time, the thermostat goes into an unoccupied mode (e.g., setback set point or off) until occupancy is sensed again. This reduces the overall time the heating or cooling system is running, saving energy.

- Areas with predictable occupancy: e.g.: classrooms, cafeteria, offices: A *programmable thermostat* is recommended. This device is programmed on a schedule to reduce the heating or cooling output of the facility's HVAC systems in relation to its predetermined occupancy schedule. In this way, the thermostat acts to set-back or set-up the facility temperature during unoccupied hours, and re-establish a comfortable facility temperature during business hours. By employing programmable thermostat technology, the heating and cooling system demand coincides with occupancy level, reducing energy usage.

- **Install Vending Misers on Vending Machines**

Vending misers for refrigerated and non-refrigerated vending machines is an often overlooked source of potential savings. Uncontrolled, vending machine lights remain on 24/7, consuming a constant amount of energy year round. By controlling these lights with an occupancy sensor, energy consumption attributed to vending machines can be reduced considerably, in many cases, by as much as 50% and can save up to $150 per machine per year.

In the case of refrigerated vending machines, electric demand can be further reduced by controlling the machines' refrigeration systems. In a manner similar to programmable thermostats, vending misers for refrigerated machines act on a pre-set occupancy schedule to allow a marginal increase in operating temperature during non-business hours. Although products in the machine are delivered to the customer at the same temperature as in an uncontrolled vending machine, products are not being cooled unnecessarily when the machine is not in use, significantly reducing the machine's energy consumption. Because of the relatively low vending miser installation cost and high operating hours of vending machines, this improvement is typically cost-effective with a very short payback period.

- **Install ENERGY STAR® Rated Equipment / Plug Load Control**

Plug loads (computers, televisions, coffee makers, etc.) account for, on average, about 10% of total energy consumption. One of the easiest and most cost-effective energy saving strategies is the reduction of electric usage through installation of efficient appliances and the control of plug loads. In addition to utilizing ENERGY STAR® qualified appliances, greater savings can be realized through the various devices available that control every day plug loads.

By connecting non-critical loads (coffee makers, fans, microwave ovens, etc.) to an occupancy or timer controlled power strip, significant energy savings can be achieved. These savings result not only from the neglect of the user to turn the device off manually, but also from reduction of "phantom load". Phantom load is the small but constant energy draw from many plug-in devices when not in use. By connecting certain appliances to an occupancy controlled power strip, phantom load can be eliminated by cutting power supply to those devices. When replacing or ordering new equipment, emphasize ENERGY STAR® devices when they are available. Also, purchase controlled power strips and connect appropriate devices to those strips to reduce unnecessary consumption due to phantom load and appliances left on. The EPA offers free computer power management software which has saved some districts as much as $75 per computer per year, the software can be found at http://www.energystar.gov/index.cfm?c=power_mgt.pr_power_mgt_low_carbon_join.

IV. Resources:

The State of New Hampshire along with the utility companies offer multiple programs designed to improve the energy efficiency of schools through financial incentives and technical support, including:

Northeast Energy Efficiency Partnerships:

- **Northeast Collaborative for High Performance Schools (NE-CHPS)**
  NE-CHPS is a set of building and design standards for all schools from pre-K through community colleges tailored specifically for NH state code requirements, the New England climate, and the environmental priorities of the region. NH Department of Education offers up to a 3% re-imbursement for New Construction School projects. To learn more about NE-CHPS and incentive programs please visit: http://neep.org/public-policy/hpse/hpse-nechps.

New Hampshire Public Utilities Commission:

- **New Hampshire Pay for Performance**
  This program addresses the energy efficiency improvement needs of the commercial and industrial sector. The Program is implemented through a network of qualified Program Partners. Incentives will be paid out on the following three payment schedule: Incentive #1: Is based on the area of conditioned space in square feet. Incentive #2: Per/kWh saved and per/MMBTU saved based on projected savings and paid at construction completion. Incentive #3: Per/kWh saved and per/MMBTU saved based on actual energy savings performance one year post construction. Total performance incentives (#2 and #3) will be capped at $200,000 or 50% of project cost on a per project basis. For more information visit http://nhp4p.com.

- **New Hampshire Public Utilities Commission's Renewable Energy Rebates**
  The Sustainable Energy Division provides an incentive program for solar electric (photovoltaic or PV) arrays and solar thermal systems for domestic hot water, space and process heat, with a capacity of 100 kW or equivalent thermal output or less. The rebate for PV systems as follows: $1.00 per Watt, capped at 25% of the costs of the system or $50,000, whichever is less. For solar hot water (SHW) systems, the base rebate is $0.07 per rated or modeled kBtu/year, capped at 25% of the cost of the facility or $50,000, whichever is less, as a one-time incentive payment. http://www.puc.state.nh.us/Sustainable%20Energy/RenewableEnergyRebates-CI.html.

New Hampshire Community Development Finance Authority:

- **New Hampshire Community Development Finance Authority Revolving Loan Fund**
  The Enterprise Energy Fund is a low-interest loan and grant program available to businesses and nonprofit organizations to help finance energy improvements and renewable energy projects in their buildings. The loans will range from $10,000 to $500,000. Larger amounts will be considered on a case by case basis. The program is available to finance improvements to the overall energy-efficiency performance of buildings owned by businesses and nonprofits, thereby lowering their overall energy costs and the associated carbon emissions. More information about the program can be found on their website www.nhcdfa.org. These activities may include:

  - Improvements to the building's envelope, including air sealing and insulation in the walls, attics and foundations;
  - Improvements to HVAC equipment and air exchange;
  - Installation of renewable energy systems;
  - Improvements to lighting, equipment, and other electrical systems; and
  - Conduction of comprehensive, fuel-blind energy audits.

Public Service of New Hampshire (PSNH):

- **Commercial (Electric) Energy Efficiency Incentive Programs**
  This program targets any commercial/industrial member building a new facility, undergoing a major renovation, or replacing failed (end-of-life) equipment. The program offers prescriptive and custom rebates for lighting and lighting controls, motors, VFDs, HVAC systems, chillers and custom projects. http://www.psnh.com/SaveEnergyMoney/For-Business/Energy-Saving-Programs-and-Incentives.aspx

- **SmartSTART**
  The SmartSTART (Savings Through Affordable Retrofit Technologies) advantage is simple - pay nothing out of pocket to have energy efficiency products and services installed in your building. The Smart Start program is limited to PSNH's municipal customers only and includes schools. The program is available on a first-come, first served basis to projects which have been pre-qualified by PSNH. The cost of the improvements is fronted by PSNH which is then repaid over time by the municipality or school using the savings generated by the products themselves! This program is for lighting and lighting controls, air sealing, insulation and other verifiable energy savings measures which have sufficient kilowatt-hour savings. For more information on this program visit:
  http://www.psnh.com/SaveEnergyMoney/For-Business/Municipal-Smart-Start-Program.aspx

- **Schools Program**
  For major renovation or equipment replacement projects, this program offers prescriptive and custom rebates for energy efficient lighting, motors, HVAC, chillers, and variable frequency drives to towns or cities that install energy efficient equipment at their schools. Financial incentives are available for qualifying energy efficient equipment. Technical assistance is also offered through the Schools Program. http://www.psnh.com/SaveEnergyMoney/Large-Power/Schools-Program.aspx

Unitil:

- **Commercial and Industrial Energy Efficiency Programs**
  Subject to program qualifications and availability of funding - Unitil offers different programs for its commercial, industrial, and institutional customers in New Hampshire: the Small Business Energy Efficiency Program, the Small Commercial and Industrial Program, the Large Commercial and Industrial Program, the Large Commercial and Industrial (C&I) Retrofit Program, and the Large C&I New Construction Program. Rebates are available for various technologies including water heaters, lighting, lighting controls/sensors, chillers, furnaces, boilers, central air conditioners, compressed air, programmable thermostats, energy management systems/building controls, motors, motor VFDs, processing and manufacturing equipment, LED exit signs, commercial cooking and refrigeration equipment. http://www.unitil.com/.

Clean Air – Cool Planet:

- **Community Energy Efficiency**
  CA-CP works with communities throughout the Northeast to find solutions to climate change and build constituencies for effective climate policies and actions. Much of their work focuses on successful models for energy efficiency and renewable energy planning. They advise and partner with citizens, educators, faith groups, small businesses, municipal governments, and other local leaders. They explore cost-effective opportunities that exist for communities to reduce their emissions as well as their vulnerability to climate impacts. One such example is CA-CP's partnership with the University of NH, NH Sustainable Energy Association and UNH Cooperative Extension to create myenergyplan.net, a groundbreaking suite of web and outreach tools for individual action used by households, schools and community groups around the northeast. http://www.cleanair-coolplanet.org/for_communities/index.php.

Environmental Protection Agency (EPA):

- **ENERGY STAR Challenge for Schools**
  EPA is challenging school administrators and building managers to improve energy efficiency throughout their facilities. More than 500 school districts across the country are helping to fight climate change by committing to reducing their energy use with help from ENERGY STAR. Schools that take the ENERGY STAR Challenge can use energy tracking tools, technical guidance, case studies and other ENERGY STAR tools and resources to help them improve their energy efficiency. More information can be found at:
  http://yosemite.epa.gov/opa/admpress.nsf/d985312f6895893b852574ac005f1e40/d74f768ecfa9e11f8525762500522260!OpenDocument

For additional assistance in helping you save money and improve school conditions, please call TRC at (603) 766-1913 or (877) 442-9181.

NEW HAMPSHIRE ENERGYSMART SCHOOLS PROGRAM

Energy Benchmarking Report for:

Gonic Elementary School

Gonic, NH

Period: ***July 1, 2010*** through ***June 30, 2011***

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I. Introduction

The Sustainable Energy Division of the New Hampshire Public Utilities Commission, with support from the New Hampshire Department of Education has sponsored TRC to develop the New Hampshire ***EnergySmart Schools Program*** to support New Hampshire K-12 public and private schools in the pursuit of energy efficiency and sustainability initiatives.

Energy efficiency has become an increasingly important issue for schools due to tightening budgets and rising energy costs. Since 2003, the prices of natural gas, fuel oil and electricity have increased by 123%, 107% and 32% respectively. Schools that have participated in energy benchmarking programs have shown a decrease in overall energy use by approximately 22% through the adoption of energy efficiency measures.

Tracking and documenting the energy use and associated carbon emissions in the state's K-12 schools will allow New Hampshire to account for the impact of its energy efficiency and renewable energy programs and determine which have the greatest effect. The analysis in this report, provided by the ***EnergySmart Schools Program*** is designed to help you:

- Understand the energy consumption and cost trends at each of your school buildings.
- Learn how your buildings are performing compared to other schools locally and nationally.
- Identify opportunities for improving operations and reducing costs.
- Take advantage of resources to implement efficiency improvements and save money.

The analysis was based on the information provided on the *Building Data Request Form* submitted, which included building descriptions, energy suppliers and other information. The building's utility bills were also used to assess its electricity and heating fuel consumption for the year(s) provided.

The energy performance for your school has been compared to national data for similar school facilities through EPA's ENERGY STAR® Portfolio Manager. Also shown are the five major benchmarks used to analyze building performance, which include: electricity use; heating fuel use; weather-normalized heating fuel use; total cost; and total cost per student, all of which have been normalized for comparison by square footage and weather. As part of the program's focus on sustainability, your school's carbon footprint is also presented.

II. Benchmarking Analysis and Review Results

Building and energy usage of your school was analyzed to assess the basic nature of your energy consumption and utility costs. The Building Data Summary table shown below summarizes this information.

Table 1: Building Data Summary for Gonic Elementary School

Building Data			
District	SAU 54 Rochester School Department	**School Name**	Gonic Elementary School
City	Gonic	**Zip Code**	03839
Year Built	1897	**Floor Area (sq.ft.)**	42,400
Number of Students	260	**Number of PCs**	56
Weekly Operating Hours	60	**Months School Used**	12
Cooking?	YES	**% AC**	10
Pool Size?	N/A	**Months Pool Used**	0

Utility Data			
Data End Point	6/30/2011	**Total Cost ($)**	47,767
Electric Provider	PSNH	**Natural Gas Provider**	Unitil
Electricity Usage (kWh)	167,280	**Electricity Cost ($)**	25,280
Natural Gas Usage (therms)	16,641	**Natural Gas Cost ($)**	22,488
Fuel Oil Usage (gal)	0	**Fuel Oil Cost ($)**	0
Other Fuel Usage (gal)	0	**Other Fuel Cost ($)**	0

Energy Indicators			
EPA Score	90	**Electric Usage (kWh/sq.ft.)**	3.9
Heating Fuel Usage (kBtu/sq.ft.)	39.2	**Weather Adjusted Heating Usage Btu/sq.ft./HDD)**	5.4
Site Energy (kBtu/sq.ft.)	52.7	**Source Energy (kBtu/sq.ft.)**	86

Environmental Impact Indicators			
Greenhouse Gas Emissions			
Last Year Heating Fuel CO_2e (Mt)	88.6	**Last Year Total CO_2e (Mt)**	140.5
Last Year Electricity CO_2e (Mt)	51.9	**CO_2e Efficiency Savings Over Previous Year**	-9.5
EPA Target Score			
Target Score	Reached	**Site Energy Reduction Needed (kBtu/sq.ft.)**	N/A - Reached

Figures 1a, 1b, 2a and 2b display the energy use, demand and cost data tracked on a monthly basis. This demonstrates the energy consumption of your building over the course of the year. As a part of the program's focus on sustainability, your school's carbon footprint was also measured and is presented in Figure 3.

Figure 1a. Monthly Electric Use & Max Demand for Gonic Elementary School

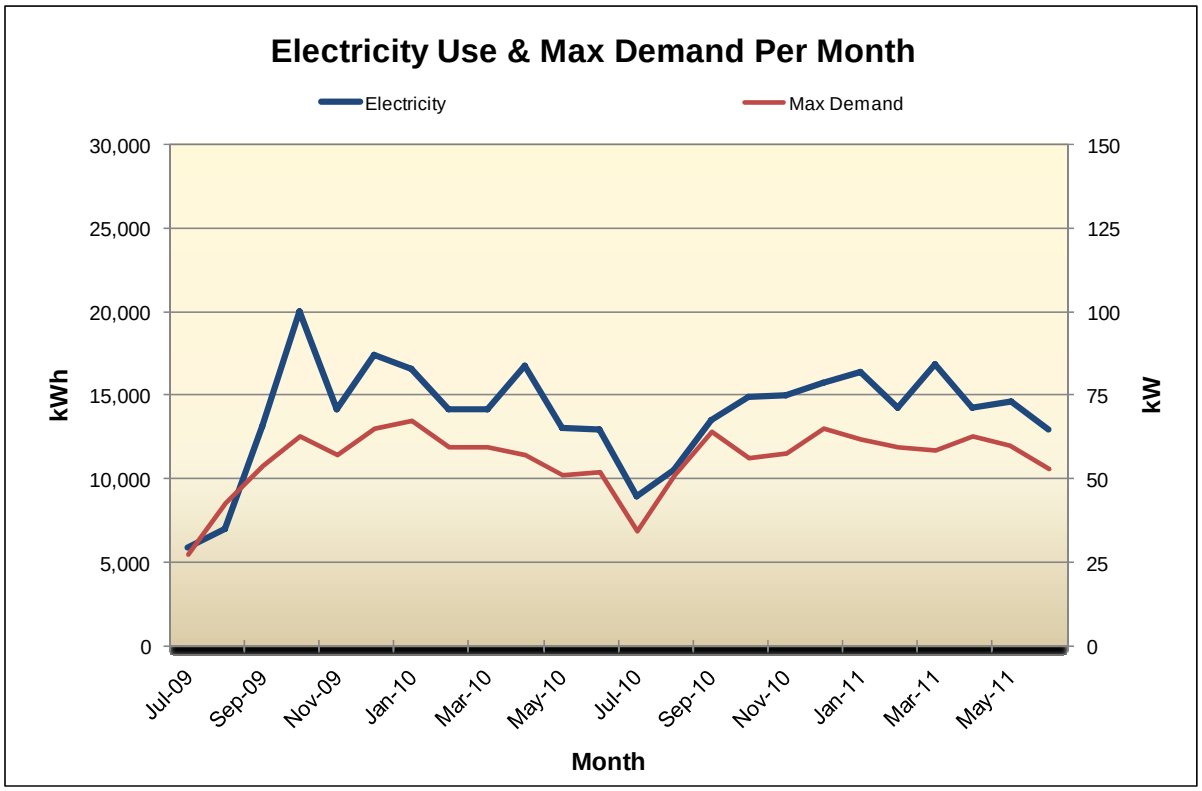


Figure 1b. Monthly Electric Use vs. Cost for Gonic Elementary School

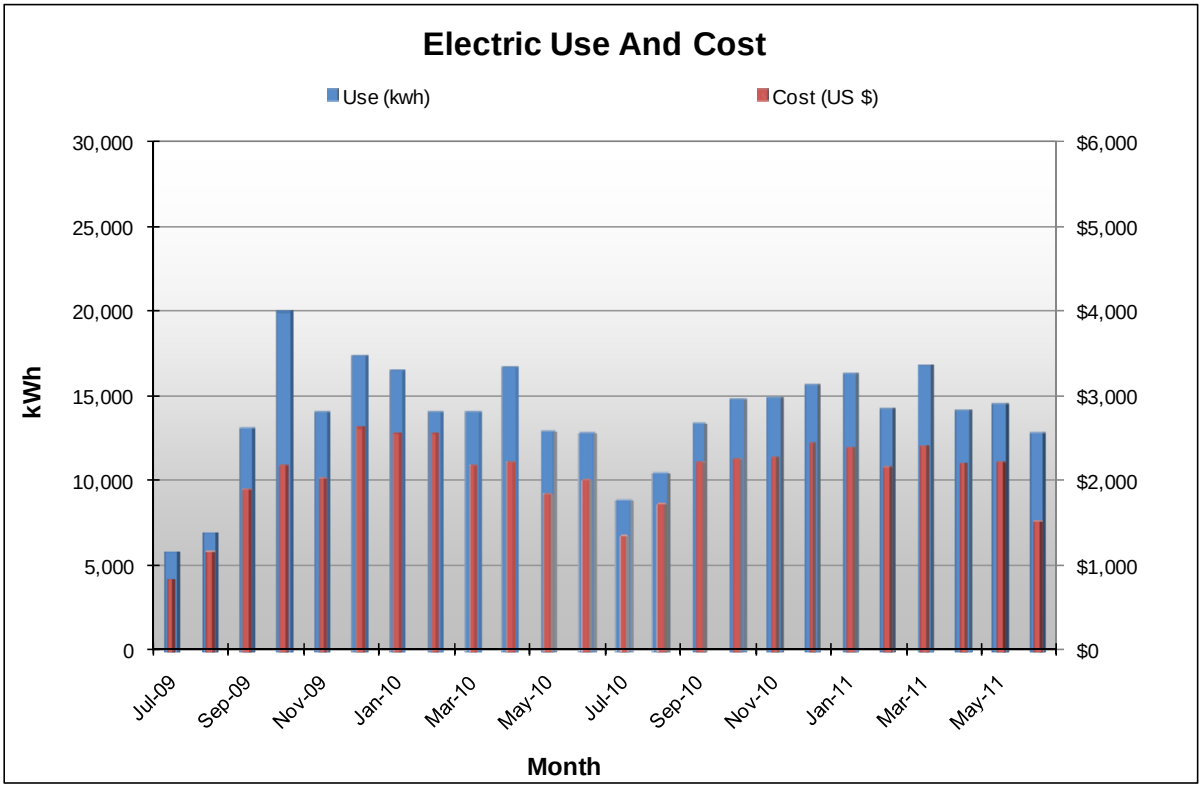


Figure 2a. Monthly Natural Gas Use for Gonic Elementary School

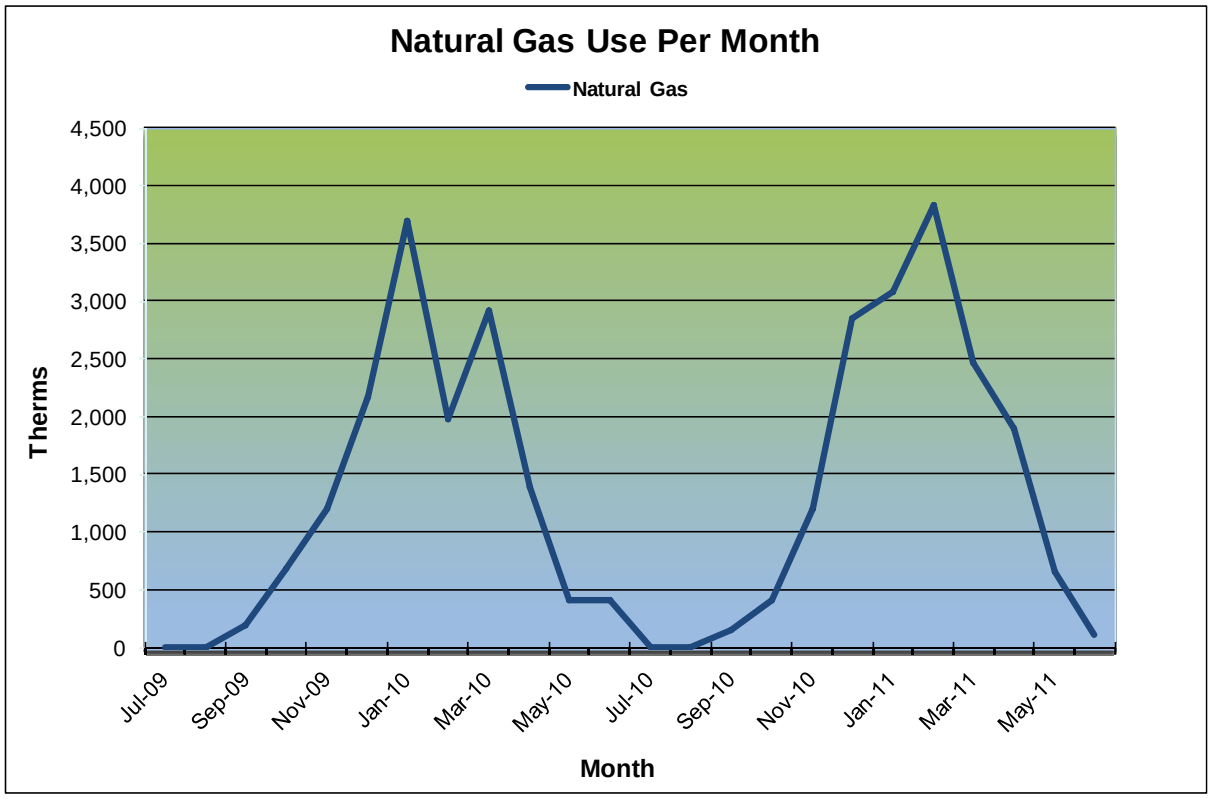


Figure 2b. Monthly Natural Gas Use vs Cost for Gonic Elementary School

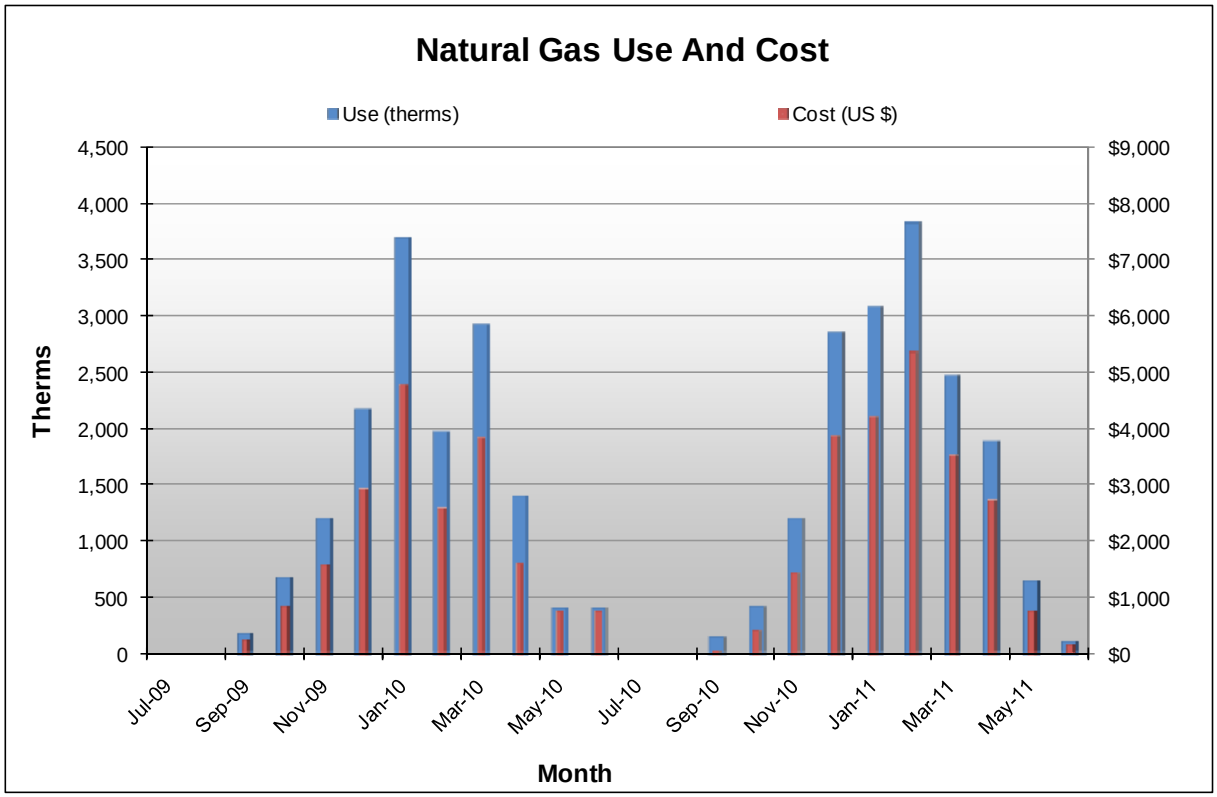
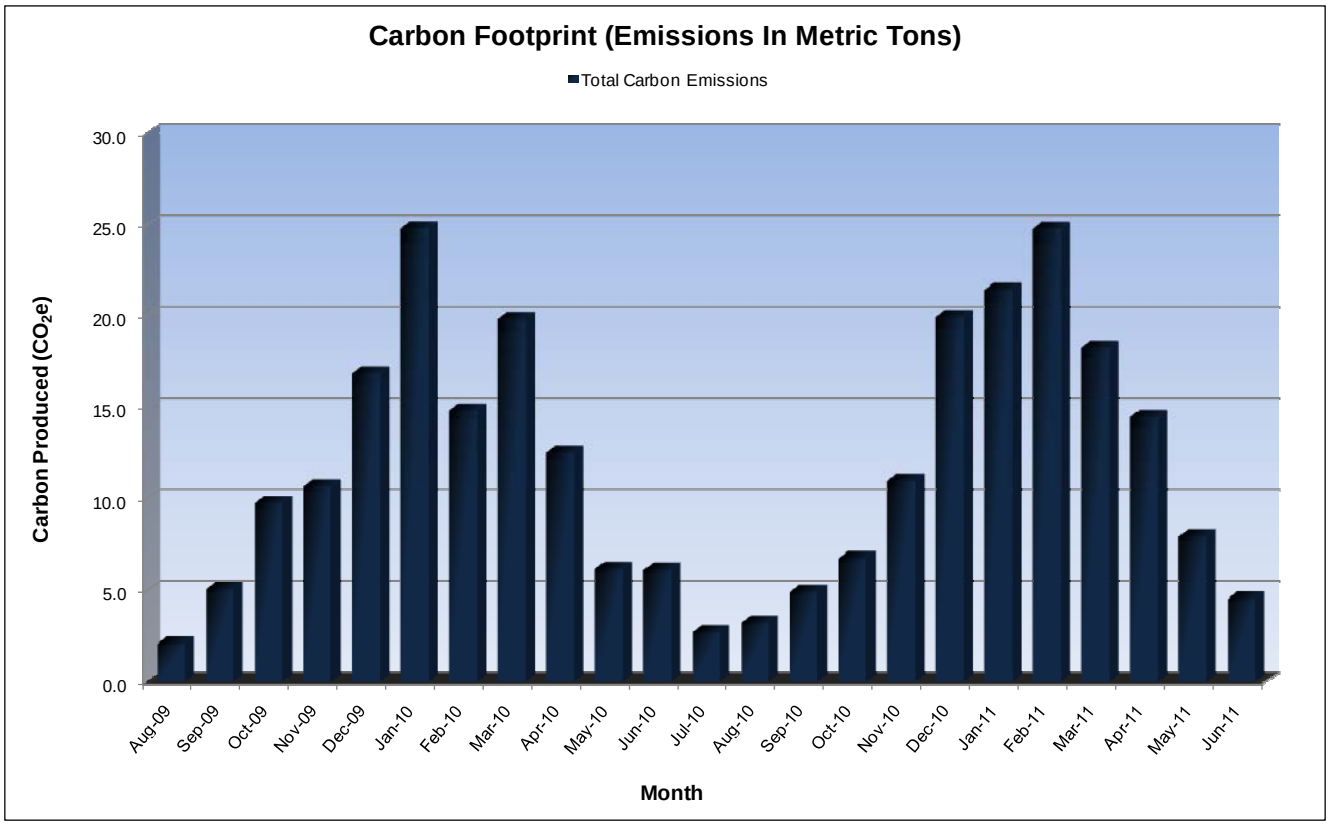


Figure 3. Monthly Greenhouse Gas Emissions for Gonic Elementary School



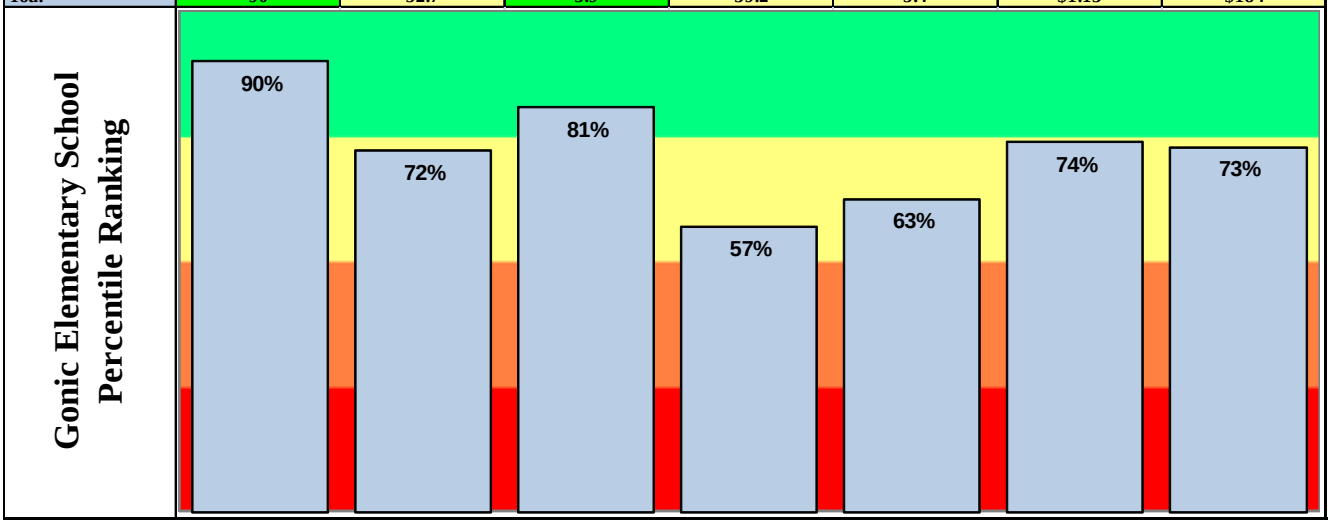
Benchmarking Data

To evaluate the energy and environmental performance of your school, the building data collected above has been compared against two different sets of school energy data: the U.S. Environmental Protection Agency's national data and New Hampshire specific state data. The results are illustrated in Figure 4 on the following page.

This will allow you to assess your building's performance relative to other buildings designed and constructed to the same codes and standards, operating under the same regulations and schedules and similar weather conditions. The indicators are calculated on a *per square foot* or *per student* basis, so you can compare your school to different sized schools.

Figure 4. EnergySmart Schools Benchmarks for Gonic Elementary School

Schools	U.S. EPA Portfolio Manager Score	New Hampshire State Schools (Annual Data)					
		Total Energy Use (kBtu/sq.ft.)	Electric Use (kWh/sq.ft.)	Heating Fuel Use (kBtu/sq.ft.)	Weather Adjusted Heating Fuel Use (Btu/sq.ft./HDD)	Total Energy Cost ($/sq.ft.)	Total Energy Cost ($/student)
NH Average:	50	60.3	5.2	41.7	5.7	$1.42	$256
You:	90	52.7	3.9	39.2	5.4	$1.13	$184



Major Benchmark Indicators

1. Total Energy Use, kBtu/sq.ft.

This indicator shows how much total energy your school consumes each year. It includes the energy used for heating, cooling (if any), lights, cooking, computers, etc.

Your school's total energy use of 52.7 kBtu per square foot per year (kBtu/sq.ft.) is better than the New Hampshire K-12 schools state average of 60.3 kBtu/sq.ft. Your total energy use figure is lower than 72% of New Hampshire K-12 schools. The EnergySmart School Report is weather normalized so fuel consumption for heating takes the difference in climate between northern and southern New Hampshire into account.

This is a good indicator of how well, overall, your school is performing. However, it doesn't help you find ***where*** in your building to look for improvement opportunities. Multiple factors included on the following pages can help with that. Analysis of energy consumption for this program does not control for operational variations. An example is an improperly ventilated school may appear to have lower energy consumption. Ventilation systems that are not operating properly result in lower indoor air quality.

2. Electricity Data

Most electric utilities use the following two factors to estimate your electricity bill – Electric Use and Electric Demand.

a. Electric Use, kWh/sq.ft.

This shows how well the building does with its lights, cooling/air conditioners and cafeteria systems (if any), and what's referred to as "plug load." Plug load is anything that plugs into a socket. The major plug loads are generally computers (including monitors, printers and copiers), refrigerators, coffee machines, fans, shop equipment and projectors. If electric consumption is much higher than average, but heating fuel use (see below) is average or better, then focus your efforts on the electric-powered elements.

New Hampshire schools state average electric use is 5.2 kWh per square foot. Your school's electric consumption of 3.9 kWh per square foot this year is lower than 81% of New Hampshire schools benchmarked through the New Hampshire EnergySmart Schools Program.

b. Electric Demand, Watts/sq.ft.

Demand is a measure of the maximum electric draw in kW that your building places on the grid and is measured by adding up the kW draw for a 15 minute period. To give an analogy, if electricity usage is the amount of water going through a hose in gallons, electric demand would be how fast that water flows expressed in gallons per minute. Whichever 15 minute period during your monthly billing cycle places the highest kW demand on the grid is the demand factor applied to your bill. The best way to improve this demand factor is to stagger the times when your electrical systems draw at their maximum or reduce unnecessary electric load altogether.

The average electric demand for New Hampshire schools is 1.9 watts per square foot. Your school's electric demand is 1.5 watts per square foot and is lower than 80% of New Hampshire Schools benchmarked through the New Hampshire EnergySmart Schools Program.

3. Heating Fuel Use, kBtu/sq.ft.

Reviewing these indicators is relatively straightforward. If your school's heating fuel use is much higher than average, an audit of your heating system along with your building envelope - doors, windows, roof - is recommended. This factor is 'fuel-neutral' as it works for either fuel oil or natural gas heating systems.

New Hampshire K-12 schools state average heating fuel use is 41.7 kBtu/sq.ft. or 5.7 Btu/sq.ft./HDD. Your school's heating fuel use of 39.2 kBtu/sq.ft. per year is lower than 57% of other New Hampshire schools in the database. Your school's weather adjusted heating fuel use of 5.4 Btu/sq.ft./HDD is lower than 63% of other New Hampshire schools benchmarked through the New Hampshire EnergySmart Schools Program.

4. Energy Cost, $/sq.ft. & $/student

Cost is the bottom line. These numbers help you understand, in terms of budget, the gain through energy efficiency improvements. New Hampshire K-12 schools state averages $1.42/sq.ft. and $256/student.

Your school's annual energy cost of $1.13 per square foot is lower than 74% of other New Hampshire benchmarked schools. Your school's cost expressed on a per student basis of $184 is lower than 73% of other New Hampshire schools benchmarked through the New Hampshire EnergySmart Schools Program.

5. U.S. EPA *Portfolio Manager* Score

Portfolio Manager is a benchmarking model based on a national set of data from K-12 schools. It is provided by the U.S. Environmental Protection Agency's ENERGY STAR® Program. The impact of factors outside of your control (such as location, occupancy and operating hours) are removed, providing a 1-100 ranking of a school's energy performance relative to the national school building market. A score of 50 represents the national average and a score of 100 is best. Schools that achieve a score of 75 or higher are eligible for EPA's ENERGY STAR® Building Label, the national symbol for protecting the environment through energy efficiency. Districts can achieve ENERGY STAR® Leader Awards in recognition if their buildings, on average, improve by 10%, 20%, 30%, etc. over their baseline year of reported energy use or if the district's overall weighted average *Portfolio Manager* Score is at least a 75.

Your school's *Portfolio Manager* Score of 90 places it higher than 90% of K-12 schools nationwide. As noted above, this rating potentially qualifies your school for the prestigious ENERGY STAR® Label for Buildings.

III. Potential Energy Saving Opportunities

Based on the preceding analysis of your school's energy performance, implementation of the following recommendations can help you save energy and money. The first step is to look at reducing electrical lighting and HVAC consumption (burners, circulators and fans) which typically account for 67% of a building's electric consumption.

- **Perform an Energy Audit on the Building**

An energy audit involves a comprehensive analysis of the building's general characteristics, its energy use and allocation of that use amongst the facility's energy end uses. The goal is to identify sources of potential energy savings. Your auditor should develop a list of recommendations that will result in substantial energy and operational cost savings. These may include, building envelope improvement and mechanical systems, lighting upgrades, equipment replacement and installation of lighting and HVAC control mechanisms, among others.

A good audit should include information specific to each recommendation which *at least* includes approximate annual energy unit and cost savings, demand reduction, installation cost, lifetime cost savings and information related to cost-effectiveness. This will help to prioritize the recommendations based on their energy efficiency and shortest payback.

The recommendations provided in an energy audit report may reduce facility energy bills by 20% or more in addition to improving occupant health and comfort. Following this report, an energy audit is the next step in realizing the full potential of energy savings opportunities.

- **Request Retro-Commissioning**

Retro-commissioning is a detailed process applied to existing facilities aimed at correcting many of the degradations and inefficiencies that are indicative of older and/or poorly performing buildings. Many older buildings tend to be less comfortable and operate less efficiently when not properly commissioned. Retro-commissioning includes a detailed energy audit and focuses on not only potential energy savings but also the interaction of the building's equipments and mechanical systems with an eye toward restoring it to optimal performance.

In contrast to an energy audit, this optimization focuses on operational improvements to existing equipment, rather than replacement. Apart from energy savings, other improvements and benefits include substantial operation and maintenance (O&M) cost savings, improved air quality, occupant comfort, health and safety, equipment controls, and improved system interactivity.

In addition to providing recommendations, retro-commissioning includes implementation of the recommended improvements and hence the cost for retro-commissioning is higher than an audit. However, when the costs of improvements are added to the energy audit cost, prices may be comparable. If high O&M costs or occupant health, comfort and safety are concerns in addition to reduction in energy use, retro-commissioning may be a suitable strategy.

- **Upgrade Lighting Systems**

Lighting typically accounts for 30-60% of all energy consumed in school buildings. Additionally, the electrical energy consumed by lights during the summer creates heat and increases cooling costs.

Gonic Elementary School's electricity consumption is low (better) compared to other schools in the State. Even so, upgraded lighting systems in high consumption areas like classrooms, gymnasiums, libraries, offices, etc. can reduce costs, improve the lighting quality and increase occupant comfort and productivity.

Over-lit Spaces: Light levels should be recorded in classrooms and hallways to ensure they are not over-lit, 40-50 foot candles are adequate light levels for an instructional space. If classroom light levels are much higher than 50 foot candles, Gonic Elementary School should consider de-lamping classrooms or installing dimming ballasts, which dim the lights when outdoor light levels are adequate. In over-lit hallway spaces photo sensors can be installed to turn lights off completely when light levels exceed a pre-set threshold.

In over-lit spaces a T8 to Super T8 lighting retro-fit can reduce the number of light fixtures needed. Super T8 lamps use between 4 and 7 Watts less electricity than standard T8 lamps, but they produce more light per Watt. In some cases this increase in light per Watt can allow for the removal of an entire lamp, saving 32 Watts. The room characteristics must be factored in before this type of retro-fit. The shape of the space, ceiling height, color of the walls, etc. all need to be taken into account when exploring a de-lamping project. We recommend that before retro-fitting the entire facility, begin by changing one classroom and monitor the comfort level of the occupants at Gonic Elementary School.

Another proven energy reduction measure with a short payback period is to identify any areas where your school may still be using metal halide lighting. Typically metal halide lights are found in gymnasiums or cafeteria areas, many districts have been very satisfied by replacing these lights with high bay T5 lighting fixtures. In addition to the reduced operational wattage, high bay T5 lights turn on instantly, as opposed to metal halide fixtures which have an extended warm up period. The long warm up period associated with metal halides typically leads to the lights being left on all day, at 250 to 400 watts a fixture; the costs begin to add up. Adding occupancy sensors to high bay T5 fixtures further reduces the payback period.

Occupancy Sensors: We recommend that you explore the use of occupancy sensors to ensure that lights are turned off in unoccupied spaces. Lights controlled by occupancy sensors typically run a third of the time when compared with manually controlled lighting. Reduced runtime leads to decreases in both energy usage and operation and maintenance costs. Additionally, a study conducted in Massachusetts found that controlling the security lighting with occupancy sensors reduced vandalism; neighbors and police recognized something wrong when the lights were on in a building that was typically dark and investigated.

To summarize and add a few ways in which Gonic Elementary School may be able to conserve energy and cost through lighting upgrades is to:

- Design light quantity and quality for the task and occupants' needs in that area.
- Maximize lamp and ballast efficiency.
- Activate the power saving features on office equipment such as copiers, printers and fax machines and ensure that they are turned off at the end of the day.
- Use automatic controls to turn lights off or dim lights in unoccupied spaces.
- Establish a maintenance schedule for group re-lamping and fixture cleaning.
- Replace T12 fixtures with the most efficient fixtures which may include T8/super T8/T5 fixtures.
- Replace incandescent lighting with compact fluorescent technology.

- Replace incandescent exit lighting which consumes 30 Watts with LED type exit lights with 1.5 Watts consumption. LED units last up to 10 years, which is a maintenance advantage.
- Install daylight sensors in areas with significant natural light.
- Install occupancy sensors in areas that are often unoccupied.
- Lighting retrofits reduce maintenance costs associated with lighting that is close to end of life.
- Establish a regular cleaning schedule particularly for areas where student safety of low light levels may be a concern, such as shop classes.
- Look to make lamp and fixture selection as uniform as possible to reduce maintenance and inventory overhead.
- Educate students and staff to turn off lights when rooms are unoccupied.

Lighting upgrades seek to reduce the connected electrical load (kW) and energy consumption (kWh) of lighting equipment. Lighting controls can also significantly reduce operating hours and costs by turning off lighting when spaces are unoccupied or sufficiently lit by natural light.

- **Install NEMA Premium Motors and VFDs**

Commercial and industrial electric motor-driven systems consume approximately 23% of all electricity in the U.S., making it the single largest category contributor to electric use in the country. With very high operating hours, the annual energy cost to run a system is more than its installation cost. Even a small increase in the efficiency of an electric motor can result in substantial energy cost savings. Typical opportunities for motor upgrades in schools include: ventilation fans, and heating and cooling system pumps and fans.

Motors with efficiency up to 90% are available to replace the older ones with efficiency less than 75%. Although standards for efficiency of new equipment are set by the Energy Policy Act, motor efficiency can be further increased by selecting Premium Efficiency motors as specified by the National Electrical Manufacturers Association (NEMA). This can cut the electric motor system demand by as much as 18%.

Savings can be increased further by optimizing system performance through the use of variable frequency drives (VFDs). When system load is known to vary substantially, these flow control systems can be utilized to match system output to system demand, significantly reducing energy usage during partial load hours. By employing high-efficiency motors and VFDs, facility owners can improve environmental conditions, utilize better control of motor-driven processes, and reduce waste output.

- **Install Demand Control Ventilation**

Demand control ventilation (DCV) monitors indoor air CO_2 content as a result of occupancy production levels and uses this data to regulate the amount of outdoor air that is permitted for ventilation. In order to ensure adequate air quality, standard ventilation systems permit outside air based on estimated occupancy levels in CFM, cubic feet per minute/occupant. However, during low occupancy hours, the space may become over ventilated due to decreased CO_2 levels and unnecessary ventilation results in wasted energy. DCV reduces unnecessary outdoor air intake by regulating ventilation based on actual CO_2 levels, saving energy. DCV is most suited for areas where occupancy levels are known to fluctuate considerably such as auditoriums, cafeterias, and gymnasiums.

Install Energy Recovery Ventilators. According to energy recovery equipment manufacturer's typical paybacks are less than 5 years for schools without cooling. The keys to success with ventilation retrofits are going with fewer larger units with long run hours as opposed to several small units with limited run time. Equipment with moisture recovery capabilities would cut humidity up to 50% during the cooling season.

- **Improve/Replace Inefficient Heating Systems**

Replacing an old boiler that is < 70% efficient with a modern 85-90% efficient natural gas-fired furnace alone will reduce heating costs by 15-20%. This combined with additional system improvements and installation of advanced HVAC control mechanisms can result in up to 20%+ heating load reduction.

Because of the high capital cost of new heating systems, some financial analysis should be performed to assess the cost-effectiveness of immediate replacement. If the current system is fairly new, replacement may not be immediately justifiable from a financial standpoint. However, as is the case with cooling systems, early replacement may prove to be a more cost-effective solution than waiting until existing systems fail or reach the end of their estimated useful life.

- **Improve/Replace Inefficient Air Conditioning Systems**

The useful life of a rooftop A/C unit is generally 12-18 years. However, depending on the efficiency, early replacement of outdated, inefficient, split, or packaged rooftop air conditioning units with new A/C systems that are 15% more efficient than 10-15 year old equipments can considerably reduce annual energy consumption. The energy cost savings and maintenance savings offset the high installation cost of a more efficient system. Installing thermostats and/or economizers on new or existing A/C systems will further reduce the cooling demand.

Economizers provide "free" cooling by using controllable dampers that bring in outside air to cool the space when the outdoor temperature or enthalpy is below the building's return air conditions. Although they require operation by a well calibrated and maintained control system, economizers have impressive energy-saving capabilities.

Install Occupancy Controlled/Programmable Thermostats

Combining efficient HVAC equipment with occupancy controlled and programmable thermostats can save a facility up to 10% of its annual heating and cooling costs:

- Areas with unpredictable occupancy on a daily/weekly basis - gym, bathrooms, outdoors: Use an *occupancy controlled thermostat* - a thermostat paired with a sensor and/or door detector to identify movement/occupancy. If occupancy is sensed by the sensor, the thermostat goes into an occupied mode (i.e. programmed set point). If a pre-programmed time frame elapses (i.e. 30 minutes) and no occupancy is sensed during that time, the thermostat goes into an unoccupied mode (e.g., setback set point or off) until occupancy is sensed again. This reduces the overall time the heating or cooling system is running, saving energy.

- Areas with predictable occupancy: e.g.: classrooms, cafeteria, offices: A *programmable thermostat* is recommended. This device is programmed on a schedule to reduce the heating or cooling output of the facility's HVAC systems in relation to its predetermined occupancy schedule. In this way, the thermostat acts to set-back or set-up the facility temperature during unoccupied hours, and re-establish a comfortable facility temperature during business hours. By employing programmable thermostat technology, the heating and cooling system demand coincides with occupancy level, reducing energy usage.

- **Install Vending Misers on Vending Machines**

Vending misers for refrigerated and non-refrigerated vending machines is an often overlooked source of potential savings. Uncontrolled, vending machine lights remain on 24/7, consuming a constant amount of energy year round. By controlling these lights with an occupancy sensor, energy consumption attributed to vending machines can be reduced considerably, in many cases, by as much as 50% and can save up to $150 per machine per year.

In the case of refrigerated vending machines, electric demand can be further reduced by controlling the machines' refrigeration systems. In a manner similar to programmable thermostats, vending misers for refrigerated machines act on a pre-set occupancy schedule to allow a marginal increase in operating temperature during non-business hours. Although products in the machine are delivered to the customer at the same temperature as in an uncontrolled vending machine, products are not being cooled unnecessarily when the machine is not in use, significantly reducing the machine's energy consumption. Because of the relatively low vending miser installation cost and high operating hours of vending machines, this improvement is typically cost-effective with a very short payback period.

- **Install ENERGY STAR® Rated Equipment / Plug Load Control**

Plug loads (computers, televisions, coffee makers, etc.) account for, on average, about 10% of total energy consumption. One of the easiest and most cost-effective energy saving strategies is the reduction of electric usage through installation of efficient appliances and the control of plug loads. In addition to utilizing ENERGY STAR® qualified appliances, greater savings can be realized through the various devices available that control every day plug loads.

By connecting non-critical loads (coffee makers, fans, microwave ovens, etc.) to an occupancy or timer controlled power strip, significant energy savings can be achieved. These savings result not only from the neglect of the user to turn the device off manually, but also from reduction of "phantom load". Phantom load is the small but constant energy draw from many plug-in devices when not in use. By connecting certain appliances to an occupancy controlled power strip, phantom load can be eliminated by cutting power supply to those devices. When replacing or ordering new equipment, emphasize ENERGY STAR® devices when they are available. Also, purchase controlled power strips and connect appropriate devices to those strips to reduce unnecessary consumption due to phantom load and appliances left on. The EPA offers free computer power management software which has saved some districts as much as $75 per computer per year, the software can be found at http://www.energystar.gov/index.cfm?c=power_mgt.pr_power_mgt_low_carbon_join.

IV. Resources:

The State of New Hampshire along with the utility companies offer multiple programs designed to improve the energy efficiency of schools through financial incentives and technical support, including:

Northeast Energy Efficiency Partnerships:

- **Northeast Collaborative for High Performance Schools (NE-CHPS)**
  NE-CHPS is a set of building and design standards for all schools from pre-K through community colleges tailored specifically for NH state code requirements, the New England climate, and the environmental priorities of the region. NH Department of Education offers up to a 3% re-imbursement for New Construction School projects. To learn more about NE-CHPS and incentive programs please visit: http://neep.org/public-policy/hpse/hpse-nechps.

New Hampshire Public Utilities Commission:

- **New Hampshire Pay for Performance**
  This program addresses the energy efficiency improvement needs of the commercial and industrial sector. The Program is implemented through a network of qualified Program Partners. Incentives will be paid out on the following three payment schedule: Incentive #1: Is based on the area of conditioned space in square feet. Incentive #2: Per/kWh saved and Per/MMBTU saved based on projected savings and paid at construction completion. Incentive #3: Per/kWh saved and Per/MMBTU saved based on actual energy savings performance one year post construction. Total performance incentives (#2 and #3) will be capped at $200,000 or 50% of project cost on a per project basis. For more information visit http://nhp4p.com.

- **New Hampshire Public Utilities Commission's Renewable Energy Rebates**
  The Sustainable Energy Division provides an incentive program for solar electric (photovoltaic or PV) arrays and solar thermal systems for domestic hot water, space and process heat, with a capacity of 100 kW or equivalent thermal output or less. The rebate for PV systems as follows: $1.00 per Watt, capped at 25% of the costs of the system or $50,000, whichever is less. For solar hot water (SHW) systems, the base rebate is $0.07 per rated or modeled kBtu/year, capped at 25% of the cost of the facility or $50,000, whichever is less, as a one-time incentive payment. http://www.puc.state.nh.us/Sustainable%20Energy/RenewableEnergyRebates-CI.html.

New Hampshire Community Development Finance Authority:

- **New Hampshire Community Development Finance Authority Revolving Loan Fund**
  The Enterprise Energy Fund is a low-interest loan and grant program available to businesses and nonprofit organizations to help finance energy improvements and renewable energy projects in their buildings. The loans will range from $10,000 to $500,000. Larger amounts will be considered on a case by case basis. The program is available to finance improvements to the overall energy-efficiency performance of buildings owned by businesses and nonprofits, thereby lowering their overall energy costs and the associated carbon emissions. More information about the program can be found on their website www.nhcdfa.org. These activities may include:

  - Improvements to the building's envelope, including air sealing and insulation in the walls, attics and foundations;
  - Improvements to HVAC equipment and air exchange;
  - Installation of renewable energy systems;
  - Improvements to lighting, equipment, and other electrical systems; and
  - Conduction of comprehensive, fuel-blind energy audits.

Public Service of New Hampshire (PSNH):

- **Commercial (Electric) Energy Efficiency Incentive Programs**
  This program targets any commercial/industrial member building a new facility, undergoing a major renovation, or replacing failed (end-of-life) equipment. The program offers prescriptive and custom rebates for lighting and lighting controls, motors, VFDs, HVAC systems, chillers and custom projects. http://www.psnh.com/SaveEnergyMoney/For-Business/Energy-Saving-Programs-and-Incentives.aspx

- **SmartSTART**
  The SmartSTART (Savings Through Affordable Retrofit Technologies) advantage is simple - pay nothing out of pocket to have energy efficiency products and services installed in your building. The Smart Start program is limited to PSNH's municipal customers only and includes schools. The program is available on a first-come, first served basis to projects which have been pre-qualified by PSNH. The cost of the improvements is fronted by PSNH which is then repaid over time by the municipality or school using the savings generated by the products themselves! This program is for lighting and lighting controls, air sealing, insulation and other verifiable energy savings measures which have sufficient kilowatt-hour savings. For more information on this program visit:
  http://www.psnh.com/SaveEnergyMoney/For-Business/Municipal-Smart-Start-Program.aspx

- **Schools Program**
  For major renovation or equipment replacement projects, this program offers prescriptive and custom rebates for energy efficient lighting, motors, HVAC, chillers, and variable frequency drives to towns or cities that install energy efficient equipment at their schools. Financial incentives are available for qualifying energy efficient equipment. Technical assistance is also offered through the Schools Program. http://www.psnh.com/SaveEnergyMoney/Large-Power/Schools-Program.aspx

Unitil:

- **Commercial and Industrial Energy Efficiency Programs**
  Subject to program qualifications and availability of funding - Unitil offers different programs for its commercial, industrial, and institutional customers in New Hampshire: the Small Business Energy Efficiency Program, the Small Commercial and Industrial Program, the Large Commercial and Industrial Program, the Large Commercial and Industrial (C&I) Retrofit Program, and the Large C&I New Construction Program. Rebates are available for various technologies including water heaters, lighting, lighting controls/sensors, chillers, furnaces, boilers, central air conditioners, compressed air, programmable thermostats, energy management systems/building controls, motors, motor VFDs, processing and manufacturing equipment, LED exit signs, commercial cooking and refrigeration equipment. http://www.unitil.com/.

Clean Air – Cool Planet:

- **Community Energy Efficiency**
  CA-CP works with communities throughout the Northeast to find solutions to climate change and build constituencies for effective climate policies and actions. Much of their work focuses on successful models for energy efficiency and renewable energy planning. They advise and partner with citizens, educators, faith groups, small businesses, municipal governments, and other local leaders. They explore cost-effective opportunities that exist for communities to reduce their emissions as well as their vulnerability to climate impacts. One such example is CA-CP's partnership with the University of NH, NH Sustainable Energy Association and UNH Cooperative Extension to create www.myenergyplan.net, a groundbreaking suite of web and outreach tools for individual action used by households, schools and community groups around the northeast. http://www.cleanair-coolplanet.org/for_communities/index.php.

Environmental Protection Agency (EPA):

- **ENERGY STAR Challenge for Schools**
  EPA is challenging school administrators and building managers to improve energy efficiency throughout their facilities. More than 500 school districts across the country are helping to fight climate change by committing to reducing their energy use with help from ENERGY STAR. Schools that take the ENERGY STAR Challenge can use energy tracking tools, technical guidance, case studies and other ENERGY STAR tools and resources to help them improve their energy efficiency. More information can be found at:
  http://yosemite.epa.gov/opa/admpress.nsf/d985312f6895893b852574ac005f1e40/d74f768ecfa9e11f8525762500522260!OpenDocument

For additional assistance in helping you save money and improve school conditions, please call TRC at (603) 766-1913 or (877) 442-9181.

NEW HAMPSHIRE ENERGYSMART SCHOOLS PROGRAM

Energy Benchmarking Report for:

East Rochester Elementary School

East Rochester, NH

Period: ***July 1, 2010*** through ***June 30, 2011***

PREPARED BY:

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Table of Contents

I. Introduction

The Sustainable Energy Division of the New Hampshire Public Utilities Commission, with support from the New Hampshire Department of Education has sponsored TRC to develop the New Hampshire ***EnergySmart Schools Program*** to support New Hampshire K-12 public and private schools in the pursuit of energy efficiency and sustainability initiatives.

Energy efficiency has become an increasingly important issue for schools due to tightening budgets and rising energy costs. Since 2003, the prices of natural gas, fuel oil and electricity have increased by 123%, 107% and 32% respectively. Schools that have participated in energy benchmarking programs have shown a decrease in overall energy use by approximately 22% through the adoption of energy efficiency measures.

Tracking and documenting the energy use and associated carbon emissions in the state's K-12 schools will allow New Hampshire to account for the impact of its energy efficiency and renewable energy programs and determine which have the greatest effect. The analysis in this report, provided by the ***EnergySmart Schools Program*** is designed to help you:

- Understand the energy consumption and cost trends at each of your school buildings.
- Learn how your buildings are performing compared to other schools locally and nationally.
- Identify opportunities for improving operations and reducing costs.
- Take advantage of resources to implement efficiency improvements and save money.

The analysis was based on the information provided on the *Building Data Request Form* submitted, which included building descriptions, energy suppliers and other information. The building's utility bills were also used to assess its electricity and heating fuel consumption for the year(s) provided.

The energy performance for your school has been compared to national data for similar school facilities through EPA's ENERGY STAR® Portfolio Manager. Also shown are the five major benchmarks used to analyze building performance, which include: electricity use; heating fuel use; weather-normalized heating fuel use; total cost; and total cost per student, all of which have been normalized for comparison by square footage and weather. As part of the program's focus on sustainability, your school's carbon footprint is also presented.

II. Benchmarking Analysis and Review Results

Building and energy usage of your school was analyzed to assess the basic nature of your energy consumption and utility costs. The Building Data Summary table shown below summarizes this information.

Table 1: Building Data Summary for East Rochester Elementary School

Building Data			
District	SAU 54 Rochester School Department	**School Name**	East Rochester Elementary School
City	East Rochester	**Zip Code**	03868
Year Built	1968	**Floor Area (sq.ft.)**	51,400
Number of Students	362	**Number of PCs**	69
Weekly Operating Hours	60	**Months School Used**	12
Cooking?	YES	**% AC**	0
Pool Size?	N/A	**Months Pool Used**	0

Utility Data			
Data End Point	6/30/2011	**Total Cost ($)**	47,694
Electric Provider	PSNH	**Natural Gas Provider**	Unitil
Electricity Usage (kWh)	211,304	**Electricity Cost ($)**	32,874
Natural Gas Usage (therms)	10,701	**Natural Gas Cost ($)**	14,819
Fuel Oil Usage (gal)	0	**Fuel Oil Cost ($)**	0
Other Fuel Usage (gal)	0	**Other Fuel Cost ($)**	0

Energy Indicators			
EPA Score	95	**Electric Usage (kWh/sq.ft.)**	4.1
Heating Fuel Usage (kBtu/sq.ft.)	20.8	**Weather Adjusted Heating Usage Btu/sq.ft./HDD)**	2.9
Site Energy (kBtu/sq.ft.)	34.8	**Source Energy (kBtu/sq.ft.)**	69

Environmental Impact Indicators			
Greenhouse Gas Emissions			
Last Year Heating Fuel CO_2e (Mt)	57.1	**Last Year Total CO_2e (Mt)**	122.7
Last Year Electricity CO_2e (Mt)	65.6	**CO_2e Efficiency Savings Over Previous Year**	35.9
EPA Target Score			
Target Score	N/A - Reached	**Site Energy Reduction Needed (kBtu/sq.ft.)**	N/A - Reached

Figures 1a, 1b, 2a and 2b display the energy use, demand and cost data tracked on a monthly basis. This demonstrates the energy consumption of your building over the course of the year. As a part of the program's focus on sustainability, your school's carbon footprint was also measured and is presented in Figure 3.

Figure 1a. Monthly Electric Use & Max Demand for East Rochester Elementary

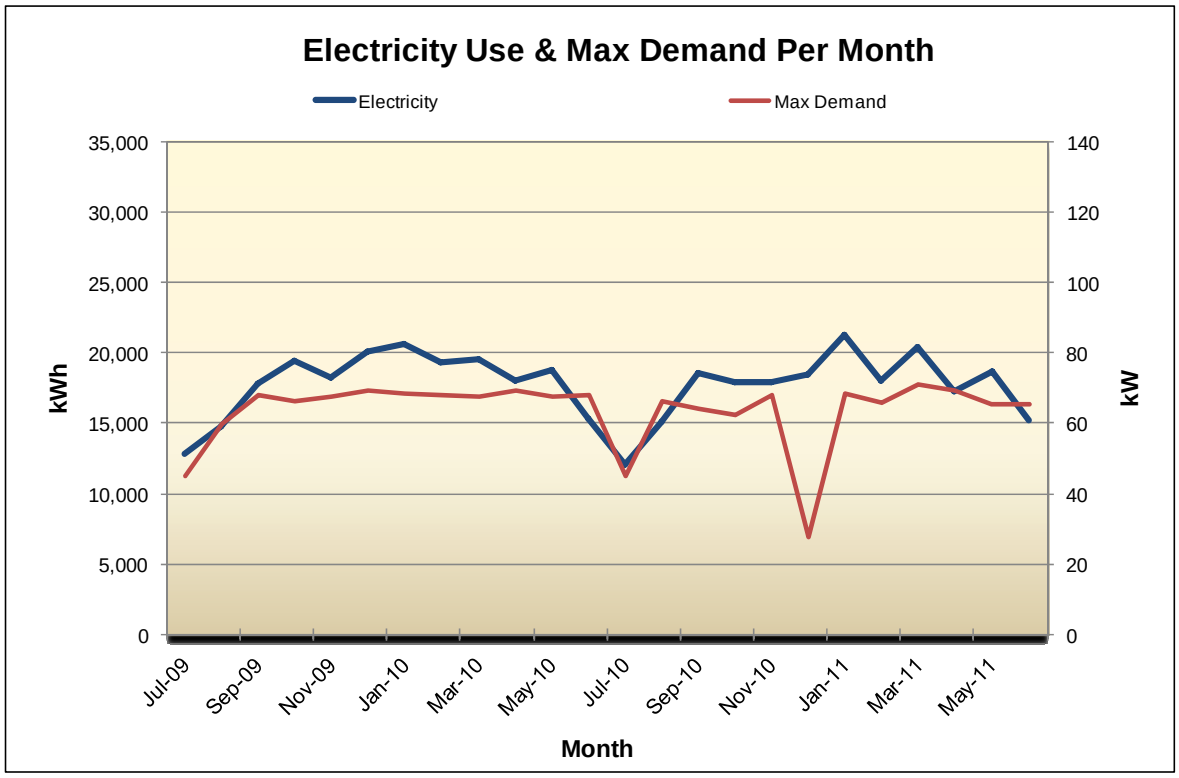
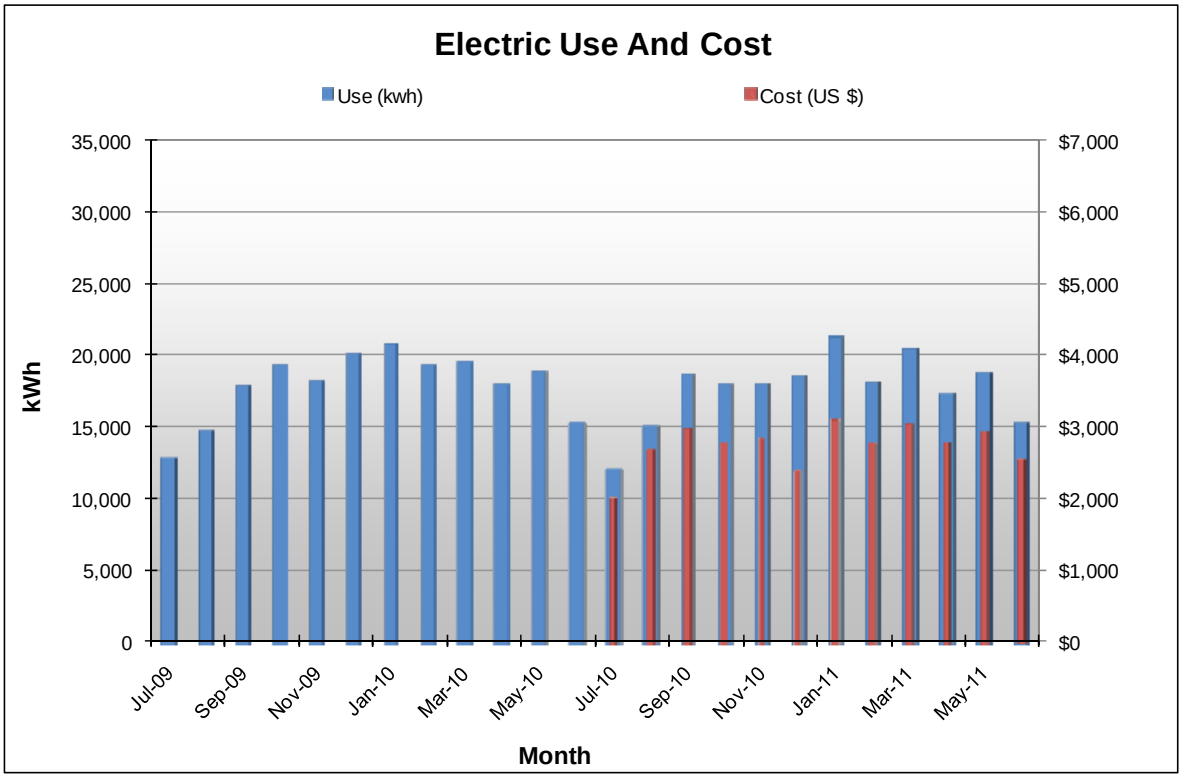


Figure 1b. Monthly Electric Use vs. Cost for East Rochester Elementary



Note: Electric Cost was only available for the most recent 12 month period.

Figure 2a. Monthly Heating Fuel Use for East Rochester Elementary

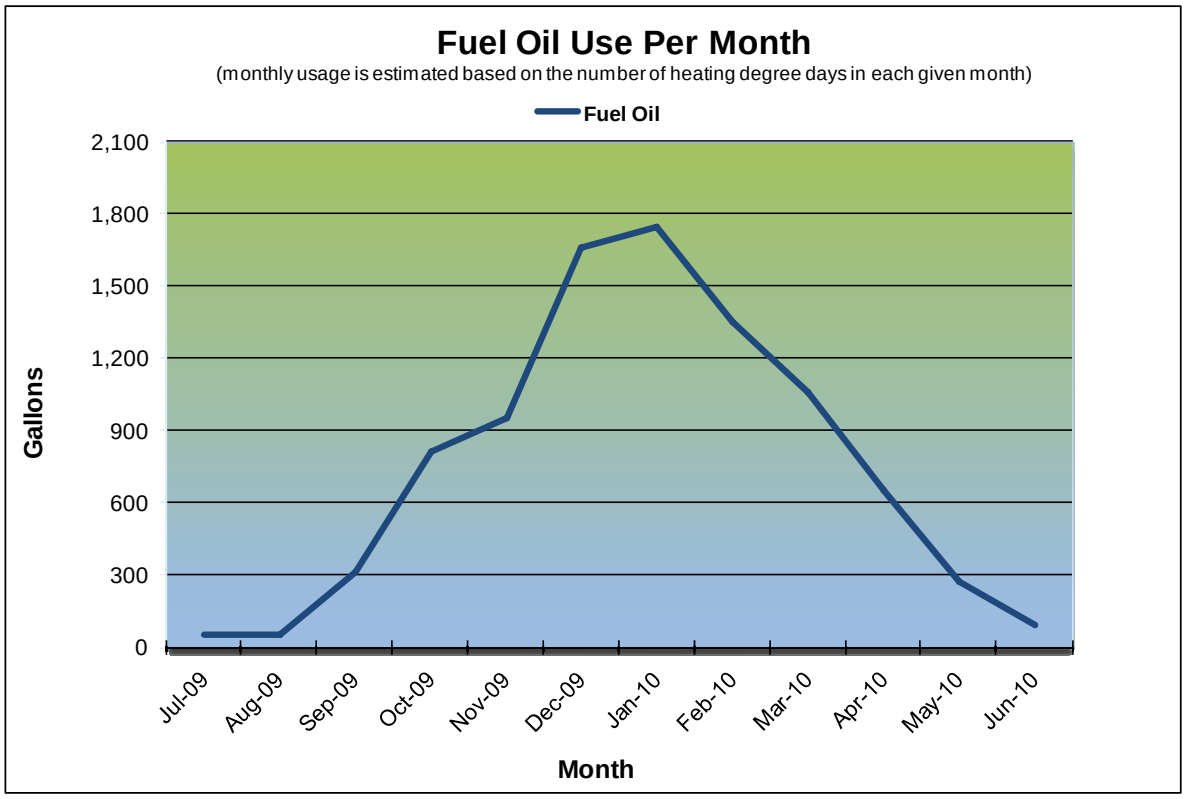


Figure 2b. Monthly Heating Fuel Use vs Cost for East Rochester Elementary

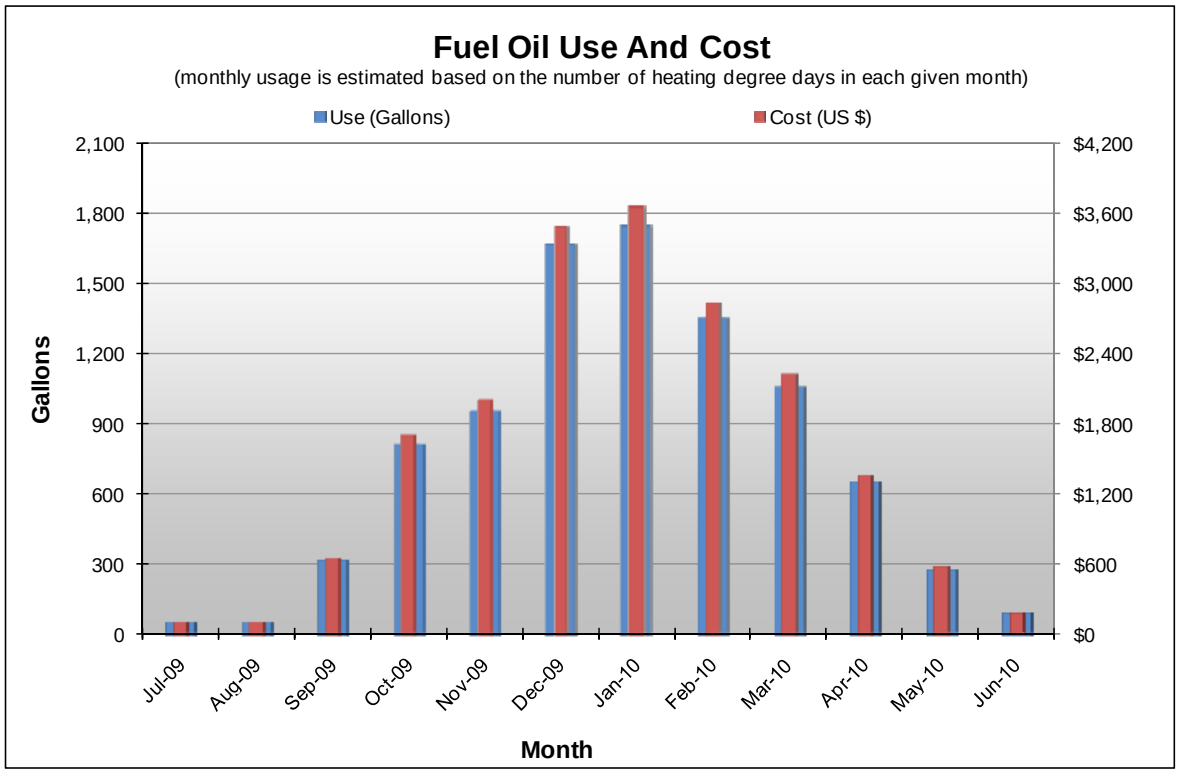


Figure 2a. Monthly Heating Fuel Use for East Rochester Elementary

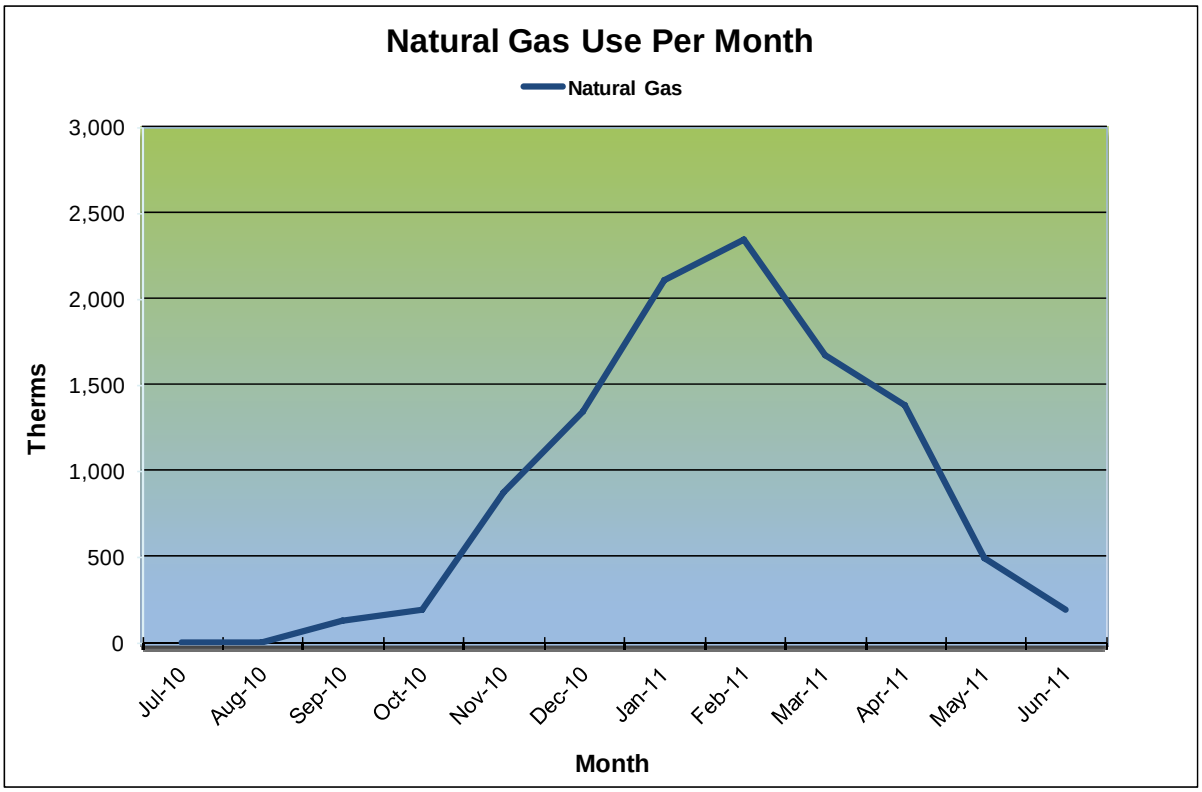


Figure 2b. Monthly Heating Fuel Use vs Cost for East Rochester Elementary

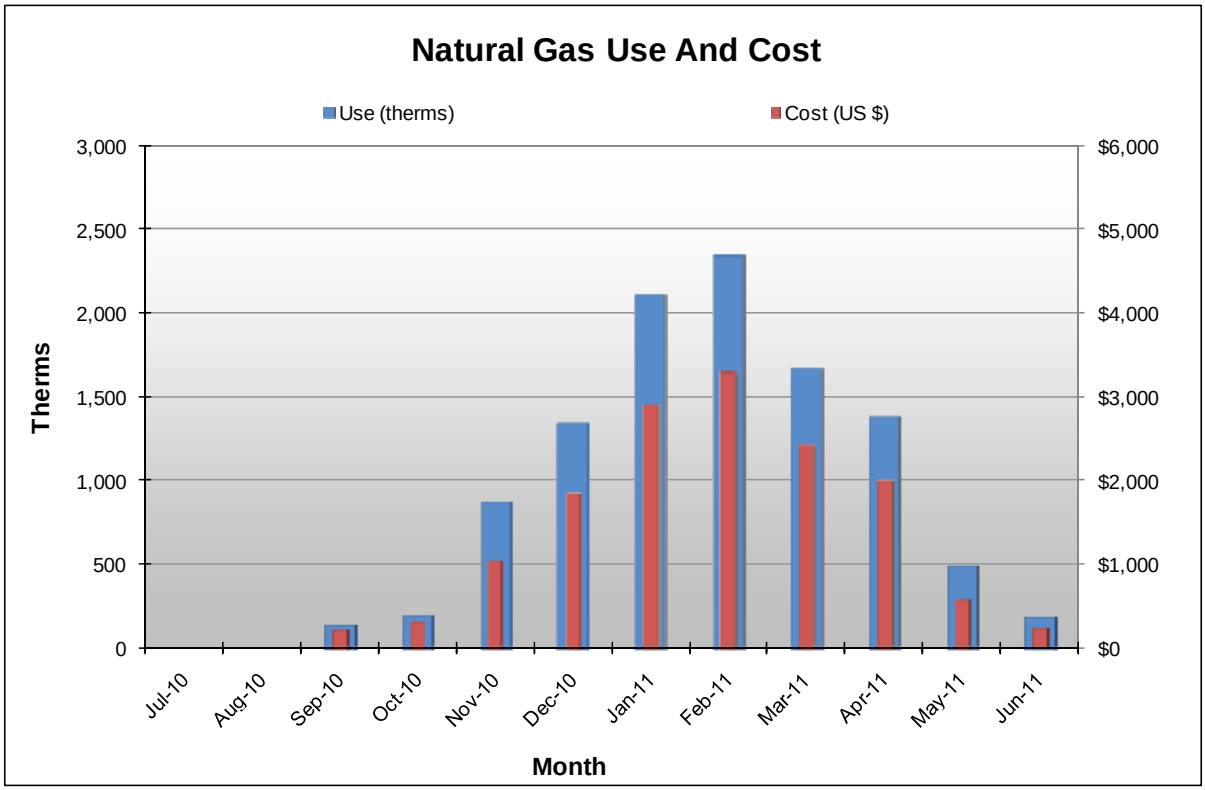
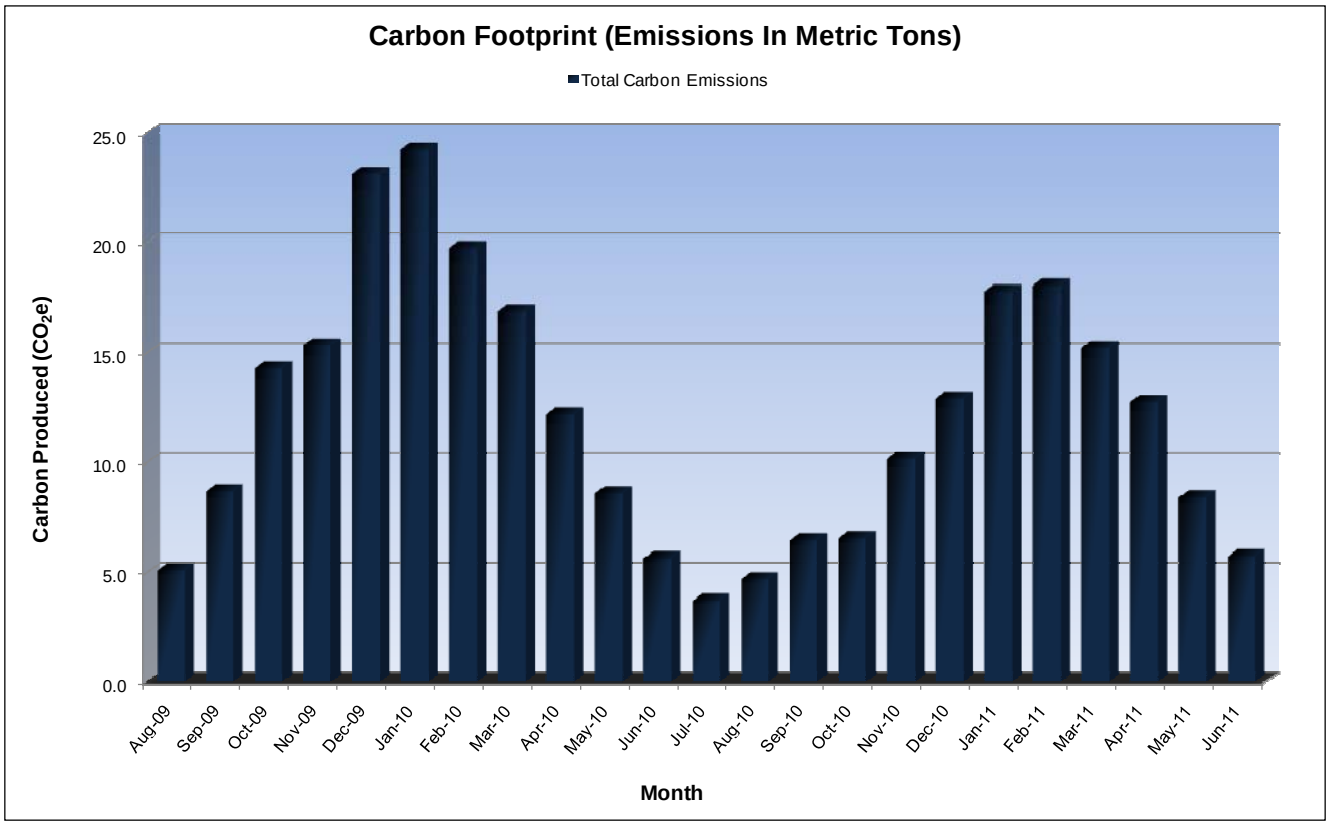


Figure 3. Monthly Greenhouse Gas Emissions for East Rochester Elementary



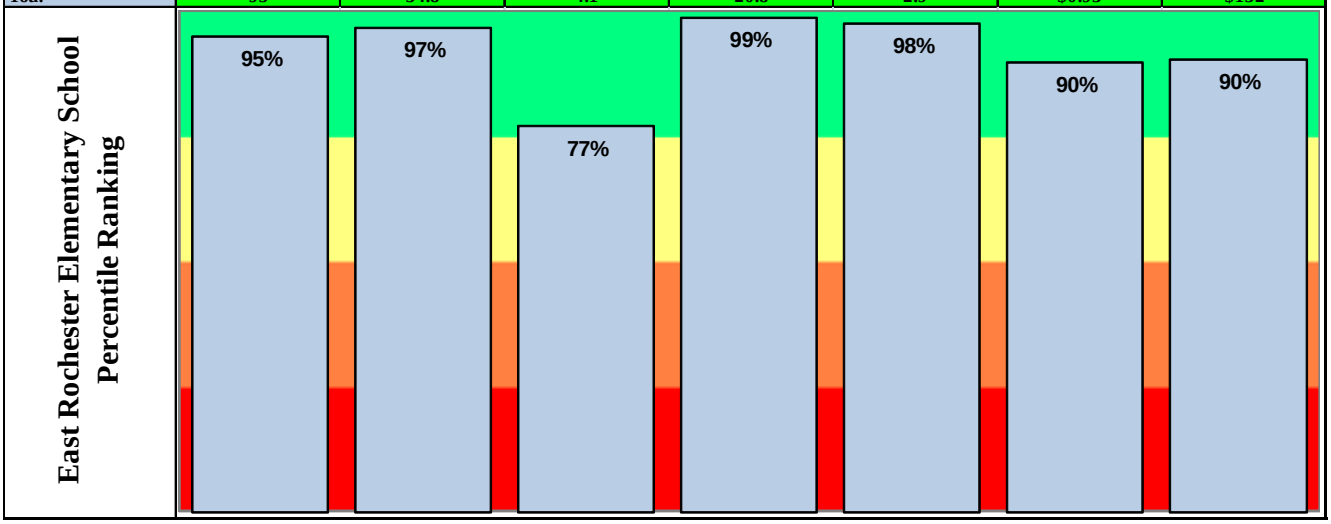
Benchmarking Data

To evaluate the energy and environmental performance of your school, the building data collected above has been compared against two different sets of school energy data: the U.S. Environmental Protection Agency's national data and New Hampshire specific state data. The results are illustrated in Figure 4 on the following page.

This will allow you to assess your building's performance relative to other buildings designed and constructed to the same codes and standards, operating under the same regulations and schedules and similar weather conditions. The indicators are calculated on a *per square foot* or *per student* basis, so you can compare your school to different sized schools.

Figure 4. EnergySmart Schools Benchmarks for East Rochester Elementary

Schools	U.S. EPA Portfolio Manager Score	New Hampshire State Schools (Annual Data)					
		Total Energy Use (kBtu/sq.ft.)	Electric Use (kWh/sq.ft.)	Heating Fuel Use (kBtu/sq.ft.)	Weather Adjusted Heating Fuel Use (Btu/sq.ft./HDD)	Total Energy Cost ($/sq.ft.)	Total Energy Cost ($/student)
NH Average:	50	60.3	5.2	41.7	5.7	$1.42	$256
You:	95	34.8	4.1	20.8	2.9	$0.93	$132



Major Benchmark Indicators

1. Total Energy Use, kBtu/sq.ft.

This indicator shows how much total energy your school consumes each year. It includes the energy used for heating, cooling (if any), lights, cooking, computers, etc.

Your school's total energy use of 34.8 kBtu per square foot per year (kBtu/sq.ft.) is significantly better than the New Hampshire K-12 schools state average of 60.3 kBtu/sq.ft. Your total energy use figure is lower than 97% of New Hampshire K-12 schools. The EnergySmart School Report is weather normalized so fuel consumption for heating takes the difference in climate between northern and southern New Hampshire into account.

This is a good indicator of how well, overall, your school is performing. However, it doesn't help you find ***where*** in your building to look for improvement opportunities. Multiple factors included on the following pages can help with that. Analysis of energy consumption for this program does not control for operational variations. An example is an improperly ventilated school may appear to have lower energy consumption. Ventilation systems that are not operating properly result in lower indoor air quality.

2. Electricity Data

Most electric utilities use the following two factors to estimate your electricity bill – Electric Use and Electric Demand.

a. Electric Use, kWh/sq.ft.

This shows how well the building does with its lights, cooling/air conditioners and cafeteria systems (if any), and what's referred to as "plug load." Plug load is anything that plugs into a socket. The major plug loads are generally computers (including monitors, printers and copiers), refrigerators, coffee machines, fans, shop equipment and projectors. If electric consumption is much higher than average, but heating fuel use (see below) is average or better, then focus your efforts on the electric-powered elements.

New Hampshire schools state average electric use is 5.2 kWh per square foot. Your school's electric consumption of 4.1 kWh per square foot this year is lower than 77% of New Hampshire schools benchmarked through the New Hampshire EnergySmart Schools Program.

b. Electric Demand, Watts/sq.ft.

Demand is a measure of the maximum electric draw in kW that your building places on the grid and is measured by adding up the kW draw for a 15 minute period. To give an analogy, if electricity usage is the amount of water going through a hose in gallons, electric demand would be how fast that water flows expressed in gallons per minute. Whichever 15 minute period during your monthly billing cycle places the highest kW demand on the grid is the demand factor applied to your bill. The best way to improve this demand factor is to stagger the times when your electrical systems draw at their maximum or reduce unnecessary electric load altogether.

The average electric demand for New Hampshire schools is 1.9 watts per square foot. Your school's electric demand is 1.4 watts per square foot and is lower than 87% of New Hampshire Schools benchmarked through the New Hampshire EnergySmart Schools Program.

3. Heating Fuel Use, kBtu/sq.ft.

Reviewing these indicators is relatively straightforward. If your school's heating fuel use is much higher than average, an audit of your heating system along with your building envelope - doors, windows, roof - is recommended. This factor is 'fuel-neutral' as it works for either fuel oil or natural gas heating systems.

New Hampshire K-12 schools state average heating fuel use is 41.7 kBtu/sq.ft. or 5.7 Btu/sq.ft./HDD. Your school's heating fuel use of 20.8 kBtu/sq.ft. per year is lower than 99% of other New Hampshire schools in the database. Your school's weather adjusted heating fuel use of 2.9 Btu/sq.ft./HDD is lower than 98% of other New Hampshire schools benchmarked through the New Hampshire EnergySmart Schools Program.

4. Energy Cost, $/sq.ft. & $/student

Cost is the bottom line. These numbers help you understand, in terms of budget, the gain through energy efficiency improvements. New Hampshire K-12 schools state averages $1.42/sq.ft. and $256/student.

Your school's annual energy cost of $0.93 per square foot is lower than 90% of other New Hampshire benchmarked schools. Your school's cost expressed on a per student basis of $132 is also lower than 90% of other New Hampshire schools benchmarked through the New Hampshire EnergySmart Schools Program.

5. U.S. EPA *Portfolio Manager* Score

Portfolio Manager is a benchmarking model based on a national set of data from K-12 schools. It is provided by the U.S. Environmental Protection Agency's ENERGY STAR® Program. The impact of factors outside of your control (such as location, occupancy and operating hours) are removed, providing a 1-100 ranking of a school's energy performance relative to the national school building market. A score of 50 represents the national average and a score of 100 is best. Schools that achieve a score of 75 or higher are eligible for EPA's ENERGY STAR® Building Label, the national symbol for protecting the environment through energy efficiency. Districts can achieve ENERGY STAR® Leader Awards in recognition if their buildings, on average, improve by 10%, 20%, 30%, etc. over their baseline year of reported energy use or if the district's overall weighted average *Portfolio Manager* Score is at least a 75.

Your school's *Portfolio Manager* Score of 95 places it higher than 95% of K-12 schools nationwide. As noted above, this rating potentially qualifies your school for the prestigious ENERGY STAR® Label for Buildings.

III. Potential Energy Saving Opportunities

Based on the preceding analysis of your school's energy performance, implementation of the following recommendations can help you save energy and money. The first step is to look at reducing electrical lighting and HVAC consumption (burners, circulators and fans) which typically account for 67% of a building's electric consumption.

- **Perform an Energy Audit on the Building**

An energy audit involves a comprehensive analysis of the building's general characteristics, its energy use and allocation of that use amongst the facility's energy end uses. The goal is to identify sources of potential energy savings. Your auditor should develop a list of recommendations that will result in substantial energy and operational cost savings. These may include, building envelope improvement and mechanical systems, lighting upgrades, equipment replacement and installation of lighting and HVAC control mechanisms, among others.

A good audit should include information specific to each recommendation which *at least* includes approximate annual energy unit and cost savings, demand reduction, installation cost, lifetime cost savings and information related to cost-effectiveness. This will help to prioritize the recommendations based on their energy efficiency and shortest payback.

The recommendations provided in an energy audit report may reduce facility energy bills by 20% or more in addition to improving occupant health and comfort. Following this report, an energy audit is the next step in realizing the full potential of energy savings opportunities.

- **Request Retro-Commissioning**

Retro-commissioning is a detailed process applied to existing facilities aimed at correcting many of the degradations and inefficiencies that are indicative of older and/or poorly performing buildings. Many older buildings tend to be less comfortable and operate less efficiently when not properly commissioned. Retro-commissioning includes a detailed energy audit and focuses on not only potential energy savings but also the interaction of the building's equipments and mechanical systems with an eye toward restoring it to optimal performance.

In contrast to an energy audit, this optimization focuses on operational improvements to existing equipment, rather than replacement. Apart from energy savings, other improvements and benefits include substantial operation and maintenance (O&M) cost savings, improved air quality, occupant comfort, health and safety, equipment controls, and improved system interactivity.

In addition to providing recommendations, retro-commissioning includes implementation of the recommended improvements and hence the cost for retro-commissioning is higher than an audit. However, when the costs of improvements are added to the energy audit cost, prices may be comparable. If high O&M costs or occupant health, comfort and safety are concerns in addition to reduction in energy use, retro-commissioning may be a suitable strategy.

- **Upgrade Lighting Systems**

Lighting typically accounts for 30-60% of all energy consumed in school buildings. Additionally, the electrical energy consumed by lights during the summer creates heat and increases cooling costs.

East Rochester Elementary School's electricity consumption is low (better) compared to other schools in the State. Even so, upgraded lighting systems in high consumption areas like classrooms, gymnasiums, libraries, offices, etc. can reduce these costs even further, improve the lighting quality and increase occupant comfort and productivity.

Over-lit Spaces: Light levels should be recorded in classrooms and hallways to ensure they are not over-lit, 40-50 foot candles are adequate light levels for an instructional space. If classroom light levels are much higher than 50 foot candles, East Rochester Elementary School should consider de-lamping classrooms or installing dimming ballasts, which dim the lights when outdoor light levels are adequate. In over-lit hallway spaces photo sensors can be installed to turn lights off completely when light levels exceed a pre-set threshold.

In over-lit spaces a T8 to Super T8 lighting retro-fit can reduce the number of light fixtures needed. Super T8 lamps use between 4 and 7 Watts less electricity than standard T8 lamps, but they produce more light per Watt. In some cases this increase in light per Watt can allow for the removal of an entire lamp, saving 32 Watts. The room characteristics must be factored in before this type of retro-fit. The shape of the space, ceiling height, color of the walls, etc. all need to be taken into account when exploring a de-lamping project. We recommend that before retro-fitting the entire facility, begin by changing one classroom and monitor the comfort level of the occupants at East Rochester Elementary School.

Another proven energy reduction measure with a short payback period is to identify any areas where your school may still be using metal halide lighting. Typically metal halide lights are found in gymnasiums or cafeteria areas, many districts have been very satisfied by replacing these lights with high bay T5 lighting fixtures. In addition to the reduced operational wattage, high bay T5 lights turn on instantly, as opposed to metal halide fixtures which have an extended warm up period. The long warm up period associated with metal halides typically leads to the lights being left on all day, at 250 to 400 watts a fixture; the costs begin to add up. Adding occupancy sensors to high bay T5 fixtures further reduces the payback period.

Occupancy Sensors: We recommend that you explore the use of occupancy sensors to ensure that lights are turned off in unoccupied spaces. Lights controlled by occupancy sensors typically run a third of the time when compared with manually controlled lighting. Reduced runtime leads to decreases in both energy usage and operation and maintenance costs. Additionally, a study conducted in Massachusetts found that controlling the security lighting with occupancy sensors reduced vandalism; neighbors and police recognized something wrong when the lights were on in a building that was typically dark and investigated.

To summarize and add a few ways in which East Rochester Elementary School may be able to conserve energy and cost through lighting upgrades is to:

- Design light quantity and quality for the task and occupants' needs in that area.
- Maximize lamp and ballast efficiency.
- Activate the power saving features on office equipment such as copiers, printers and fax machines and ensure that they are turned off at the end of the day.
- Use automatic controls to turn lights off or dim lights in unoccupied spaces.
- Establish a maintenance schedule for group re-lamping and fixture cleaning.
- Replace T12 fixtures with the most efficient fixtures which may include T8/super T8/T5 fixtures.
- Replace incandescent lighting with compact fluorescent technology.

- Replace incandescent exit lighting which consumes 30 Watts with LED type exit lights with 1.5 Watts consumption. LED units last up to 10 years, which is a maintenance advantage.
- Install daylight sensors in areas with significant natural light.
- Install occupancy sensors in areas that are often unoccupied.
- Lighting retrofits reduce maintenance costs associated with lighting that is close to end of life.
- Establish a regular cleaning schedule particularly for areas where student safety of low light levels may be a concern, such as shop classes.
- Look to make lamp and fixture selection as uniform as possible to reduce maintenance and inventory overhead.
- Educate students and staff to turn off lights when rooms are unoccupied.

Lighting upgrades seek to reduce the connected electrical load (kW) and energy consumption (kWh) of lighting equipment. Lighting controls can also significantly reduce operating hours and costs by turning off lighting when spaces are unoccupied or sufficiently lit by natural light.

- **Install NEMA Premium Motors and VFDs**

Commercial and industrial electric motor-driven systems consume approximately 23% of all electricity in the U.S., making it the single largest category contributor to electric use in the country. With very high operating hours, the annual energy cost to run a system is more than its installation cost. Even a small increase in the efficiency of an electric motor can result in substantial energy cost savings. Typical opportunities for motor upgrades in schools include: ventilation fans, and heating and cooling system pumps and fans.

Motors with efficiency up to 90% are available to replace the older ones with efficiency less than 75%. Although standards for efficiency of new equipment are set by the Energy Policy Act, motor efficiency can be further increased by selecting Premium Efficiency motors as specified by the National Electrical Manufacturers Association (NEMA). This can cut the electric motor system demand by as much as 18%.

Savings can be increased further by optimizing system performance through the use of variable frequency drives (VFDs). When system load is known to vary substantially, these flow control systems can be utilized to match system output to system demand, significantly reducing energy usage during partial load hours. By employing high-efficiency motors and VFDs, facility owners can improve environmental conditions, utilize better control of motor-driven processes, and reduce waste output.

- **Install Demand Control Ventilation**

Demand control ventilation (DCV) monitors indoor air CO_2 content as a result of occupancy production levels and uses this data to regulate the amount of outdoor air that is permitted for ventilation. In order to ensure adequate air quality, standard ventilation systems permit outside air based on estimated occupancy levels in CFM, cubic feet per minute/occupant. However, during low occupancy hours, the space may become over ventilated due to decreased CO_2 levels and unnecessary ventilation results in wasted energy. DCV reduces unnecessary outdoor air intake by regulating ventilation based on actual CO_2 levels, saving energy. DCV is most suited for areas where occupancy levels are known to fluctuate considerably such as auditoriums, cafeterias, and gymnasiums.

Install Energy Recovery Ventilators. According to energy recovery equipment manufacturer's typical paybacks are less than 5 years for schools without cooling. The keys to success with ventilation retrofits are going with fewer larger units with long run hours as opposed to several small units with limited run time. Equipment with moisture recovery capabilities would cut humidity up to 50% during the cooling season.

- **Improve/Replace Inefficient Heating Systems**

Replacing an old boiler that is < 70% efficient with a modern 85-90% efficient natural gas-fired furnace alone will reduce heating costs by 15-20%. This combined with additional system improvements and installation of advanced HVAC control mechanisms can result in up to 20%+ heating load reduction.

Because of the high capital cost of new heating systems, some financial analysis should be performed to assess the cost-effectiveness of immediate replacement. If the current system is fairly new, replacement may not be immediately justifiable from a financial standpoint. However, as is the case with cooling systems, early replacement may prove to be a more cost-effective solution than waiting until existing systems fail or reach the end of their estimated useful life.

- **Improve/Replace Inefficient Air Conditioning Systems**

The useful life of a rooftop A/C unit is generally 12-18 years. However, depending on the efficiency, early replacement of outdated, inefficient, split, or packaged rooftop air conditioning units with new A/C systems that are 15% more efficient than 10-15 year old equipments can considerably reduce annual energy consumption. The energy cost savings and maintenance savings offset the high installation cost of a more efficient system. Installing thermostats and/or economizers on new or existing A/C systems will further reduce the cooling demand.

Economizers provide "free" cooling by using controllable dampers that bring in outside air to cool the space when the outdoor temperature or enthalpy is below the building's return air conditions. Although they require operation by a well calibrated and maintained control system, economizers have impressive energy-saving capabilities.

Install Occupancy Controlled/Programmable Thermostats

Combining efficient HVAC equipment with occupancy controlled and programmable thermostats can save a facility up to 10% of its annual heating and cooling costs:

- Areas with unpredictable occupancy on a daily/weekly basis - gym, bathrooms, outdoors: Use an *occupancy controlled thermostat* - a thermostat paired with a sensor and/or door detector to identify movement/occupancy. If occupancy is sensed by the sensor, the thermostat goes into an occupied mode (i.e. programmed set point). If a pre-programmed time frame elapses (i.e. 30 minutes) and no occupancy is sensed during that time, the thermostat goes into an unoccupied mode (e.g., setback set point or off) until occupancy is sensed again. This reduces the overall time the heating or cooling system is running, saving energy.

- Areas with predictable occupancy: e.g.: classrooms, cafeteria, offices: A *programmable thermostat* is recommended. This device is programmed on a schedule to reduce the heating or cooling output of the facility's HVAC systems in relation to its predetermined occupancy schedule. In this way, the thermostat acts to set-back or set-up the facility temperature during unoccupied hours, and re-establish a comfortable facility temperature during business hours. By employing programmable thermostat technology, the heating and cooling system demand coincides with occupancy level, reducing energy usage.

- **Install Vending Misers on Vending Machines**

Vending misers for refrigerated and non-refrigerated vending machines is an often overlooked source of potential savings. Uncontrolled, vending machine lights remain on 24/7, consuming a constant amount of energy year round. By controlling these lights with an occupancy sensor, energy consumption attributed to vending machines can be reduced considerably, in many cases, by as much as 50% and can save up to $150 per machine per year.

In the case of refrigerated vending machines, electric demand can be further reduced by controlling the machines' refrigeration systems. In a manner similar to programmable thermostats, vending misers for refrigerated machines act on a pre-set occupancy schedule to allow a marginal increase in operating temperature during non-business hours. Although products in the machine are delivered to the customer at the same temperature as in an uncontrolled vending machine, products are not being cooled unnecessarily when the machine is not in use, significantly reducing the machine's energy consumption. Because of the relatively low vending miser installation cost and high operating hours of vending machines, this improvement is typically cost-effective with a very short payback period.

- **Install ENERGY STAR® Rated Equipment / Plug Load Control**

Plug loads (computers, televisions, coffee makers, etc.) account for, on average, about 10% of total energy consumption. One of the easiest and most cost-effective energy saving strategies is the reduction of electric usage through installation of efficient appliances and the control of plug loads. In addition to utilizing ENERGY STAR® qualified appliances, greater savings can be realized through the various devices available that control every day plug loads.

By connecting non-critical loads (coffee makers, fans, microwave ovens, etc.) to an occupancy or timer controlled power strip, significant energy savings can be achieved. These savings result not only from the neglect of the user to turn the device off manually, but also from reduction of "phantom load". Phantom load is the small but constant energy draw from many plug-in devices when not in use. By connecting certain appliances to an occupancy controlled power strip, phantom load can be eliminated by cutting power supply to those devices. When replacing or ordering new equipment, emphasize ENERGY STAR® devices when they are available. Also, purchase controlled power strips and connect appropriate devices to those strips to reduce unnecessary consumption due to phantom load and appliances left on. The EPA offers free computer power management software which has saved some districts as much as $75 per computer per year, the software can be found at http://www.energystar.gov/index.cfm?c=power_mgt.pr_power_mgt_low_carbon_join.

IV. Resources:

The State of New Hampshire along with the utility companies offer multiple programs designed to improve the energy efficiency of schools through financial incentives and technical support, including:

Northeast Energy Efficiency Partnerships:

- **Northeast Collaborative for High Performance Schools (NE-CHPS)**
  NE-CHPS is a set of building and design standards for all schools from pre-K through community colleges tailored specifically for NH state code requirements, the New England climate, and the environmental priorities of the region. NH Department of Education offers up to a 3% re-imbursement for New Construction School projects. To learn more about NE-CHPS and incentive programs please visit: http://neep.org/public-policy/hpse/hpse-nechps.

New Hampshire Public Utilities Commission:

- **New Hampshire Pay for Performance**
  This program addresses the energy efficiency improvement needs of the commercial and industrial sector. The Program is implemented through a network of qualified Program Partners. Incentives will be paid out on the following three payment schedule: Incentive #1: Is based on the area of conditioned space in square feet. Incentive #2: Per/kWh saved and Per/MMBTU saved based on projected savings and paid at construction completion. Incentive #3: Per/kWh saved and Per/MMBTU saved based on actual energy savings performance one year post construction. Total performance incentives (#2 and #3) will be capped at $200,000 or 50% of project cost on a per project basis. For more information visit http://nhp4p.com.

- **New Hampshire Public Utilities Commission's Renewable Energy Rebates**
  The Sustainable Energy Division provides an incentive program for solar electric (photovoltaic or PV) arrays and solar thermal systems for domestic hot water, space and process heat, with a capacity of 100 kW or equivalent thermal output or less. The rebate for PV systems as follows: $1.00 per Watt, capped at 25% of the costs of the system or $50,000, whichever is less. For solar hot water (SHW) systems, the base rebate is $0.07 per rated or modeled kBtu/year, capped at 25% of the cost of the facility or $50,000, whichever is less, as a one-time incentive payment. http://www.puc.state.nh.us/Sustainable%20Energy/RenewableEnergyRebates-CI.html.

New Hampshire Community Development Finance Authority:

- **New Hampshire Community Development Finance Authority Revolving Loan Fund**
  The Enterprise Energy Fund is a low-interest loan and grant program available to businesses and nonprofit organizations to help finance energy improvements and renewable energy projects in their buildings. The loans will range from $10,000 to $500,000. Larger amounts will be considered on a case by case basis. The program is available to finance improvements to the overall energy-efficiency performance of buildings owned by businesses and nonprofits, thereby lowering their overall energy costs and the associated carbon emissions. More information about the program can be found on their website www.nhcdfa.org. These activities may include:

  - Improvements to the building's envelope, including air sealing and insulation in the walls, attics and foundations;
  - Improvements to HVAC equipment and air exchange;
  - Installation of renewable energy systems;
  - Improvements to lighting, equipment, and other electrical systems; and
  - Conduction of comprehensive, fuel-blind energy audits.

Public Service of New Hampshire (PSNH):

- **Commercial (Electric) Energy Efficiency Incentive Programs**
  This program targets any commercial/industrial member building a new facility, undergoing a major renovation, or replacing failed (end-of-life) equipment. The program offers prescriptive and custom rebates for lighting and lighting controls, motors, VFDs, HVAC systems, chillers and custom projects. http://www.psnh.com/SaveEnergyMoney/For-Business/Energy-Saving-Programs-and-Incentives.aspx

- **SmartSTART**
  The SmartSTART (Savings Through Affordable Retrofit Technologies) advantage is simple - pay nothing out of pocket to have energy efficiency products and services installed in your building. The Smart Start program is limited to PSNH's municipal customers only and includes schools. The program is available on a first-come, first served basis to projects which have been pre-qualified by PSNH. The cost of the improvements is fronted by PSNH which is then repaid over time by the municipality or school using the savings generated by the products themselves! This program is for lighting and lighting controls, air sealing, insulation and other verifiable energy savings measures which have sufficient kilowatt-hour savings. For more information on this program visit:
  http://www.psnh.com/SaveEnergyMoney/For-Business/Municipal-Smart-Start-Program.aspx

- **Schools Program**
  For major renovation or equipment replacement projects, this program offers prescriptive and custom rebates for energy efficient lighting, motors, HVAC, chillers, and variable frequency drives to towns or cities that install energy efficient equipment at their schools. Financial incentives are available for qualifying energy efficient equipment. Technical assistance is also offered through the Schools Program. http://www.psnh.com/SaveEnergyMoney/Large-Power/Schools-Program.aspx

Unitil:

- **Commercial and Industrial Energy Efficiency Programs**
  Subject to program qualifications and availability of funding - Unitil offers different programs for its commercial, industrial, and institutional customers in New Hampshire: the Small Business Energy Efficiency Program, the Small Commercial and Industrial Program, the Large Commercial and Industrial Program, the Large Commercial and Industrial (C&I) Retrofit Program, and the Large C&I New Construction Program. Rebates are available for various technologies including water heaters, lighting, lighting controls/sensors, chillers, furnaces, boilers, central air conditioners, compressed air, programmable thermostats, energy management systems/building controls, motors, VFDs, processing and manufacturing equipment, LED exit signs, commercial cooking and refrigeration equipment. http://www.unitil.com/.

Clean Air – Cool Planet:

- **Community Energy Efficiency**
  CA-CP works with communities throughout the Northeast to find solutions to climate change and build constituencies for effective climate policies and actions. Much of their work focuses on successful models for energy efficiency and renewable energy planning. They advise and partner with citizens, educators, faith groups, small businesses, municipal governments, and other local leaders. They explore cost-effective opportunities that exist for communities to reduce their emissions as well as their vulnerability to climate impacts. One such example is CA-CP's partnership with the University of NH, NH Sustainable Energy Association and UNH Cooperative Extension to create myenergyplan.net, a groundbreaking suite of web and outreach tools for individual action used by households, schools and community groups around the northeast. http://www.cleanair-coolplanet.org/for_communities/index.php.

Environmental Protection Agency (EPA):

- **ENERGY STAR Challenge for Schools**
  EPA is challenging school administrators and building managers to improve energy efficiency throughout their facilities. More than 500 school districts across the country are helping to fight climate change by committing to reducing their energy use with help from ENERGY STAR. Schools that take the ENERGY STAR Challenge can use energy tracking tools, technical guidance, case studies and other ENERGY STAR tools and resources to help them improve their energy efficiency. More information can be found at:
  http://yosemite.epa.gov/opa/admpress.nsf/d985312f6895893b852574ac005f1e40/d74f768ecfa9e11f8525762500522260!OpenDocument

For additional assistance in helping you save money and improve school conditions, please call TRC at (603) 766-1913 or (877) 442-9181.

NEW HAMPSHIRE ENERGYSMART SCHOOLS PROGRAM

Energy Benchmarking Report for:

Chamberlain Street Elementary

Rochester, NH

Period: ***July 1, 2010*** through ***June 30, 2011***

PREPARED BY:

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Portsmouth, NH 03801

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Table of Contents

I. Introduction

The Sustainable Energy Division of the New Hampshire Public Utilities Commission, with support from the New Hampshire Department of Education has sponsored TRC to develop the New Hampshire ***EnergySmart Schools Program*** to support New Hampshire K-12 public and private schools in the pursuit of energy efficiency and sustainability initiatives.

Energy efficiency has become an increasingly important issue for schools due to tightening budgets and rising energy costs. Since 2003, the prices of natural gas, fuel oil and electricity have increased by 123%, 107% and 32% respectively. Schools that have participated in energy benchmarking programs have shown a decrease in overall energy use by approximately 22% through the adoption of energy efficiency measures.

Tracking and documenting the energy use and associated carbon emissions in the state's K-12 schools will allow New Hampshire to account for the impact of its energy efficiency and renewable energy programs and determine which have the greatest effect. The analysis in this report, provided by the ***EnergySmart Schools Program*** is designed to help you:

- Understand the energy consumption and cost trends at each of your school buildings.
- Learn how your buildings are performing compared to other schools locally and nationally.
- Identify opportunities for improving operations and reducing costs.
- Take advantage of resources to implement efficiency improvements and save money.

The analysis was based on the information provided on the *Building Data Request Form* submitted, which included building descriptions, energy suppliers and other information. The building's utility bills were also used to assess its electricity and heating fuel consumption for the year(s) provided.

The energy performance for your school has been compared to national data for similar school facilities through EPA's ENERGY STAR® Portfolio Manager. Also shown are the five major benchmarks used to analyze building performance, which include: electricity use; heating fuel use; weather-normalized heating fuel use; total cost; and total cost per student, all of which have been normalized for comparison by square footage and weather. As part of the program's focus on sustainability, your school's carbon footprint is also presented.

II. Benchmarking Analysis and Review Results

Building and energy usage of your school was analyzed to assess the basic nature of your energy consumption and utility costs. The Building Data Summary table shown below summarizes this information.

Table 1: Building Data Summary for Chamberlain Street Elementary School

Building Data			
District	SAU 54 Rochester School Department	**School Name**	Chamberlain Street Elementary School
City	Rochester	**Zip Code**	03867
Year Built	1961	**Floor Area (sq.ft.)**	48,800
Number of Students	358	**Number of PCs**	79
Weekly Operating Hours	60	**Months School Used**	12
Cooking?	YES	**% AC**	0
Pool Size?	N/A	**Months Pool Used**	0

Utility Data			
Data End Point	6/30/2011	**Total Cost ($)**	52,821
Electric Provider	PSNH	**Natural Gas Provider**	Unitil Corporation
Electricity Usage (kWh)	215,140	**Electricity Cost ($)**	33,893
Natural Gas Usage (therms)	15,806	**Natural Gas Cost ($)**	18,929
Fuel Oil Usage (gal)	0	**Fuel Oil Cost ($)**	0
Other Fuel Usage (gal)	0	**Other Fuel Cost ($)**	0

Energy Indicators			
EPA Score	89	**Electric Usage (kWh/sq.ft.)**	4.4
Heating Fuel Usage (kBtu/sq.ft.)	32.4	**Weather Adjusted Heating Usage Btu/sq.ft./HDD)**	4.5
Site Energy (kBtu/sq.ft.)	47.4	**Source Energy (kBtu/sq.ft.)**	84

Environmental Impact Indicators			
Greenhouse Gas Emissions			
Last Year Heating Fuel CO_2e (Mt)	83.9	**Last Year Total CO_2e (Mt)**	150.6
Last Year Electricity CO_2e (Mt)	66.7	**CO_2e Efficiency Savings Over Previous Year**	23.9
EPA Target Score			
Target Score	N/A - Reached	**Site Energy Reduction Needed (kBtu/sq.ft.)**	N/A - Reached

Figures 1a, 1b, 2a and 2b display the energy use, demand and cost data tracked on a monthly basis. This demonstrates the energy consumption of your building over the course of the year. As a part of the program's focus on sustainability, your school's carbon footprint was also measured and is presented in Figure 3.

Figure 1a. Monthly Electric Use & Max Demand for Chamberlain Elementary

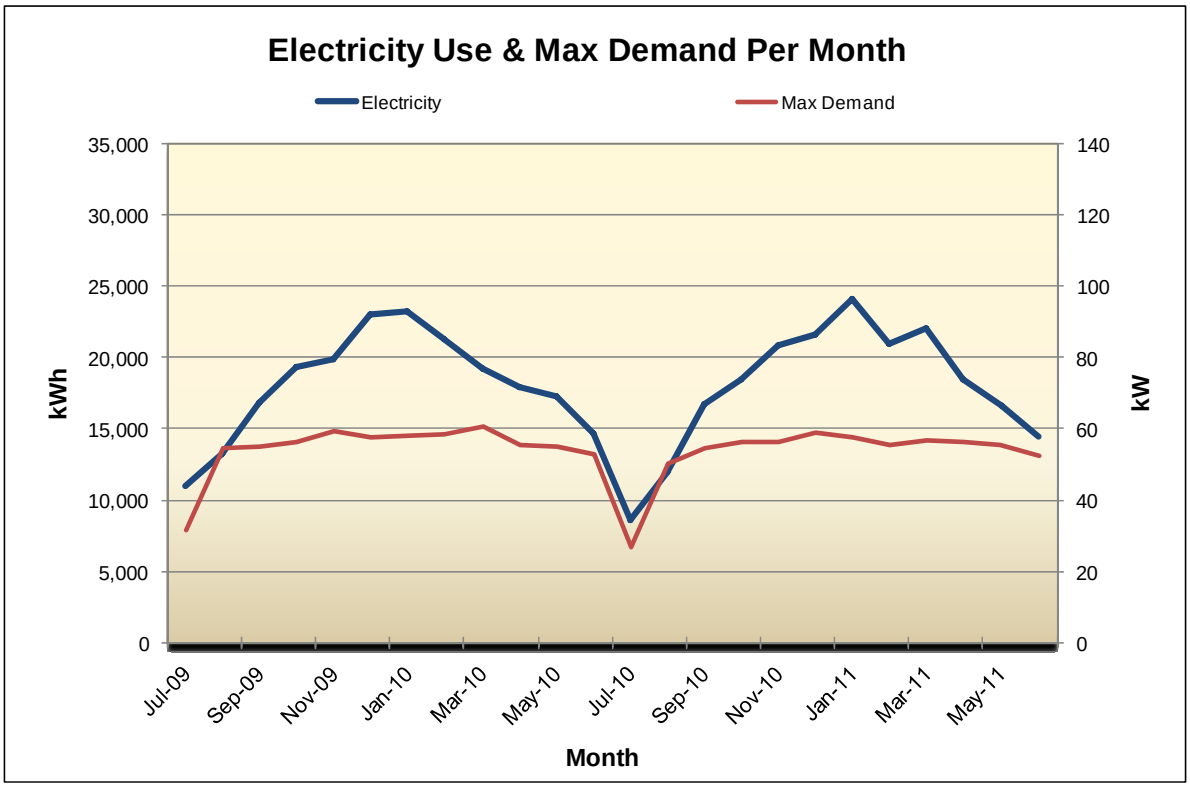
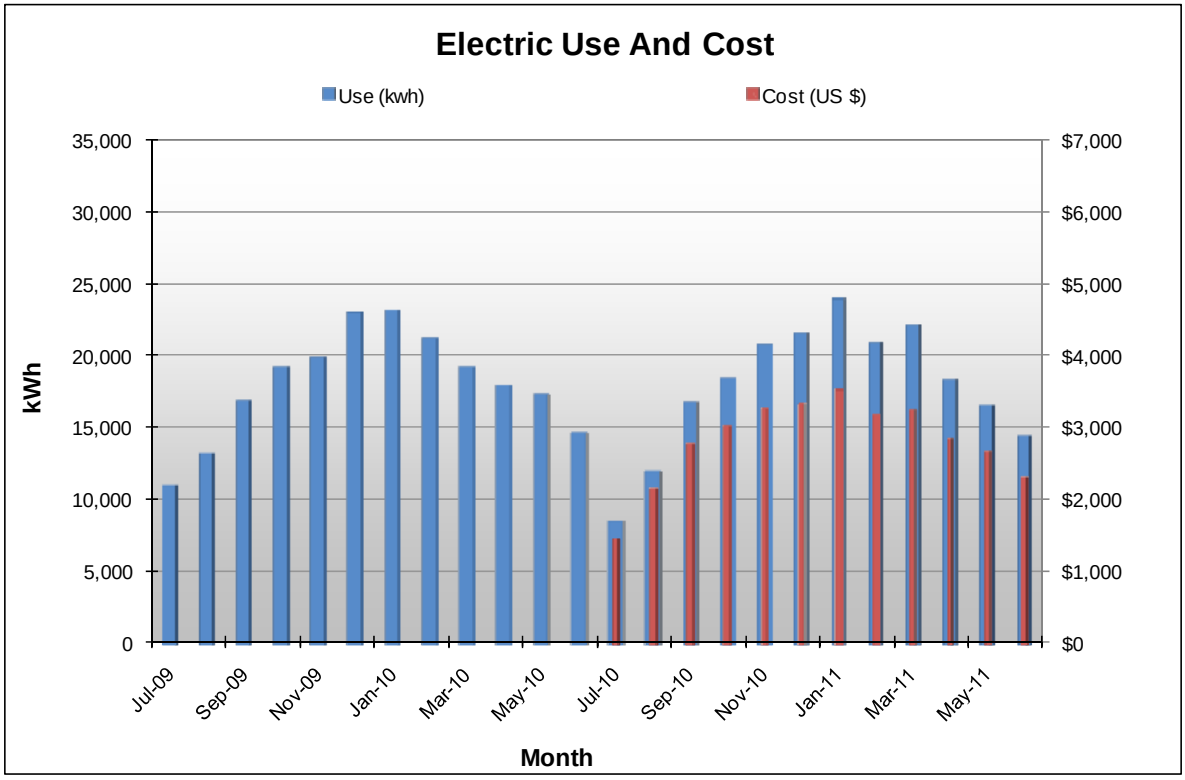


Figure 1b. Monthly Electric Use vs. Cost for Chamberlain Elementary



Note: Electric Cost was only available for the most recent 12 month period.

Figure 2a. Monthly Heating Fuel Use for Chamberlain Elementary

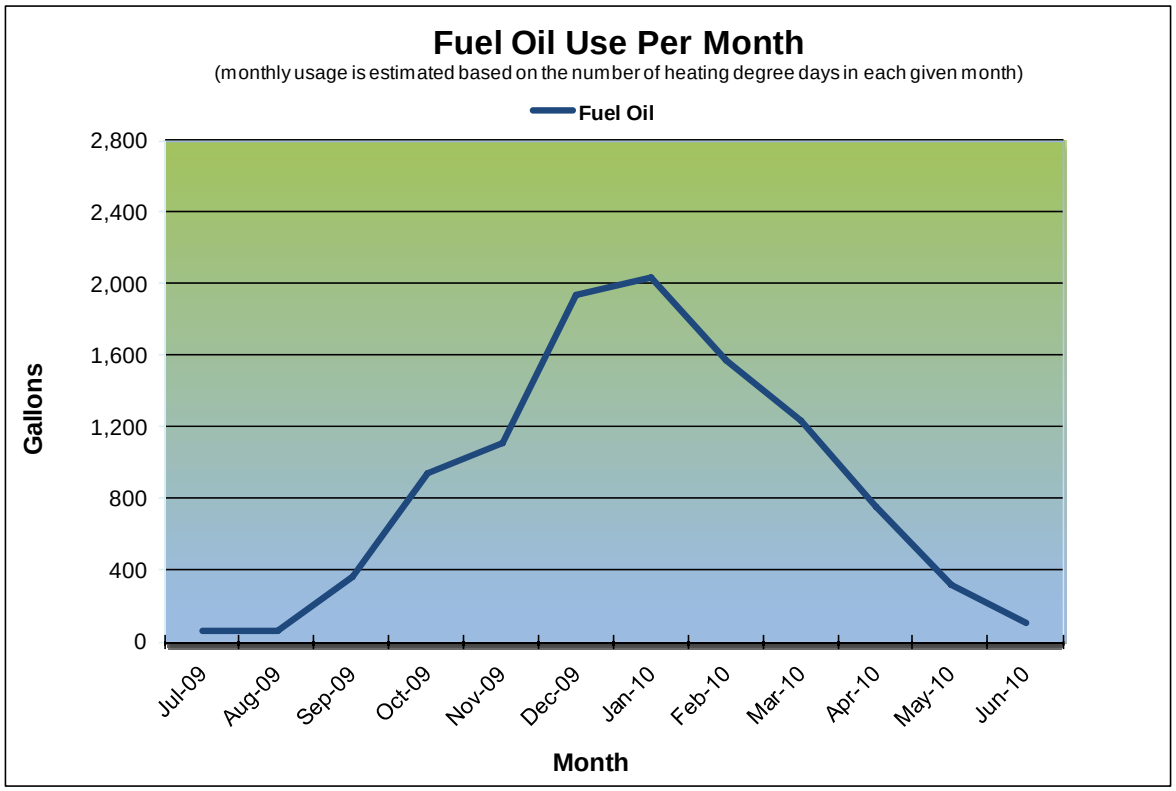


Figure 2b. Monthly Heating Fuel Use vs Cost for Chamberlain Elementary

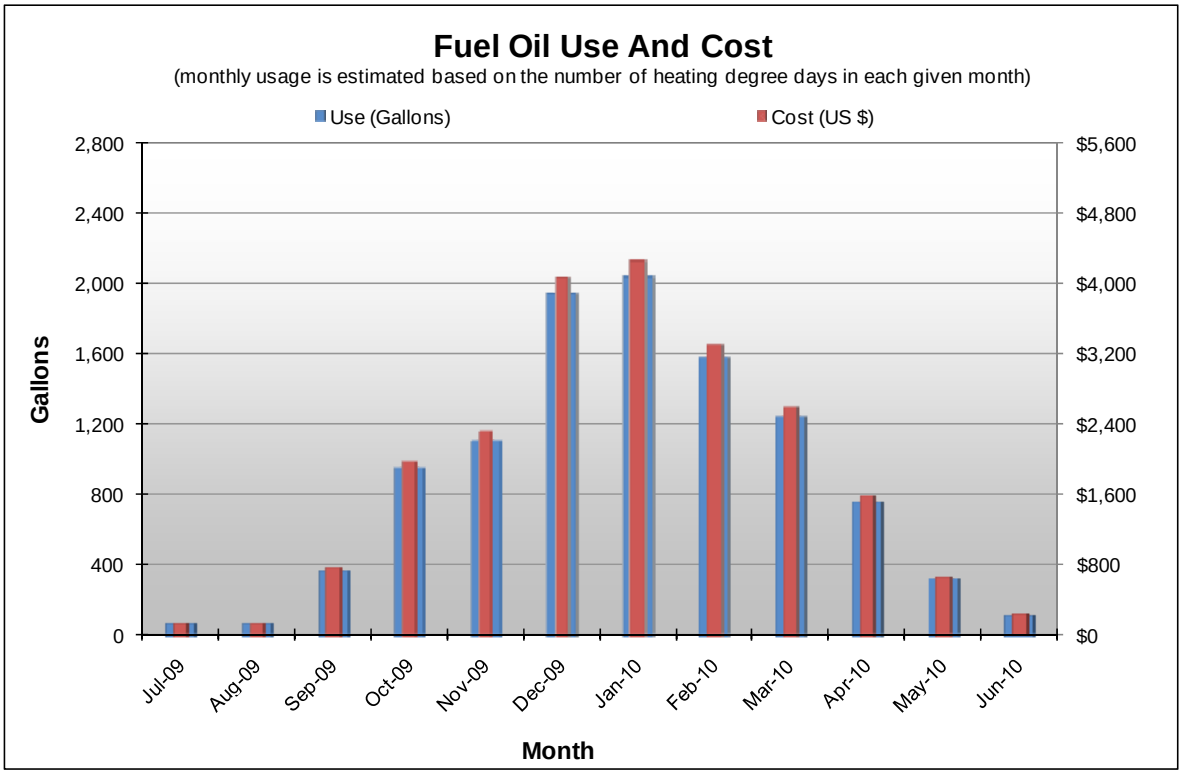


Figure 2a. Monthly Heating Fuel Use for Chamberlain Elementary

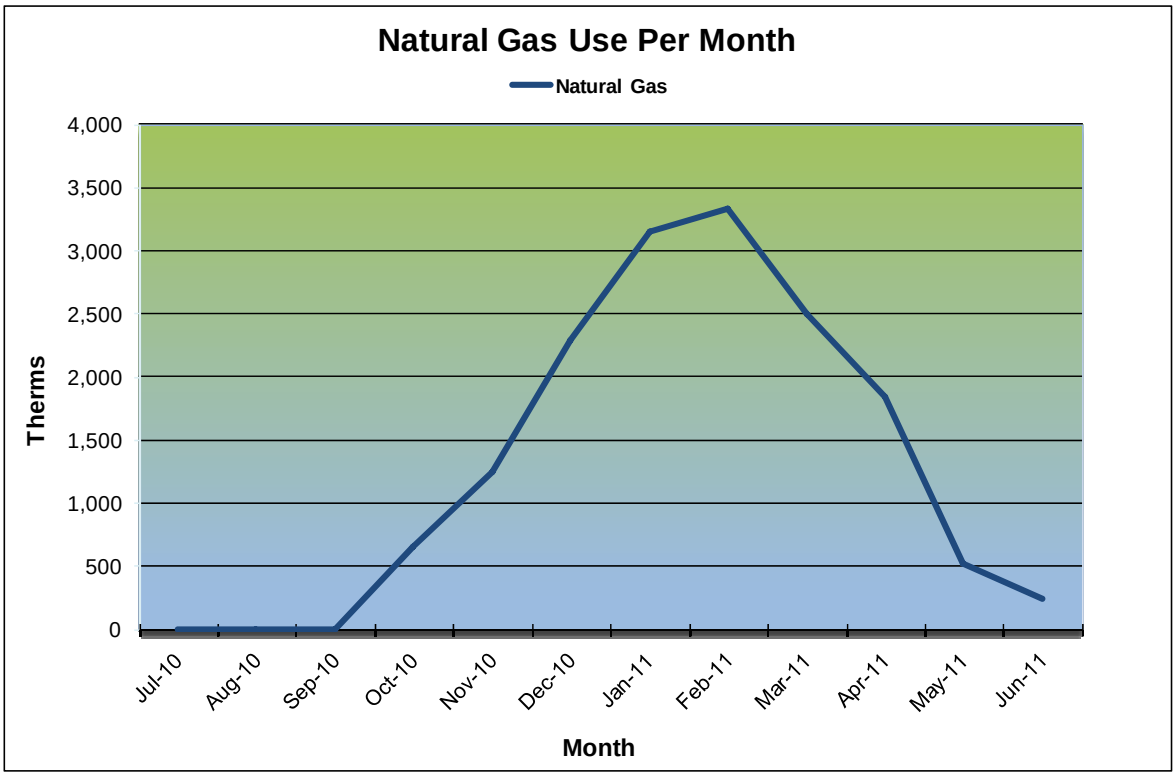


Figure 2b. Monthly Heating Fuel Use vs Cost for Chamberlain Elementary

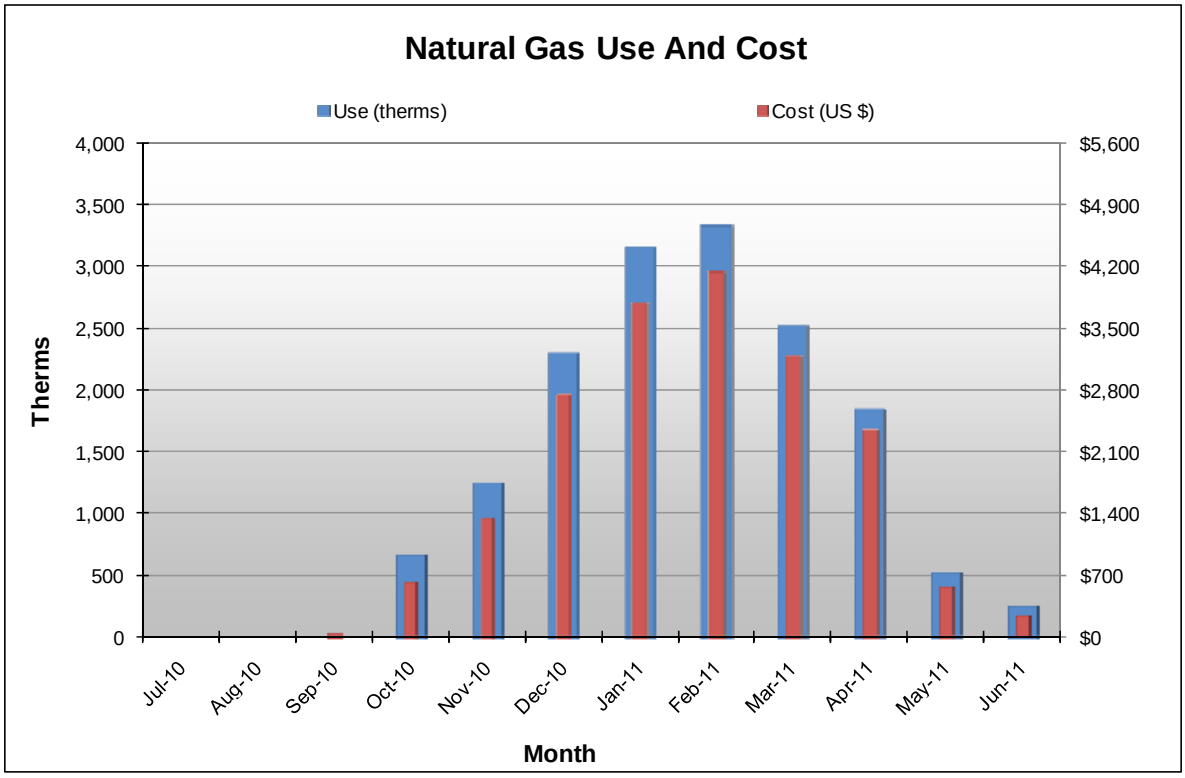
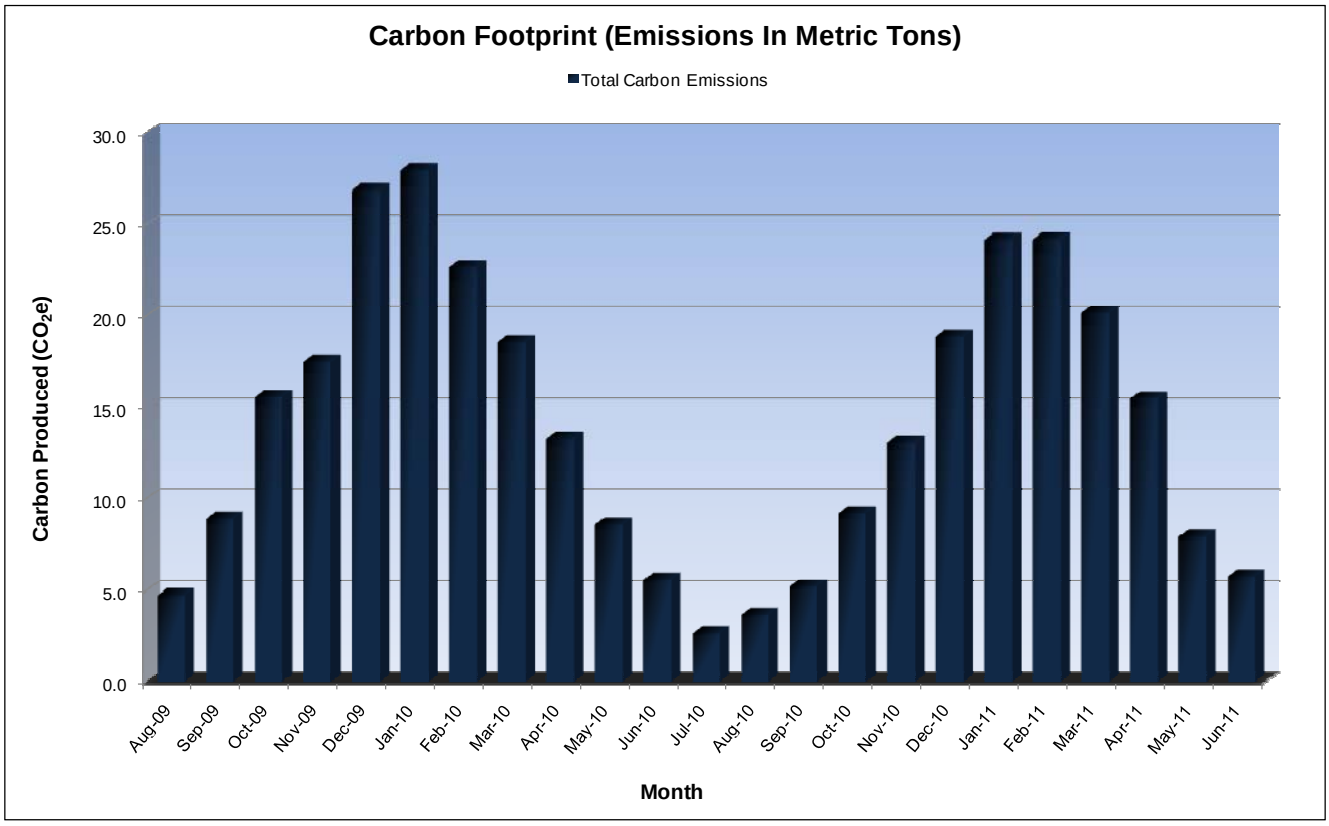


Figure 3. Monthly Greenhouse Gas Emissions for Chamberlain Street Elementary



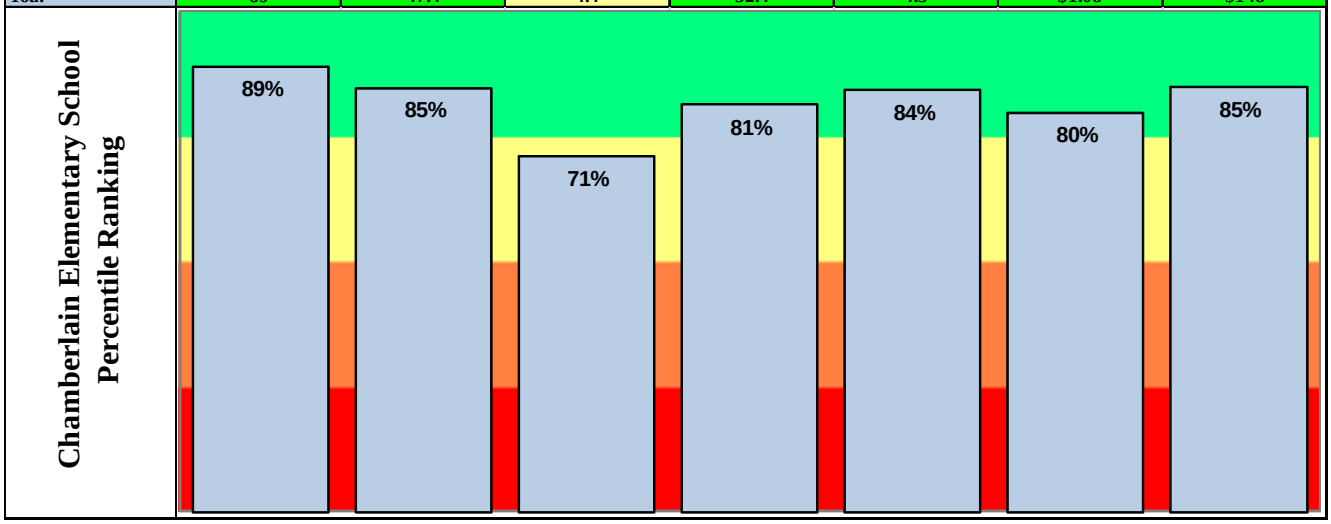
Benchmarking Data

To evaluate the energy and environmental performance of your school, the building data collected above has been compared against two different sets of school energy data: the U.S. Environmental Protection Agency's national data and New Hampshire specific state data. The results are illustrated in Figure 4 on the following page.

This will allow you to assess your building's performance relative to other buildings designed and constructed to the same codes and standards, operating under the same regulations and schedules and similar weather conditions. The indicators are calculated on a *per square foot* or *per student* basis, so you can compare your school to different sized schools.

Figure 4. EnergySmart Schools Benchmarks for Chamberlain Street Elementary

Schools	U.S. EPA Portfolio Manager Score	New Hampshire State Schools (Annual Data)					
		Total Energy Use (kBtu/sq.ft.)	Electric Use (kWh/sq.ft.)	Heating Fuel Use (kBtu/sq.ft.)	Weather Adjusted Heating Fuel Use (Btu/sq.ft./HDD)	Total Energy Cost ($/sq.ft.)	Total Energy Cost ($/student)
NH Average:	50	60.3	5.2	41.7	5.7	$1.42	$256
You:	89	47.4	4.4	32.4	4.5	$1.08	$148



Major Benchmark Indicators

1. Total Energy Use, kBtu/sq.ft.

This indicator shows how much total energy your school consumes each year. It includes the energy used for heating, cooling (if any), lights, cooking, computers, etc.

Your school's total energy use of 47.4 kBtu per square foot per year (kBtu/sq.ft.) is better than the New Hampshire K-12 schools state average of 60.3 kBtu/sq.ft. Your total energy use figure is lower than 85% of New Hampshire K-12 schools. The EnergySmart School Report is weather normalized so fuel consumption for heating takes the difference in climate between northern and southern New Hampshire into account.

This is a good indicator of how well, overall, your school is performing. However, it doesn't help you find ***where*** in your building to look for improvement opportunities. Multiple factors included on the following pages can help with that. Analysis of energy consumption for this program does not control for operational variations. An example is an improperly ventilated school may appear to have lower energy consumption. Ventilation systems that are not operating properly result in lower indoor air quality.

2. Electricity Data

Most electric utilities use the following two factors to estimate your electricity bill – Electric Use and Electric Demand.

a. Electric Use, kWh/sq.ft.

This shows how well the building does with its lights, cooling/air conditioners and cafeteria systems (if any), and what's referred to as "plug load." Plug load is anything that plugs into a socket. The major plug loads are generally computers (including monitors, printers and copiers), refrigerators, coffee machines, fans, shop equipment and projectors. If electric consumption is much higher than average, but heating fuel use (see below) is average or better, then focus your efforts on the electric-powered elements.

New Hampshire schools state average electric use is 5.2 kWh per square foot. Your school's electric consumption of 4.4 kWh per square foot this year is lower than 71% of New Hampshire schools benchmarked through the New Hampshire EnergySmart Schools Program.

b. Electric Demand, Watts/sq.ft.

Demand is a measure of the maximum electric draw in kW that your building places on the grid and is measured by adding up the kW draw for a 15 minute period. To give an analogy, if electricity usage is the amount of water going through a hose in gallons, electric demand would be how fast that water flows expressed in gallons per minute. Whichever 15 minute period during your monthly billing cycle places the highest kW demand on the grid is the demand factor applied to your bill. The best way to improve this demand factor is to stagger the times when your electrical systems draw at their maximum or reduce unnecessary electric load altogether.

The average electric demand for New Hampshire schools is 1.9 watts per square foot. Your school's electric demand is 1.2 watts per square foot and is lower than 93% of New Hampshire Schools benchmarked through the New Hampshire EnergySmart Schools Program.

3. Heating Fuel Use, kBtu/sq.ft.

Reviewing these indicators is relatively straightforward. If your school's heating fuel use is much higher than average, an audit of your heating system along with your building envelope - doors, windows, roof - is recommended. This factor is 'fuel-neutral' as it works for either fuel oil or natural gas heating systems.

New Hampshire K-12 schools state average heating fuel use is 41.7 kBtu/sq.ft. or 5.7 Btu/sq.ft./HDD. Your school's heating fuel use of 32.4 kBtu/sq.ft. per year is lower than 81% of other New Hampshire schools in the database. Your school's weather adjusted heating fuel use of 4.5 Btu/sq.ft./HDD is lower than 84% of other New Hampshire schools benchmarked through the New Hampshire EnergySmart Schools Program.

4. Energy Cost, $/sq.ft. & $/student

Cost is the bottom line. These numbers help you understand, in terms of budget, the gain through energy efficiency improvements. New Hampshire K-12 schools state averages $1.42/sq.ft. and $256/student.

Your school's annual energy cost of $1.08 per square foot is lower than 80% of other New Hampshire benchmarked schools. Your school's cost expressed on a per student basis of $148 is lower than 85% of other New Hampshire schools benchmarked through the New Hampshire EnergySmart Schools Program.

5. U.S. EPA *Portfolio Manager* Score

Portfolio Manager is a benchmarking model based on a national set of data from K-12 schools. It is provided by the U.S. Environmental Protection Agency's ENERGY STAR® Program. The impact of factors outside of your control (such as location, occupancy and operating hours) are removed, providing a 1-100 ranking of a school's energy performance relative to the national school building market. A score of 50 represents the national average and a score of 100 is best. Schools that achieve a score of 75 or higher are eligible for EPA's ENERGY STAR® Building Label, the national symbol for protecting the environment through energy efficiency. Districts can achieve ENERGY STAR® Leader Awards in recognition if their buildings, on average, improve by 10%, 20%, 30%, etc. over their baseline year of reported energy use or if the district's overall weighted average *Portfolio Manager* Score is at least a 75.

Your school's *Portfolio Manager* Score of 89 places it higher than 89% of K-12 schools nationwide. As noted above, this rating potentially qualifies your school for the prestigious ENERGY STAR® Label for Buildings.

III. Potential Energy Saving Opportunities

Based on the preceding analysis of your school's energy performance, implementation of the following recommendations can help you save energy and money. The first step is to look at reducing electrical lighting and HVAC consumption (burners, circulators and fans) which typically account for 67% of a building's electric consumption.

- **Perform an Energy Audit on the Building**

An energy audit involves a comprehensive analysis of the building's general characteristics, its energy use and allocation of that use amongst the facility's energy end uses. The goal is to identify sources of potential energy savings. Your auditor should develop a list of recommendations that will result in substantial energy and operational cost savings. These may include, building envelope improvement and mechanical systems, lighting upgrades, equipment replacement and installation of lighting and HVAC control mechanisms, among others.

A good audit should include information specific to each recommendation which *at least* includes approximate annual energy unit and cost savings, demand reduction, installation cost, lifetime cost savings and information related to cost-effectiveness. This will help to prioritize the recommendations based on their energy efficiency and shortest payback.

The recommendations provided in an energy audit report may reduce facility energy bills by 20% or more in addition to improving occupant health and comfort. Following this report, an energy audit is the next step in realizing the full potential of energy savings opportunities.

- **Request Retro-Commissioning**

Retro-commissioning is a detailed process applied to existing facilities aimed at correcting many of the degradations and inefficiencies that are indicative of older and/or poorly performing buildings. Many older buildings tend to be less comfortable and operate less efficiently when not properly commissioned. Retro-commissioning includes a detailed energy audit and focuses on not only potential energy savings but also the interaction of the building's equipments and mechanical systems with an eye toward restoring it to optimal performance.

In contrast to an energy audit, this optimization focuses on operational improvements to existing equipment, rather than replacement. Apart from energy savings, other improvements and benefits include substantial operation and maintenance (O&M) cost savings, improved air quality, occupant comfort, health and safety, equipment controls, and improved system interactivity.

In addition to providing recommendations, retro-commissioning includes implementation of the recommended improvements and hence the cost for retro-commissioning is higher than an audit. However, when the costs of improvements are added to the energy audit cost, prices may be comparable. If high O&M costs or occupant health, comfort and safety are concerns in addition to reduction in energy use, retro-commissioning may be a suitable strategy.

- **Upgrade Lighting Systems**

Lighting typically accounts for 30-60% of all energy consumed in school buildings. Additionally, the electrical energy consumed by lights during the summer creates heat and increases cooling costs.

Chamberlain Street Elementary School's electricity consumption is low (better) compared to other schools in the State. Even so, upgraded lighting systems in high consumption areas like classrooms, gymnasiums, libraries, offices, etc. can reduce these costs even further and improve the lighting quality and increase occupant comfort and productivity.

Over-lit Spaces: Light levels should be recorded in classrooms and hallways to ensure they are not over-lit, 40-50 foot candles are adequate light levels for an instructional space. If classroom light levels are much higher than 50 foot candles, Chamberlain Street Elementary School should consider de-lamping classrooms or installing dimming ballasts, which dim the lights when outdoor light levels are adequate. In over-lit hallway spaces photo sensors can be installed to turn lights off completely when light levels exceed a pre-set threshold.

In over-lit spaces a T8 to Super T8 lighting retro-fit can reduce the number of light fixtures needed. Super T8 lamps use between 4 and 7 Watts less electricity than standard T8 lamps, but they produce more light per Watt. In some cases this increase in light per Watt can allow for the removal of an entire lamp, saving 32 Watts. The room characteristics must be factored in before this type of retro-fit. The shape of the space, ceiling height, color of the walls, etc. all need to be taken into account when exploring a de-lamping project. We recommend that before retro-fitting the entire facility, begin by changing one classroom and monitor the comfort level of the occupants at Chamberlain Street Elementary School.

Another proven energy reduction measure with a short payback period is to identify any areas where your school may still be using metal halide lighting. Typically metal halide lights are found in gymnasiums or cafeteria areas, many districts have been very satisfied by replacing these lights with high bay T5 lighting fixtures. In addition to the reduced operational wattage, high bay T5 lights turn on instantly, as opposed to metal halide fixtures which have an extended warm up period. The long warm up period associated with metal halides typically leads to the lights being left on all day, at 250 to 400 watts a fixture; the costs begin to add up. Adding occupancy sensors to high bay T5 fixtures further reduces the payback period.

Occupancy Sensors: We recommend that you explore the use of occupancy sensors to ensure that lights are turned off in unoccupied spaces. Lights controlled by occupancy sensors typically run a third of the time when compared with manually controlled lighting. Reduced runtime leads to decreases in both energy usage and operation and maintenance costs. Additionally, a study conducted in Massachusetts found that controlling the security lighting with occupancy sensors reduced vandalism; neighbors and police recognized something wrong when the lights were on in a building that was typically dark and investigated.

To summarize and add a few ways in which Chamberlain Street Elementary School may be able to conserve energy and cost through lighting upgrades is to:

- Design light quantity and quality for the task and occupants' needs in that area.
- Maximize lamp and ballast efficiency.
- Activate the power saving features on office equipment such as copiers, printers and fax machines and ensure that they are turned off at the end of the day.
- Use automatic controls to turn lights off or dim lights in unoccupied spaces.
- Establish a maintenance schedule for group re-lamping and fixture cleaning.
- Replace T12 fixtures with the most efficient fixtures which may include T8/super T8/T5 fixtures.
- Replace incandescent lighting with compact fluorescent technology.

- Replace incandescent exit lighting which consumes 30 Watts with LED type exit lights with 1.5 Watts consumption. LED units last up to 10 years, which is a maintenance advantage.
- Install daylight sensors in areas with significant natural light.
- Install occupancy sensors in areas that are often unoccupied.
- Lighting retrofits reduce maintenance costs associated with lighting that is close to end of life.
- Establish a regular cleaning schedule particularly for areas where student safety of low light levels may be a concern, such as shop classes.
- Look to make lamp and fixture selection as uniform as possible to reduce maintenance and inventory overhead.
- Educate students and staff to turn off lights when rooms are unoccupied.

Lighting upgrades seek to reduce the connected electrical load (kW) and energy consumption (kWh) of lighting equipment. Lighting controls can also significantly reduce operating hours and costs by turning off lighting when spaces are unoccupied or sufficiently lit by natural light.

- **Install NEMA Premium Motors and VFDs**

Commercial and industrial electric motor-driven systems consume approximately 23% of all electricity in the U.S., making it the single largest category contributor to electric use in the country. With very high operating hours, the annual energy cost to run a system is more than its installation cost. Even a small increase in the efficiency of an electric motor can result in substantial energy cost savings. Typical opportunities for motor upgrades in schools include: ventilation fans, and heating and cooling system pumps and fans.

Motors with efficiency up to 90% are available to replace the older ones with efficiency less than 75%. Although standards for efficiency of new equipment are set by the Energy Policy Act, motor efficiency can be further increased by selecting Premium Efficiency motors as specified by the National Electrical Manufacturers Association (NEMA). This can cut the electric motor system demand by as much as 18%.

Savings can be increased further by optimizing system performance through the use of variable frequency drives (VFDs). When system load is known to vary substantially, these flow control systems can be utilized to match system output to system demand, significantly reducing energy usage during partial load hours. By employing high-efficiency motors and VFDs, facility owners can improve environmental conditions, utilize better control of motor-driven processes, and reduce waste output.

- **Install Demand Control Ventilation**

Demand control ventilation (DCV) monitors indoor air CO_2 content as a result of occupancy production levels and uses this data to regulate the amount of outdoor air that is permitted for ventilation. In order to ensure adequate air quality, standard ventilation systems permit outside air based on estimated occupancy levels in CFM, cubic feet per minute/occupant. However, during low occupancy hours, the space may become over ventilated due to decreased CO_2 levels and unnecessary ventilation results in wasted energy. DCV reduces unnecessary outdoor air intake by regulating ventilation based on actual CO_2 levels, saving energy. DCV is most suited for areas where occupancy levels are known to fluctuate considerably such as auditoriums, cafeterias, and gymnasiums.

Install Energy Recovery Ventilators. According to energy recovery equipment manufacturer's typical paybacks are less than 5 years for schools without cooling. The keys to success with ventilation retrofits are going with fewer larger units with long run hours as opposed to several small units with limited run time. Equipment with moisture recovery capabilities would cut humidity up to 50% during the cooling season.

- **Improve/Replace Inefficient Heating Systems**

Replacing an old boiler that is < 70% efficient with a modern 85-90% efficient natural gas-fired furnace alone will reduce heating costs by 15-20%. This combined with additional system improvements and installation of advanced HVAC control mechanisms can result in up to 20%+ heating load reduction.

Because of the high capital cost of new heating systems, some financial analysis should be performed to assess the cost-effectiveness of immediate replacement. If the current system is fairly new, replacement may not be immediately justifiable from a financial standpoint. However, as is the case with cooling systems, early replacement may prove to be a more cost-effective solution than waiting until existing systems fail or reach the end of their estimated useful life.

- **Improve/Replace Inefficient Air Conditioning Systems**

The useful life of a rooftop A/C unit is generally 12-18 years. However, depending on the efficiency, early replacement of outdated, inefficient, split, or packaged rooftop air conditioning units with new A/C systems that are 15% more efficient than 10-15 year old equipments can considerably reduce annual energy consumption. The energy cost savings and maintenance savings offset the high installation cost of a more efficient system. Installing thermostats and/or economizers on new or existing A/C systems will further reduce the cooling demand.

Economizers provide "free" cooling by using controllable dampers that bring in outside air to cool the space when the outdoor temperature or enthalpy is below the building's return air conditions. Although they require operation by a well calibrated and maintained control system, economizers have impressive energy-saving capabilities.

Install Occupancy Controlled/Programmable Thermostats

Combining efficient HVAC equipment with occupancy controlled and programmable thermostats can save a facility up to 10% of its annual heating and cooling costs:

- Areas with unpredictable occupancy on a daily/weekly basis - gym, bathrooms, outdoors: Use an *occupancy controlled thermostat* - a thermostat paired with a sensor and/or door detector to identify movement/occupancy. If occupancy is sensed by the sensor, the thermostat goes into an occupied mode (i.e. programmed set point). If a pre-programmed time frame elapses (i.e. 30 minutes) and no occupancy is sensed during that time, the thermostat goes into an unoccupied mode (e.g., setback set point or off) until occupancy is sensed again. This reduces the overall time the heating or cooling system is running, saving energy.

- Areas with predictable occupancy: e.g.: classrooms, cafeteria, offices: A *programmable thermostat* is recommended. This device is programmed on a schedule to reduce the heating or cooling output of the facility's HVAC systems in relation to its predetermined occupancy schedule. In this way, the thermostat acts to set-back or set-up the facility temperature during unoccupied hours, and re-establish a comfortable facility temperature during business hours. By employing programmable thermostat technology, the heating and cooling system demand coincides with occupancy level, reducing energy usage.

- **Install Vending Misers on Vending Machines**

Vending misers for refrigerated and non-refrigerated vending machines is an often overlooked source of potential savings. Uncontrolled, vending machine lights remain on 24/7, consuming a constant amount of energy year round. By controlling these lights with an occupancy sensor, energy consumption attributed to vending machines can be reduced considerably, in many cases, by as much as 50% and can save up to $150 per machine per year.

In the case of refrigerated vending machines, electric demand can be further reduced by controlling the machines' refrigeration systems. In a manner similar to programmable thermostats, vending misers for refrigerated machines act on a pre-set occupancy schedule to allow a marginal increase in operating temperature during non-business hours. Although products in the machine are delivered to the customer at the same temperature as in an uncontrolled vending machine, products are not being cooled unnecessarily when the machine is not in use, significantly reducing the machine's energy consumption. Because of the relatively low vending miser installation cost and high operating hours of vending machines, this improvement is typically cost-effective with a very short payback period.

- **Install ENERGY STAR® Rated Equipment / Plug Load Control**

Plug loads (computers, televisions, coffee makers, etc.) account for, on average, about 10% of total energy consumption. One of the easiest and most cost-effective energy saving strategies is the reduction of electric usage through installation of efficient appliances and the control of plug loads. In addition to utilizing ENERGY STAR® qualified appliances, greater savings can be realized through the various devices available that control every day plug loads.

By connecting non-critical loads (coffee makers, fans, microwave ovens, etc.) to an occupancy or timer controlled power strip, significant energy savings can be achieved. These savings result not only from the neglect of the user to turn the device off manually, but also from reduction of "phantom load". Phantom load is the small but constant energy draw from many plug-in devices when not in use. By connecting certain appliances to an occupancy controlled power strip, phantom load can be eliminated by cutting power supply to those devices. When replacing or ordering new equipment, emphasize ENERGY STAR® devices when they are available. Also, purchase controlled power strips and connect appropriate devices to those strips to reduce unnecessary consumption due to phantom load and appliances left on. The EPA offers free computer power management software which has saved some districts as much as $75 per computer per year, the software can be found at http://www.energystar.gov/index.cfm?c=power_mgt.pr_power_mgt_low_carbon_join.

IV. Resources:

The State of New Hampshire along with the utility companies offer multiple programs designed to improve the energy efficiency of schools through financial incentives and technical support, including:

Northeast Energy Efficiency Partnerships:

- **Northeast Collaborative for High Performance Schools (NE-CHPS)**
  NE-CHPS is a set of building and design standards for all schools from pre-K through community colleges tailored specifically for NH state code requirements, the New England climate, and the environmental priorities of the region. NH Department of Education offers up to a 3% re-imbursement for New Construction School projects. To learn more about NE-CHPS and incentive programs please visit: http://neep.org/public-policy/hpse/hpse-nechps.

New Hampshire Public Utilities Commission:

- **New Hampshire Pay for Performance**
  This program addresses the energy efficiency improvement needs of the commercial and industrial sector. The Program is implemented through a network of qualified Program Partners. Incentives will be paid out on the following three payment schedule: Incentive #1: Is based on the area of conditioned space in square feet. Incentive #2: Per/kWh saved and Per/MMBTU saved based on projected savings and paid at construction completion. Incentive #3: Per/kWh saved and Per/MMBTU saved based on actual energy savings performance one year post construction. Total performance incentives (#2 and #3) will be capped at $200,000 or 50% of project cost on a per project basis. For more information visit http://nhp4p.com.

- **New Hampshire Public Utilities Commission's Renewable Energy Rebates**
  The Sustainable Energy Division provides an incentive program for solar electric (photovoltaic or PV) arrays and solar thermal systems for domestic hot water, space and process heat, with a capacity of 100 kW or equivalent thermal output or less. The rebate for PV systems as follows: $1.00 per Watt, capped at 25% of the costs of the system or $50,000, whichever is less. For solar hot water (SHW) systems, the base rebate is $0.07 per rated or modeled kBtu/year, capped at 25% of the cost of the facility or $50,000, whichever is less, as a one-time incentive payment. http://www.puc.state.nh.us/Sustainable%20Energy/RenewableEnergyRebates-CI.html.

New Hampshire Community Development Finance Authority:

- **New Hampshire Community Development Finance Authority Revolving Loan Fund**
  The Enterprise Energy Fund is a low-interest loan and grant program available to businesses and nonprofit organizations to help finance energy improvements and renewable energy projects in their buildings. The loans will range from $10,000 to $500,000. Larger amounts will be considered on a case by case basis. The program is available to finance improvements to the overall energy-efficiency performance of buildings owned by businesses and nonprofits, thereby lowering their overall energy costs and the associated carbon emissions. More information about the program can be found on their website www.nhcdfa.org. These activities may include:

  - Improvements to the building's envelope, including air sealing and insulation in the walls, attics and foundations;
  - Improvements to HVAC equipment and air exchange;
  - Installation of renewable energy systems;
  - Improvements to lighting, equipment, and other electrical systems; and
  - Conduction of comprehensive, fuel-blind energy audits.

Public Service of New Hampshire (PSNH):

- **Commercial (Electric) Energy Efficiency Incentive Programs**
  This program targets any commercial/industrial member building a new facility, undergoing a major renovation, or replacing failed (end-of-life) equipment. The program offers prescriptive and custom rebates for lighting and lighting controls, motors, VFDs, HVAC systems, chillers and custom projects. http://www.psnh.com/SaveEnergyMoney/For-Business/Energy-Saving-Programs-and-Incentives.aspx

- **SmartSTART**
  The SmartSTART (Savings Through Affordable Retrofit Technologies) advantage is simple - pay nothing out of pocket to have energy efficiency products and services installed in your building. The Smart Start program is limited to PSNH's municipal customers only and includes schools. The program is available on a first-come, first served basis to projects which have been pre-qualified by PSNH. The cost of the improvements is fronted by PSNH which is then repaid over time by the municipality or school using the savings generated by the products themselves! This program is for lighting and lighting controls, air sealing, insulation and other verifiable energy savings measures which have sufficient kilowatt-hour savings. For more information on this program visit:
  http://www.psnh.com/SaveEnergyMoney/For-Business/Municipal-Smart-Start-Program.aspx

- **Schools Program**
  For major renovation or equipment replacement projects, this program offers prescriptive and custom rebates for energy efficient lighting, motors, HVAC, chillers, and variable frequency drives to towns or cities that install energy efficient equipment at their schools. Financial incentives are available for qualifying energy efficient equipment. Technical assistance is also offered through the Schools Program. http://www.psnh.com/SaveEnergyMoney/Large-Power/Schools-Program.aspx

Unitil:

- **Commercial and Industrial Energy Efficiency Programs**
  Subject to program qualifications and availability of funding - Unitil offers different programs for its commercial, industrial, and institutional customers in New Hampshire: the Small Business Energy Efficiency Program, the Small Commercial and Industrial Program, the Large Commercial and Industrial Program, the Large Commercial and Industrial (C&I) Retrofit Program, and the Large C&I New Construction Program. Rebates are available for various technologies including water heaters, lighting, lighting controls/sensors, chillers, furnaces, boilers, central air conditioners, compressed air, programmable thermostats, energy management systems/building controls, motors, VFDs, processing and manufacturing equipment, LED exit signs, commercial cooking and refrigeration equipment. http://www.unitil.com/.

Clean Air – Cool Planet:

- **Community Energy Efficiency**
  CA-CP works with communities throughout the Northeast to find solutions to climate change and build constituencies for effective climate policies and actions. Much of their work focuses on successful models for energy efficiency and renewable energy planning. They advise and partner with citizens, educators, faith groups, small businesses, municipal governments, and other local leaders. They explore cost-effective opportunities that exist for communities to reduce their emissions as well as their vulnerability to climate impacts. One such example is CA-CP's partnership with the University of NH, NH Sustainable Energy Association and UNH Cooperative Extension to create myenergyplan.net, a groundbreaking suite of web and outreach tools for individual action used by households, schools and community groups around the northeast. http://www.cleanair-coolplanet.org/for_communities/index.php.

Environmental Protection Agency (EPA):

- **ENERGY STAR Challenge for Schools**
  EPA is challenging school administrators and building managers to improve energy efficiency throughout their facilities. More than 500 school districts across the country are helping to fight climate change by committing to reducing their energy use with help from ENERGY STAR. Schools that take the ENERGY STAR Challenge can use energy tracking tools, technical guidance, case studies and other ENERGY STAR tools and resources to help them improve their energy efficiency. More information can be found at:
  http://yosemite.epa.gov/opa/admpress.nsf/d985312f6895893b852574ac005f1e40/d74f768ecfa9e11f8525762500522260!OpenDocument.

For additional assistance in helping you save money and improve school conditions, please call TRC at (603) 766-1913 or (877) 442-9181.