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1790 Westford Academy
Town of Westford
Westford Historic Society
Westford, Massachusetts
Attn: John Mangiaratti
Assistant Town Manager

March 27, 2012

Dear Mr. Mangiaratti

Thank you for the opportunity to provide this structural assessment and cost estimate for the repair of the 1790 Westford Academy building. It is a very unique building worthy of preservation.

As I viewed the building, I focused on the condition of the roof trusses and the eight-sided open belfry tower framing. I did not do an in depth study of the entire structure. I also reviewed your 2011 assessment report prepared by Finch and Rose, Preservation Consultants. I find their report thorough and comprehensive and I have utilized two drawings from that report as an aid to this document. Please refer to drawings A-1 and A-2 from that report as they provide good illustration of the areas of concern.

I was able to spend a few hours in the roof system with Penny Lacroix, Museum Director and Bill Kenison, Inspector/Facilities Technician. Both had helpful insight into the existing condition of the roof covering and cupola. Bill also spoke with me about installing a pull-down staircase to allow for easier access and regular inspection of the attic space.

Access to the attic is very limited and Bill's idea is worthwhile and quite doable given the spacing of the ceiling joists in the second floor museum room. It is cramped in the attic space; a result of its hip roof design and the insertion of the belfry tower within it.

The roof design of the museum incorporates two king post trusses with a structural ridge between them. Two hip rafters engage the king post of each truss and between them are a number of principal rafters that support a common purlin roof frame with a vertically sheathed roof deck.

The roof frame design is both traditional and very strong. The king post trusses are well made and include a "blind nut" tension connection that holds the bottom chord of the truss securely to the bottom of the king post. This joinery is essential given that the belfry framing directly loads both trusses.

The open belfry is also very well made. It appears that the framing for the belfry was done on the ground and that the entire belfry was lifted into place rather than built piece by piece in place. This is illustrated by the severed cross braces that are mortised and tenoned into the base of the tower framing. These braces were clearly cut away during the installation process as they interfered with the structural ridge that was already in place within the roof system.

This information is important as it relates to the issues of rot that exist in the belfry framing. There are a number of areas of concern with regard to the condition of the belfry and I will explain and recommend solutions for repair. I will work my way up through the framing as it is labeled in Bill Finches drawings:

- NORTH AND SOUTH TRANSFER BEAMS: Both transfer beams show some checking. This is because they both have what is known as "spiral grain". This occurs in trees that grow near the edge of a field where heavy winds can impact their growth. While the checks do not concern me, the size of the beams actually does. These beams span 12 feet between trusses and the belfry frame sits atop them. The beams need to be increased to 10 by 12 inches to accept the dead load of the belfry across the span and to resist bending from the live wind load that pushes often against the belfry.
- BELL DECK POSTS: The four bell deck posts are in good shape overall. They accept the lower perimeter beam and an upper perimeter beam also known as the top plate of the belfry box. All of the horizontal perimeter beams are in need of replacement due to extensive rot. Water has clearly penetrated the lower levels of the tower box and caused extensive rot in these elements.
- LOWER PERIMETER BEAMS AND UPPER PERIMETER BEAMS: These beams will need to be replaced. Some epoxy repairs have been attempted here, with very limited success. They are undersized for their purpose and they should be increased in size and I strongly recommend they be replaced in white oak for strength and rot resistance. Access to the top plate can only be gained by removing portions of the existing belfry roof. This roof is in need of replacement as well. Access to the lower perimeter girts will require the temporary support of the belfry frame from below.
- CUPOLA POST TRANSFER BEAMS: The beams that cross the lower perimeter beams and support the eight belfry posts are very deteriorated, some more than others. These beams do two things within the tower box frame that places the structure in jeopardy. First, they require the severing of mortise and tenoned cross bracing in the tower box and two, they have no joinery that locks them together or within the tower box. They sit and are held by gravity alone. This is a problem, given wind shear on the upper portions of the belfry exposed to the weather. Each time the wind blows; the belfry posts either significantly load the small transfer beams or lift up from them. This continued action results in roof leaks and instability over time.

  The transfer beams should be replaced with new white oak beams measuring 8 by 10 inches spanning from the front to the back of the lower perimeter beams. From left to right, the first transfer beam would support belfry posts C-8 and C-7. Transfer beam two would support C-1 and C-6 and so forth across the structure. These transfer beams would be bolted down to the lower perimeter beam which is mortised and tenoned into the bell deck posts.
- BELL DECK BRACES: Some of the bell deck braces can be reinstalled into the tower box frame if the cupola post transfer beams are replaced as described above. This will increase the stiffness of the tower box and create a much

stronger base for the eight-sided belfry. These braces are oak and should be replaced in kind. This is done by extending the original mortise enough to install the full-length brace. The mortise is then plugged with a wedge to fully engage the brace shoulder. Traditionally wedged open mortises allowed for bracing to be placed after the frame was erected and the wedges driven to force the brace into substantial compression load, making the frame very rigid and strong.

- CUPOLA POSTS BELOW BELL DECK ROOF: The cupola posts appear in good condition. Each pair of posts is connected with braces and horizontal girts that have some shrinkage in their joinery, but remain viable and solid. It is unusual to see braces and girts in such small spans, but it does lock the belfry post pairs together quite well below the bell deck roof. A hewn camber beam provides strength and roof pitch for the bell deck and appears in good condition despite the rotten top plate it rests upon.
- CUPOLA POSTS ABOVE BELL DECK ROOF: The cupola posts above the bell deck are painted white and become the finished elements of the exposed belfry. They pass through the bell deck roof and have been heavily tarred to try and prevent water penetration through this roof level. The asphalt rolled roof covering is beyond its lifespan and is in need of replacement. A folded seam and soldered copper roof is highly recommended for this bell deck roof. Using this material allows for the posts to be flashed properly and the roof deck becomes very durable.
- CUPOLA RAILINGS AND TRIM: The cupola railings are replacement created from very poor quality materials and should be replaced entirely. Early photographs should be studied to determine the original balustrade profile, as none of the existing material is authentic or worthwhile.

  Trim elements on the cupola posts are a mixed bag of old and new trim pieces some of which will need replacement. Many layers of paint exist on the posts and trim that should eventually be removed and the tower repainted.
- CUPOLA METAL ROOF AND WEATHER VANE: While unable to access the metal roof of the belfry during my visit, Bill Finch does make mention in his report of possible issues with the weather vane. It is wise to consider a full inspection of this roof element during the repair process when staging is in place to do the bell deck roof. It is possible to repair the upper roof and replace damaged elements on the vane at that time.

ESTIMATED COSTS FOR STRUCTURAL REPAIRS:

Please consider these estimates as planning tools. I am happy to refine exact numbers should you decide to move forward with the repair process. Preservation Timber Framing Inc. is prepared and willing to quote and perform all structural work should the town put the project out for bid. I am also happy to provide specifications and estimates that can accompany Bill Finch's recommendation for the roof replacement. It is advisable to consider doing both structural and roof work in tandem.

The structural repair of the Westford Museum will take place from heavy structural staging set from ground through the first and second floor and up to the base of the cupola. In this way we will provide access and temporary structure as the timber frame is repaired. This will require the interruption of museum space at the center of both finished floors. Access to the museum would be maintained throughout the work and an opportunity for programming around the structural issues is encouraged.

Staging will also be necessary on the roof to access the bell deck roof and eight belfry posts. This staging will be made OSHA compliant and provide access for structural repairs of the top plates and access for the coppersmith creating the new bell deck roof. All staging will be protected from public access unless authorized by the contractor, museum and city staff.

STAGING AND STABILIZATION: $24,000.00

This includes the erection and disassembly of structural staging to access the tower box from within the building. It also includes roof staging for access to the bell deck. Cross bracing and structural support beams will be integrated into the structural staging to allow for the stabilization and partial disassembly of the tower box framing as the repair process proceeds.

TIMBER FRAME REPAIRS: $64,000.00

As described above, the timber frame repairs are extensive and will require some in kind replacement of existing rotten fabric. Recommendations to bolster and increase the strength of the tower by increasing the bed timber size and the orientation of the transfer beams will ensure structural integrity and longevity.

COPPER ROOF AT BELL DECK: ***(ALLOWANCE)*** $14,000.00

This estimated cost of a folded seam and soldered copper roof is based on projects of similar size and scope. Actual costs will vary according to the timing of the projects due to the variable cost of copper at the time of construction.

EXTERIOR FINISH OF BELFRY: $22,000.00

This work includes the removal of the existing railing, its reconstruction to match historic photographs and its re-installation. It also includes repair of trim elements on the belfry posts. It allows for the scraping and painting of the exposed portions of the belfry to meet current lead paint containment requirements.

BELFRY DOME AND WEATHER VANE: ***(ALLOWANCE)*** $12,000.00

This number is a best guess given that the condition of the belfry dome was not studied due to lack of access. Existing evidence from the ground indicates some repairs are necessary to the vane and perhaps the roof as well. Full-scale replacement of this roof seems unwarranted and further investigation is required to determine actual cost.

ESTIMATED TOTAL PROJECT COST: $136,000.00

CONCLUSION:

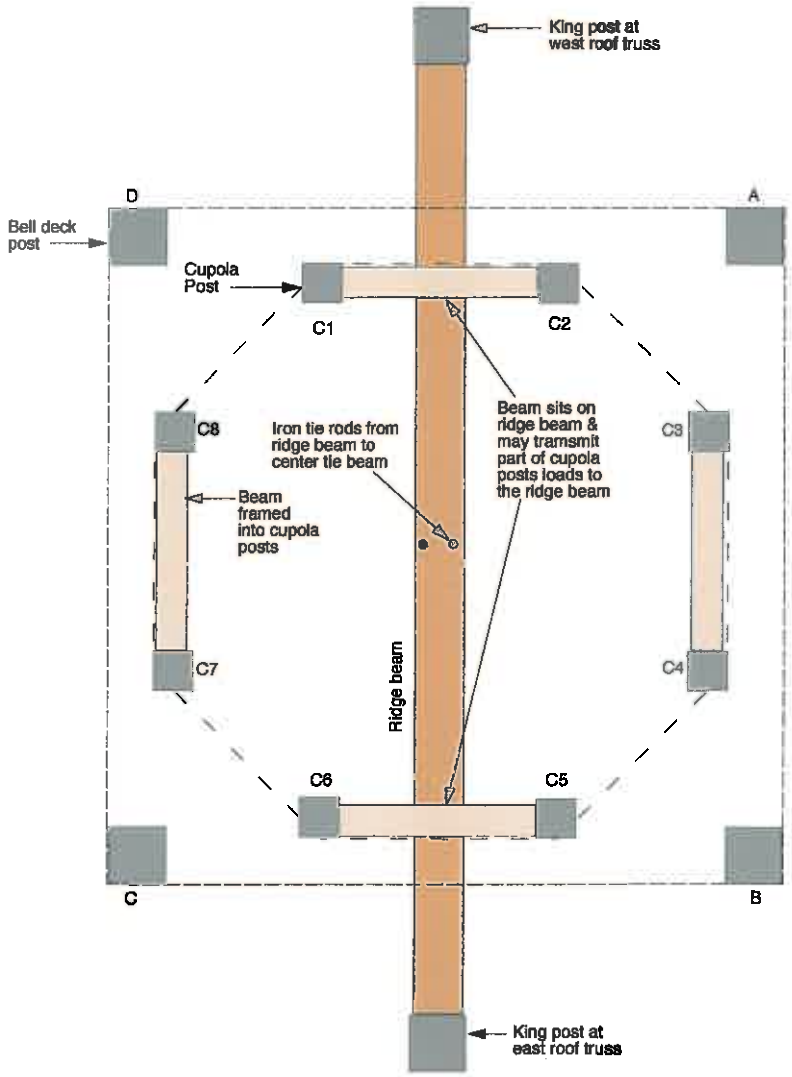
The approach described above utilizes staging for access and a traditional approach to the repair process using in kind materials to ensure structural and historic integrity. The choice was made to repair the tower in place instead of removing it from the building so that as much historic fabric could be retained as possible. It is also necessary to support the roof system throughout the repair process and keep it intact during the work. Removal of the tower would require modifications to the hip roof system that is not recommended.

Please review this document and the estimates that accompany it and do not hesitate to contact me with any questions you may have. It is my sincere hope that this report is helpful and informative as you continue your stewardship of this historic structure.

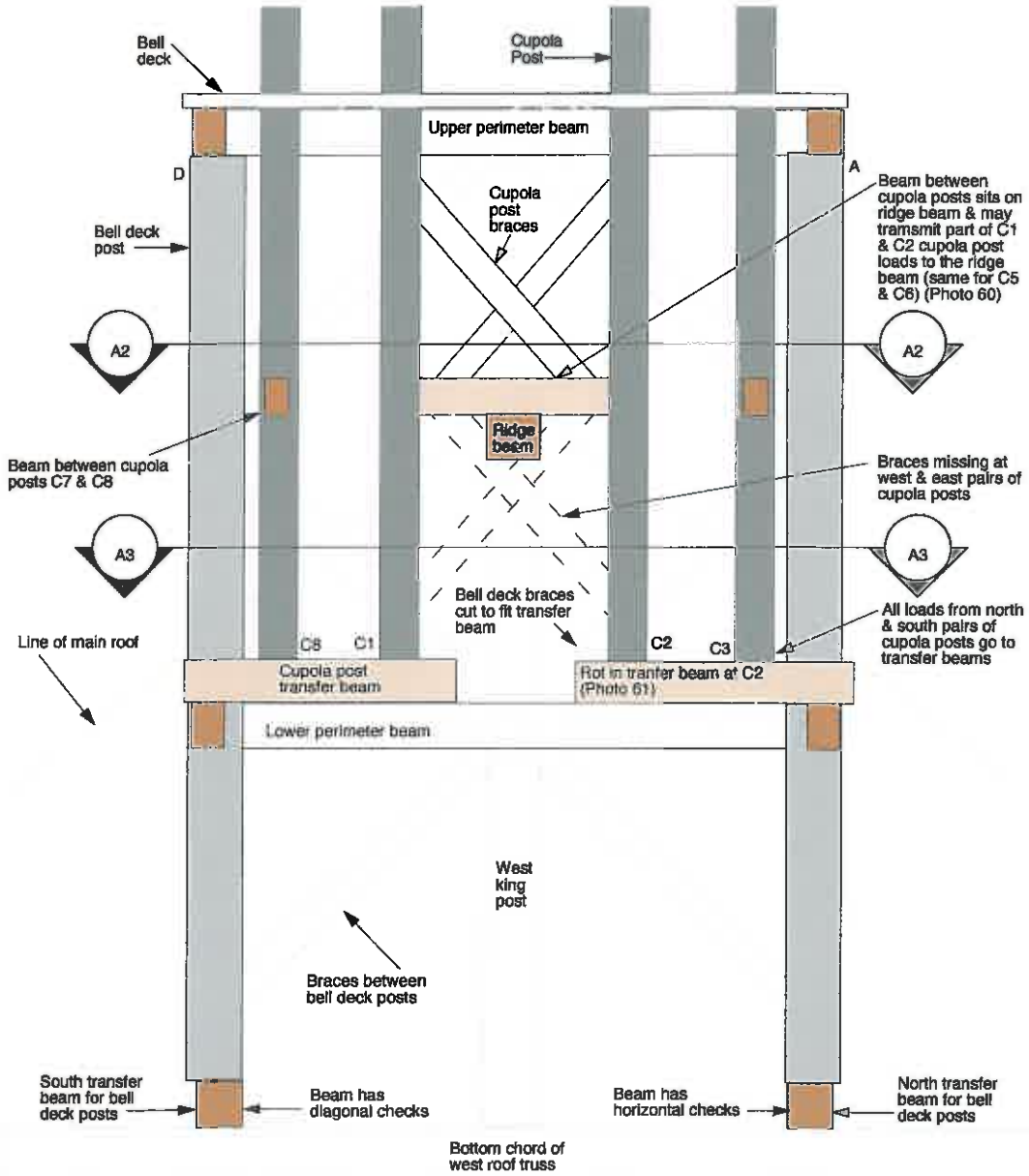
Respectfully Submitted,

Arron J. Sturgis
Preservation Timber Framing Inc.

NOTE: PAGES 6 AND 7 OF THIS REPORT ARE ADOPTED FROM THE FINCH&ROSE REPORT DATED AUGUST 1, 2011.



DRAWING A2
PLAN OF BELL DECK FRAME 2' BELOW BELL DECK
Westford Acadamy CAP Assessment
Not to Scale
Some details omitted for clarity



DRAWING A1
SECTION THRU BELL DECK FRAME
LOOKING WEST
Westford Acadamy CAP Assessment
Not to Scale
Some details omitted for clarity