FINAL CONSTRUCTION REPORT

NYSERDA
RESIDENTIAL PERFORMANCE CHALLENGE

111 MADISON ST – TROY, NY

Draft

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Submitted to:

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Home Description

The right-hand side of this existing building (111 Madison St..) was gutted to the studs and rebuilt in the Spring 2010 by The Madison Project partnership. The left-hand side of the building (109 Madison St.) had been previously gutted and renovated in 2008. This orignal house was well insulated and constructed to Energy Star Standards. Our goal for 111 Madison was to improve on that orignal design.

The two sides of the buildings are separately deeded. Each has property been made into upstairs and downstairs apartments, each with their own gas and electrical utility meters. The Madison Project currently plans to rent the appartments but may consider selling the property in the future.

Figure 1. Photo of Two Buildings

The various key construction details are summarized in the following Figures. Table 1 shows the implemented improvements compared to 109 Madison St. Table 2 summarizes the costs of the implemented improvements.

Our teamed reviewed the design of the orignal house and then proposed improvements. The focus was on improving the air tightness and evaluating alternate water heating and space heating options.

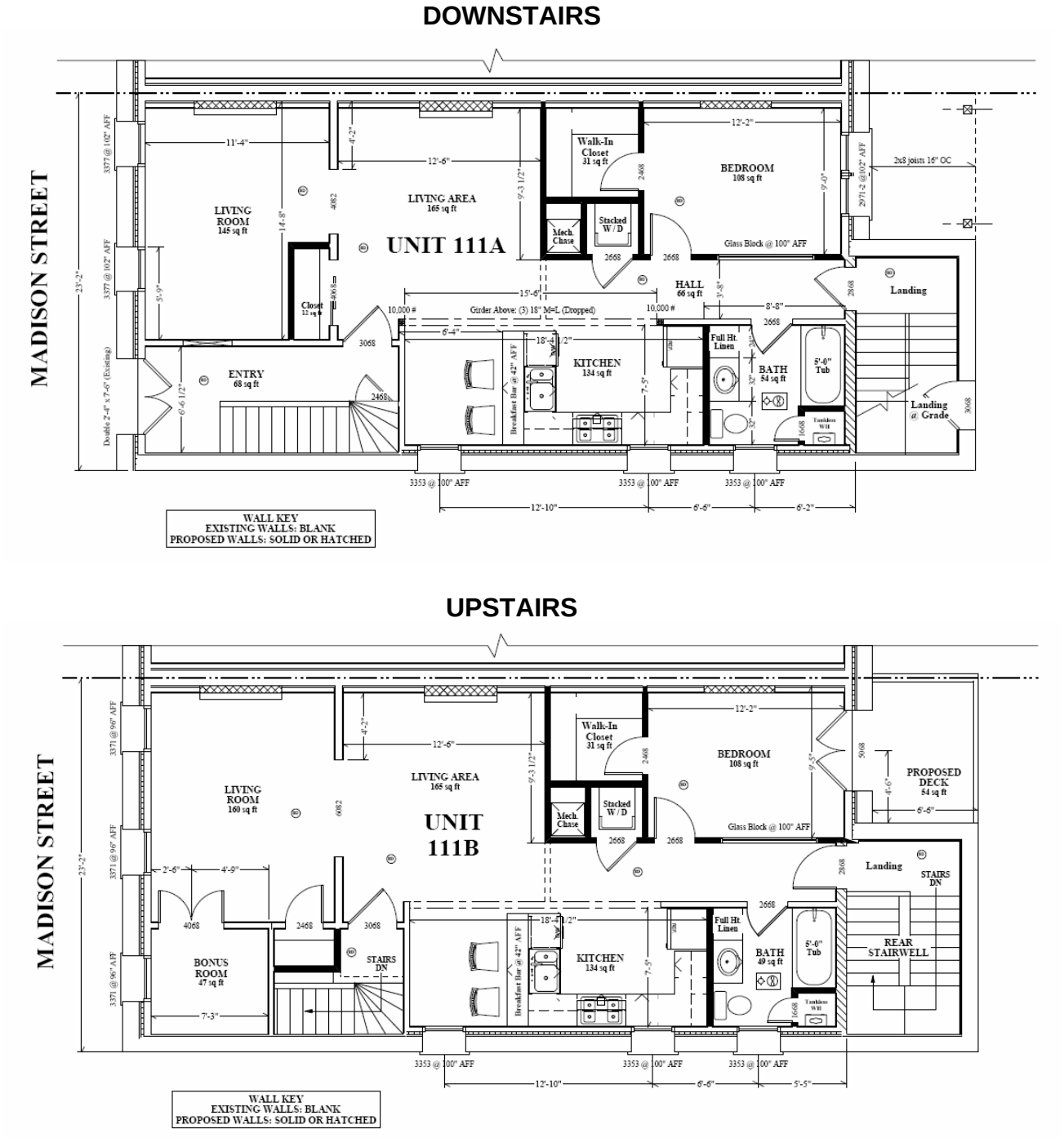

Figure 2. Floor Plans for 111 Madison St.

Table 1. Thermal Envelope Details: 111 Madison St

	Base Design (109 Madison)	**Improved Design (111 Madison)**
Walls (Front and Back Exterior)	Masonry w/ air gap and 2" Poly Iso Foam Board, 2x4 Frame w/ 6.5" netted cellulose (R-38)	Masonry w/ 2" closed cell spray foam, 2x4 w/ 6.5" to 8" netted cellulose (R-36)
Wall (Exterior Stairwell, Front)	Masonry and furring strips w/ Pieced in 1" Foam Board (R-7)	Masonry and furring strips w/ 1-1/2" closed cell spray foam (R-9)
Wall (Interior Stairwell, Front)	2x4 Frame, 4.5" Dense Deck Cellulose (R-25.5)	2x4 Frame, 1st Floor: 4.5" Dense Deck Cellulose with 1" Rigid Foam (R-25.5) 2nd Floor: 3.5" Fiberglass Batts with 1"Rigid Foam (R20)
Wall (Interior, Rear Stairwell)	2x8 Frame w/ Fiberglass batts and 1" Rigid Foam (R-24)	1st Floor, 8" wall with staggered 2x4 stud frame w/ 8" cellulose (R-30) 2nd Floor, 10" (R-37) cellulose upstairs
Wall (Kitchen and Bath)	Masonry and 2x4 Frame w/ 4.5" Cellulose and 2" Rigid Foam (R-24)	Masonry w/ 2" closed cell spray foam, 2x4 w/ 4.5" netted cellulose (R-24)
Wall (Exterior, Rear Stairwell)	Masonry and Stucco	Masonry and furring strips w/ 1-1/2" Closed cell spray foam (R-9)with sheet rock on top
2nd Floor Bonus Room Walls	2x4 Frame w/ Fiberglass Batts R13	2x4 frame w/ 3.5" Fiberglass w/ 1" rigid foam (R-20)
Bonus Room Floor	10" Fiberglass (R-35)	10" Fiberglass (R-35)
Attic	2x10 frame with 16" cellulose (R-60)	2x10 frame with 16" loose cellulose (R-60)
Basement Walls	Masonry w/ 4" closed cell spray foam (R-24)	Masonry w/ 4" closed cell spray foam (R-24)
Basement Floor	4" Stone with Poly	EPDM on dirt
Windows	U=0.32 (double hung)	U=0.32 (double hung)
Skylights[1]	N/A	N/A
Rim/Band Joists	3" Closed cell spray foam (R-18)	3" Closed cell spray foam (R-18)
Attic Hatch	4" Rigid Insulation	4" Rigid Insulation
Heating/DHW	(2) 95% Efficiency Goodman Gas Furnace with (2) Takagi T-K3 instantaneous water heaters	(2) 95% efficiency Prestige triangle tube fully condensing water boiler w/ Smart 30 indirect fired DHW heater
Air Tightness & Thermal Bypass	3.75 ACH50 (with basement)	3.29 ACH50 (with basement) Various air sealing
Ventilation	Exhaust Only Ventilation, manual control	Exhaust Only Ventilation, manual control

First Floor Front Stairwell

Blown Cellulose in Attic

Rear Wall Detail at Window (drywall returns)

Closed Cell Spray Foam in Rim Joists

Figure 3. Photos of Insulation in Various Parts of Home

The basement floor for 111 Madison St. was covered with an EPDM roofing membrane layed out over the dirt floor, instead of the tradiational poly sheeting covered with layer of stones as was used for 109 Madison St. This apporach provided a cleaner surface in the basement that was easier and cheaper to install. It also provided a better moisture barrier that is more difficult to puncture and if punctured is easier to repair.

Figure 4. Closed Cell Insulation on Basement wall with EPDM Membrane on Basement Floor

109 Madison St.used two separate 95% efficient gas furnaces for each appartment. Hot water was provided by separate tankless water heaters (Takagi T-K3). All the equipment was located in the basement.

111 Madison used a 95% efficient boiler with a 30 gallon.indirect tank in each apartment. The equipment was located near the bathtub. The wall hung boiler is a 60 MBtu/h Prestige (triangle tube) fully condensing water boiler with a Smart 30 tank. Each boiler has a separate circulation pump for space heating and water heating. Space heating is provided by conventional baseboard heaters (36 linear feet upstairs, 33 linear feet downstairs).

Wall Hung Boiler located in the Bathroom of each Apartment

The 60 MBtu/h boiler is significantly oversized for the space heating needs of each apartment. (about 18 MBtu/h). We worked with the owners and HVAC contractor to develop a lower cost way to heat the two apartments. One option was to have one boiler to serve both apartments (each with their own hot water tank). However this approach was ultimately not used because it was important to maintain separate utility metering for each apartment. We also looked at options that would integrate a hydronic AHU into the water heating system (i.e., the Rinnai AHU), but this concept was not accpted by the site.

Ventilation for the house is provided by exhaust fans in the bathroom of each unit. The downstairs fan was measured at 72 cfm while the upstairs fan was at 51 cfm. Gravity dampers close off the vents when the fans are not in use.

Table 2. Summary of Capital Cost Differences

Base Insulation and Equipment	
	Cost
Closed Cell Foam Basement Only	$ 2,100
Cellulose Attic and Exterior Walls	$ 4,500
Fiberglass Interior and Sound	$ 700
2" Poly Isocyanurate Exterior Walls	$ 1,075
Heating System:	
(2) 95% Efficient Gas fired Goodman Hot Air Furnace	$ 11,000
(2) Tagaki TK3 - DHW	$ 5,400
TOTAL	**$ 24,775**
Improvements:	
Closed Cell Foam Exterior and Basement Walls	$ 8,000
Cellulose Attic and Exterior Walls	$ 6,725
Fiberglass Interior and Sound	$ 300
Heating System:	
(2) 95% Efficient Prestige Water Boiler w/ indirect DHW	$ 20,000
TOTAL Improvements	**$ 35,025**
ADDITIONAL COST (above base cost)	**$ 10,250**

Energy Performance

The energy use predicted by RemRate for the two buildings is shown in Table 3. The design heating load improved house decreased by about one fifth compared to the base house.

Table 3. Summary of Energy Use and Savings

	Annual Load (MMBtu)	**Design Load (MBtu/h)**	**Total Fuel (MMBtu)**	**Relative Fuel**	**Annual Cost**	**Savings**
109 Madison St (3.75 ACH50)	40	25.8	78.6	100%	$1,179	$0
111 Madison St (3.29 ACH50)	28.4	18.5	63.8	81%	$957	$222

Savings are primarily due to air tightness and added insulation. We performed a blower door test to show the air tightness of both sides of the building. 111 Madison St. was tighter than 109 Madison St. but not as tight as we had anticipated. Smoke bottles were used to identify air leaks in the building as shown below. The results of this test are presented in a separate report.

Air leak at top of window

Air pocket at beam pocket vent (for moisture protection)

Air leak at ceiling fan

Fan door in old part of building (109 Madison St.)

Figure 5. Air Leakage Measurements

In addition to reviewing 12 months of utility bills, we plan to install data loggers to monitor heating system and total house performance. We will install battery powered data loggers to measure the parameters listed in Table 4 for both the upstairs and downstairs units separately. Data will be recorded at hourly intervals by battery-powered dataloggers. We will periodically retrieve data from the loggers.

Table 4. Monitored Points to be Measured at 111 Madison St

Logger Channel	Description	Eng Units	Sensor	Notes
A1	Upstairs Apartment Power	kWh	WattNode 1	(2) 100 amp CTs
A2	Downstairs Apartment Power	kWh	WattNode 2	(2) 100 amp CTs
A3	Upstairs Boiler Power	kWh	WattNode 3	(1) 25 amp CT
A4	Downstairs Boiler Power	kWh	WattNode 3	(1) 25 amp CT
B1	Upstairs Heating Pump	minutes	Veris 300	
B2	Upstairs DHW Pump	minutes	Veris 300	
B3	Downstairs Heating Pump	minutes	Veris 300	
B4	Downstairs DHW Pump	minutes	Veris 300	

In addition to energy monitoring, we will take periodic measurements of the moisture content of the various “beam pockets “ to determine if concerns about moisture buildup in the floor joists is warranted.. Camroden will use their handheld moisture meter to check the moisture content throughout the year. These “pockets” which improve drying are also thought to increase air leakage.