

November 2009

Dear Pastor,

The following is a conditions assessment of your historic church. I include recommendations for the repair of the removed belfry and roof trusses. Please review this report and let me know if you have any questions. I am happy to meet with you and your building committee to review my assessment and explain repair procedures and associated costs.

The Church is a timber framed structure built in 1838. It is a beautiful example of gothic revival architecture made popular during the mid-nineteenth century as settlement increased throughout the state of Maine. Its peaked gothic window tops and intricate belfry architrave creates an authentic Maine Church typology popular in the early to mid 1800's.

Like most churches, the building has evolved and grown over time. The Parish hall attached to the main sanctuary provides meeting space, kitchen and classroom space. A modern addition housing bathrooms and office space also allows for day-to-day operation of the church. These portions of the church property are outside the scope of this assessment. Here we focus on the earliest portion of the church including the king post truss roof system and belfry framing.

The sanctuary roof structure is made up of a series of king post trusses that allow the uninterrupted sanctuary space below. The front gable end framing and the first truss support belfry framing and loads are shared by the balcony walls at the front of the church as you face it from Main Street.

At some point water must have penetrated the wood shingle exterior of the dome atop the belfry. In November 2008 the belfry was deemed severely damaged and subsequently removed from the building. Remaining evidence within the tower box and photographs taken during removal of the belfry do not show significant rot areas. Remaining trim, of which there is little, does not show significant deterioration. Other discarded elements of the tower may have revealed the cause and location of damage due to water penetration and we must assume that damage was significant given the work completed to date.

The original bell from 1844 and portions of the bell cradle remain and the bell cradle elements can be reproduced in kind. The size and layout of the belfry framing lies intact in the severed belfry posts beneath the belfry roof. The tower box posts and portions of the tower box roof plane appear original and in good shape with no visible water damage. These posts and the exterior sheathing and siding will be retained as the belfry itself is created in kind.

The architectural elements of the belfry can be reproduced exactly given the physical remains saved from the dumpster during the removal of the structure. We know from this evidence the size of the pilaster, capitol and roof trim. We know what the horizontal sheathing is and we know inadvertently from the removal photos how the trim was attached to the timber frame.

Photographic evidence also gives us enough information to see how the dome was constructed and clad. This roof structure can be reproduced from local pine to exact measurements extrapolated from existing conditions and subsequent comparisons to historic and modern photographs.

OBSERVATIONS AND SPECIFICATIONS:

The sanctuary measures approximately 36 feet wide by 60 feet long. It is fully timber framed including a good deal of the original sills and undercarriage. The full-length 20-foot posts support a continuous plate about 7 Inches Square. This plate is bolstered by 3" by 5" angle braces framing each window opening. Studs complete the wall framing spaced about 24 inches on center. The roof system

is made up of 4 king post trusses spaced about 11 feet apart. Each gable end is created from a continuous 36-foot long tie beam accepting 3" by 4" studs, which engage gable end principal rafters.

Each truss is created from a 9" by 10" by 36 foot continuous tie beam supported mid span by a hand hewn king post. Each post hosts two struts that engage the midspan of the principal rafter chords. Each truss is connected by a principal purlin just below the half way mark along the length of the principal rafters. These purlins support common rafters spaced near 24 inches on center.

The king post roof truss system allows clear span across the sanctuary. Vertical nailers support a vaulted plaster ceiling later covered in a patterned tin. The original pews intact in the sanctuary are mortise and tenoned into the floor system. This floor system is created from half round log joists and hand hewn carrying timbers supporting two layers of one inch pine flooring. The pulpit area and baptismal were added later to the sanctuary space. This is clearly evident when viewing the stained glass window placement where the rear window is bisected by a non-bearing wall creating the elevated pulpit and organ areas.

The front gable end of the church and truss one support the tower box framing. Two sleeper beams cross from the gable end and over truss one to accept the four tower box posts. The tower box framing is also carried by the bearing wall, which supports the balcony. Two tower box posts cantilever beyond this wall and land over the sanctuary space. The balcony construction uses large timber brackets to support its weight beyond the shared bearing wall.

Each king post is joined to the bottom chord with a wedged half dovetail and steel dog that retains the tension in the king post. There is an inch or more of space between bottom shoulder of king post and bottom chord. Some of this may be shrinkage after the beams dried out, but it does appear that the truss has opened up because of the roof loads over time.

The rafter heel on the first truss has pushed through the end of the tie beam on the right side of the church as viewed from the street. This has occurred in the third truss on the left side of the church as well. This is seen both from the exterior of the building via a hump in the roof and also seen from the interior as the very end of the tie beam has broken away from the thrust of the rafter through the tie beam.

A very interesting detail revealed from the investigation is seen at the very end of each bottom chord. The bottom chord/rafter heel connection incorporates a slight let in for the base of the rafter heel culminating in a rise in the end of the tie beam acting as a stop for the rafter heel tip. This is coupled with a mortise and tenon joint at the rafter heel secured with a one-inch peg. While the mortise and tenon joinery is typical of early English framing technology, the tie beam tip is atypical. This is both unusual and weak due to the short grain at the end of the tie beam. Where the forces of the roof load have overwhelmed the truss chord/rafter heel connection, this "relish" is broken and the rafter heel will need to be re-secured.

The tower box is made up of four structural posts and measures just strong of 10 feet square. The posts sit on top of sleeper beams passing from the front gable end tie beam and crossing over the bottom chord of the first king post truss heading into the sanctuary. There is sagging and separation of the king post from the bottom chord in this location, but this may be in large part due to shrinkage of the timber frame elements and does not appear to have moved significantly in recent times.

The tower box posts are approximately 27 feet tall and are created from native pine and spruce timbers about 7 inches square. Horizontal girts stiffening the tower box posts are about 8 inches square and they are bolstered further by 3" by 5" by 3' long angle braces, which creates a very strong and rigid base for the belfry.

A timber ribbon attached to the tower box posts about 3 feet down from the roof plane supports the bases of 8 belfry posts that at one time protruded through the tower box roof plane and supported the domed roof of the belfry. The remaining post sections reveal an eight sided belfry about

7'-7" across. This evidence allows us to accurately determine the size of the belfry framing and the diameter of the 8-sided dome roof.

The dimensional ribbon supporting the base of the belfry framing is woefully undersized for its task. This is likely to have contributed to the demise of the belfry dome as the wind could easily flex the belfry framing on this base.

This structural ribbon is placed below the tower box roof plane to provide some redundancy in the frame. This means that the belfry frame telescopes from within the tower box frame and on up to the domed roof above. This telescoping framing is essential for the structural stability of the belfry and tower overall.

The tower box roof system is created from a central 8-sided king post with four hip rafters projecting to the corners of the tower box. Common rafters split the span between the hip rafters and provide the base from which the roof sheathing is nailed up.

The belfry posts pass through this roof plane and the existing asphalt shingle roof is flashed with lead at each post. Asphalt roofing also covers the main body of the sanctuary and while serviceable, it will be necessary to change the roof shingles in the next five to ten years.

RECOMMENDATIONS AND ESTIMATED COSTS:

Belfry Framing and Exterior:

It is necessary to recreate the belfry framing and architectural features. The new belfry framing will be created from pine and spruce timbers to match exactly the original fabric. Trim elements will be recreated from clear pine boards to match the layout and shape of the original fabric. This is to be accomplished by copying the remaining trim artifacts.

The belfry roof will be stripped of its old shingles and replaced with a much longer lasting copper roof that will allow for the proper flashing of each of the 8 belfry posts. The access hatch and rope hole will be retained in the new roof. The belfry framing will be capped by a reproduction of the domed roof system and the vane pole will be spliced and put back into its original location.

The domed roof system is made up of laminated rough sawn rafters shaped to the original arch angle. The sheathing will be rough boards and the roof will then be protected by an underlayment of ice and water shield followed by clear Maine white cedar shakes to re-create the original roof details. Copper flashings installed beneath the white cedar shakes will protect the detailed architrave at the base of the dome.

Once the domed roof is back in place, original and reproduction trim elements will be placed back onto the tower. This includes the original vane pole. Tongue and groove horizontal sheathing will become the finish detail on the exterior of the belfry. The 1844 Hooper bell will be replaced into the belfry frame on a repaired bell cradle.

This cradle must be made independent of the belfry posts. At some point the cradle had been bolted to four of the belfry posts with angle iron brackets. This caused extensive stress and subsequent damage to the belfry framing. The new cradle will sit directly on the belfry roof and will be through bolted into the framing members below the roof plane. In this way the load paths are directed to the four tower box posts, which are far more capable of handling the live load of the swinging bell.

Once the belfry framing and trim elements are back together, the belfry will be painted to match the original color scheme. All new wood will be back primed with two coats of "California" oil based primer followed by two coats of "California" brand latex finish paint. The tower box roof will be red copper left natural. The domed roof will be shingled with white cedar shakes primed on all surfaces prior to installation. A copper drip edge will cover the tops of the architrave at the base of the

shingled dome roof. This drip edge will come up behind the lower two courses of the shingles to ensure that the roof will not leak.

Estimated Cost: SEE ATTACHED EXCEL SPREADSHEET.

Roof Truss Repairs:

Each roof truss will be fully inspected to determine structural integrity. Truss one and three will have metal straps added to the rafter heel/bottom chord connection to secure the original joinery. Cables may be added temporarily to these two trusses to pull tension back into the truss. Staging may be placed beneath the trusses in the sanctuary to assist in taking the truss load while it is realigned. The same strap will be placed at each end of each truss rafter chord to secure the roof system in its current location. Dogs will be added to truss three and four to copy those placed in the first two trusses. The additional metal is historically accurate for truss technology of the period. The metal will be ½ inch thick by 1-1/2 inches wide and allow for the installation of 6 structural screws on each 24" leg. The strap will be U-shaped to clasp the rafter heel to the bottom chord.

In addition to securing each roof truss, the common rafters will also be bolstered to transfer roof load directly to the top plate along each eave wall. Currently the common rafters place load outside of the wall plane and cause the eave wall trim to sag. A new knee wall created from rough pine studs will be created to sit atop the eave wall plate and engage each and every common rafter along both sides of the sanctuary. This knee wall will be fastened with structural screws and provide a more substantial load path for the bottom of each common rafter.

Access to the trusses will be made from the interior of the attic space and through the roof plane when necessary. Asphalt shingles and rough board sheathing will be removed to expose the truss and then the sheathing will be replaced and new shingles will be spliced into the existing roof covering. The scope of this work is to regain the original structural integrity of the roof system. New Asphalt shingles will match the old as much as possible but some color variation is inevitable. A new asphalt roof should be placed on the sanctuary in the near future, but remains outside the scope of this project.

Estimated Cost: SEE ATTACHED EXCEL SPREADSHEET.

CONCLUSIONS:

The Church needs its belfry back. Deferred maintenance and an insensitive demolition of historic fabric has caused great damage to the building. Age and weather has also taken its toll. The structural integrity of the sanctuary roof system is catamount to the longevity of the church building itself. The new belfry created in kind to regain the historical significance of the church is symbol to both congregation and town of vibrant community action and pride.

The work ahead is extensive. With saved remnants we can re-create the belfry frame and exterior and restore the building to its original glory. With well-placed flashing, properly installed roofing and a long-term maintenance plan, members of the congregation can behold the beauty of the church for many future generations.

Our firm is capable and welcomes the opportunity to work with the Church to succeed in your goals to restore the church.

CHURCH: TASK LIST FOR BELFRY AND ROOF REPAIR		
DATE:	TASK: RECREATE BELFRY AND DOME	DAYS:
	INSTALL STAGING TO ACCESS TOWER	20
	PERMIT	1
	ENGINEERING STAMP	2
	STRIP BELFRY ROOF	1
	DE-FLASH ALL 8 POSTS	1
	REMOVE ROOF BOARDS AROUND POST	1
	EXTRACT POSTS AND CRAB	3
	CREATE AND INSTALL TEMPORARY ROOF	2
	INSTALL NEW CRAB GIRTS TO SUPPORT CRAB	4
	DRAW AND SCALE DOME FROM PHOTOS	4
	RECREATE ALL 8 POSTS IN KIND	8
	RECREATE BELFRY DOME RAFTERS	4
	CREATE MOLDING PROFILES AT BASE OF DOME	3
	CREATE GOTHIC LOUVERS IN BELFRY	3
	SPLICE EXISTING MAST	2
	RECREATE WEATHER INDICATOR	1
	RECREATE BELFRY ROOF BALLUSTRADE	4
	BACK PRIME ALL TRIM ELEMENTS	8
	CREATE CROWN AND FLAT STOCK ELEMENTS	4
	SECOND COAT PRIME ALL ELEMENTS AT INSTALL	8
	TWO COATS FINISH LATEX CALIFORNIA	15
	CREATE AND INSTALL WINDOW VENT AT REAR	2
	CASE OUT POSTS	24
	ADD CORBELS AT POST TOPS	3
	ADD CROWN, FASCIA, FRIEZE, SOFFITT AT BELFRY	10
	ADD CROWN, FASCIA, FRIEZE, SOFFITT AT DOME	8
	INSTALL WHITE CEDAR SHAKES ON DOME	19
	CLAPBOARD ALL FACES OF BELFRY BOX	12
	ADD NEW CRADLE FOR BELL	4
	ADD CROSS BRACING AT BASE OF DOME	1
	ADD CEILING TO BASE OF DOME	2
	INSTALL NEWLY CREATED BELFRY INTO TOWER	12
	CLEAN UP	4
		200
	ROOF WORK:	
	OPEN ROOF SHINGLES ALONG BOTH EAVES	6
		14

	COPPER ROOF TO FOLLOW BASE OF DOME	0	
	FLASH 8 POST PENETRATIONS	0	
	FLASH A ROPE HOLE	0	
	COPPER OVER BELL CRADLE BASE BLOCKS	0	
	(SEE SUMMARY FOR COPPER ALLOWANCE)		
		DAYS:	COST:
SUMMARY OF LABOR:	RECREATE BELFRY AND DOME:	200	
	REPAIR ROOF TRUSSES:	58	
	COPPER ROOF WORK: <i>ALLOWANCE:</i>	0	
SUMMARY OF MATERIALS:	1000 BOARD FEET OF CLEAR PINE FOR TRIM		
	HEMLOCK POSTS TO CREATE BELFRY		
	HEMLOCK GIRTS FOR BELFRY		
	TURNED PINE MAST		
	WHITE OAK BELL CRADLE FOR BELL		
	SHEATHING FOR BELFRY ROOF AND DECK		
	PAINT, FASTENERS AND RIGGING		
	CRANE FOR INSTALLING BELFRY		
	<i>ALLOWANCE, MATERIALS TO BE PROVIDED AT COST.</i>		
	ESTIMATED PROJECT COST:		
	SUGGESTED CONTINGENCY: x% OF PROJECT COST:		
	TOTAL POTENTIAL COST:		
NOTE: THESE NUMBERS ARE MEANT AS AN ESTIMATE OF POTENTIAL COSTS FOR THE REPAIR OF THE SANCTUARY ROOF SYSTEM AND THE IN KIND REPLACEMENT OF THE REMOVED BELFRY. ESTIMATES ARE BASED ON AN HOURLY RATE OF \$x PER HOUR PER PERSON FOR A TEN HOUR DAY. LABOR WILL BE CLOSELY TRACKED FOR EACH TASK LISTED HEREIN. TASK SEQUENCE AND DURATION MAY VARY ACCORDING TO FOUND CONDITIONS. THIS NUMBER SHOULD BE CONSIDERED A NOT TO EXCEED ESTIMATE FOR THE WORK DESCRIBED IN THE ATTACHED WORD DOCUMENT EXPLAINING THE EXISTIING CONDITION OF THE CHURCH ROOF AND BELFRY.			
UNUSED CONTINGENCY FUND SHOULD TRANSFER TO A DEDICATED MAINTENANCE FUND AT PROJECT COMPLETION.			