Assessment of Roof Conditions

Town of Lancaster

Thayer Memorial Library and
the Town Community Center

August 6, 2015

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EXECUTIVE SUMMARY

The slate roofing on Thayer Memorial Library is, overall, in good serviceable condition. However, some flashing assemblies have been identified as at or near the end of their useful service lives. Addressing these items soon will almost certainly prevent damage due to imminent water intrusion. Other items, such as the gutters and snow pans and the remaining circa 1929 flashings should be replaced in the near future. A capital campaign, initiated within the next couple of years, should help defray the cost of such work.

Whether it’s the gutters of the community center or the valleys on the library roof, it is critical that the work is performed by a competent, qualified contractor. While contracting and procurement regulations mandate hiring the lowest bidder in most public works projects, the Town may screen contractors for work on similar projects and ensure that the bidder has a proven track record and requisite skill sets to successfully complete the job.

Prospective bidders must be able to demonstrate proficiency through past projects. By exercising proper, allowable due diligence in the screening process, unqualified contractors will be eliminated from the selection pool. The Town will then identify and hire the lowest-priced, most advantageous, responsible bidder. The Town should also require in forthcoming bid documents that the roof work at the library be performed by a contractor with a DCAM certification in historic roofing if threshold contract values are crossed.

The most important component of any plan to preserve a historic structure is maintenance. As soon as a building is constructed or rehabilitated, the natural process of deterioration begins. The roof and roof drainage systems should be inspected biannually as well as after any major weather event. During such inspections broken/missing slate should be replaced and gutter troughs/outlets cleaned. Routine inspection and maintenance of roofing and gutters is essential to prolonging the useful service lives of the roofs and gutters as well as guarding against the threat of water intrusion and internal damage.

Olde Mohawk Historic Preservation was contracted to perform the assessment of the condition roof systems of the library and community center. Assessment included a physical examination of the elements of the roof system to include, but not limited to: roof covering materials, flashing assemblies and roof drainage systems. The primary focus was on the library due to the historic significance of the building and recent issues with water intrusion. However, the gutter failures at the community center should not be ignored as failure to maintain proper roof drainage may lead to failures in other systems of the building envelope.

Deliverables include this report which photographically documents existing conditions, specifies historically appropriate treatments, and assigns a projected construction budget. Details specified were sourced from the National Slate Association’s *Slate Roofs: Design and Installation Manual* (2010) and wholly consistent with SMACNA’s *Architectural Sheet Metal Manual,* Seventh Edition. The consultant is qualified to perform this work based on occupational experience and an advanced degree in the field of historic preservation.[1]

[1] Secretary of the Interior’s Standards: Professional Qualifications Standards for Architectural Historian to perform identification, evaluation, registration, and treatment activities, U.S. Code of Federal Regulations, 36 CFR Part 61

HISTORICAL CONTEXT

The Lancaster Town Library is a contributing resource in the Lancaster Center Village Historic District, added to National Register of Historic Places on September 15, 1977. The Town Community Center was formerly a school building and is not formally recognized as having historical significance at this time.

In 1866, the Town of Lancaster received through a communication from Nathaniel Thayer, Esq., offering $5,000 for the building of a library. On November 7, 1866, a committee of seven was chosen to erect a library building which should also be a memorial to the soldiers of Lancaster who had fought and died in the Civil War. The committee consisted of Nathaniel Thayer, George M. Bartol, Jacob Fisher, Henry Wilder, J.L.S. Thompson, Quincy Whitney and Dr. Edward M. Fuller. The First Church of Christ in Lancaster generously allowed the building to be erected on part of its common land for which no compensation or rent has ever been paid or expected.

The cost of building was nearly $30,000 of which more than two-thirds was paid by Mr. Thayer in addition to his endowment of $5,000 for the purchase of books. At the same time the Hon. Francis B. Fay, in addition to his original subscription of $1,000, gave $100 for the purchase of a clock. George A. Parker, Esq., gave $500 worth of books on art and also $700 for the further increase of such a department. Later, stacks were added at the rear of the building. A Children's Room, the gift of Mrs. Bayard Thayer in memory of her son Nathaniel Thayer, 2nd, was added to the building in 1929.

One of the earliest funds donated was that of the Hon. George Bancroft, the eminent historian, Secretary of the Navy, minister to Great Britain and Germany, and the first Commandant of the United States Naval Academy at Annapolis. He addressed a letter to the selectmen of the town, dated September 20, 1878, which is on file in the Historical Commission Office. In it he gave $1,000 for the benefit of the Lancaster Town Library, to be called the Captain Samuel Ward Library Fund, the income only to be expended year by year for the purchase of books in the department of History. Other funds have since been given to the library.

The museum of the Library, established in 1863, has continued to grow and now occupies the second floor of the library building. It contains many interesting objects connected with the history of the town. The Lancaster Collection, containing the publications of Lancaster natives and residents, was begun in 1905. It contains a fairly complete set of Lancaster imprints including those of Carter & Andrews, genealogies of Lancaster families, manuscript sermons of the early ministers and manuscripts and records of the many societies and associations of Lancaster's past. Altogether it contains 681 volumes and forms as complete a source of local history as could be desired in a small New England town.

In 1996, a grant was awarded for the expansion and renovation of the library; construction began two years later. The Board of Trustees voted to rename the Lancaster Town Library to honor the Thayer family and the rededication and opening of the newly renovated Thayer Memorial Library took place on November 28, 1999.

ASSESSMENT OF CONDITIONS

During the conditions assessment, the various systems of the building envelope are examined for present condition and performance. Each is evaluated in context relative to its importance as an element of the building envelope, assessed based on known, acceptable standards, and described according to subjective terminology. Loosely defined, these terms are:

Excellent	the brief moment that a system is brand new or completely restored; this condition descriptor is symbolic only
Very good	the next moment, after the new or restored system is completed; regular inspections will suffice until maintenance is required
Good	a system that is functioning properly and routine maintenance is needed; painting, replacing slates and repointing masonry are maintenance tasks
Fair	a system that is functioning adequately but work is needed, beyond routine maintenance, to improve system performance
Poor	a system that is not functioning adequately; significant work will be needed to restore the system to an acceptable condition
Very Poor	a system that is not functioning or absent; wholesale replacement of some or all of the components of the system are necessary

Using the above-described criteria for evaluating conditions, the various tasks to bring all systems to a 'good' or better condition are then described in detail in the *Specific recommendations* section. All recommendations are for historically appropriate treatments. The criticality of fully restoring each as a functioning element of the building envelope should be prioritized accordingly. The descriptors assigned to each should be viewed independently and are not assigned relative to the importance to, or correlation with, other systems.

TREATMENT OF CHARACTER-DEFINING FEATURES, MATERIALS AND FINISHES

Historic building fabric defines the heritage of our built environment and provides context. It gives a building character, texture and authenticity. Historic fabric is a term used quite regularly in the historic preservation world but defining it is not as easy as one might think. It would be ideal to point to a definition supplied in the Secretary of the Interior's Standards for the Treatment of Historic Properties but one does not exist. McGraw-Hill's Dictionary of Architecture and Construction defines *historic fabric* as "those portions of a building fabric that are of historic significance."

The Secretary's Standards do address significance, however, as it relates to tangible things like cornices and columns and they identify four strategies for effectively dealing with historic buildings: preservation, rehabilitation, restoration, and reconstruction. The first approach, preservation, is the most desirable and "places a high premium on the retention of all historic fabric through conservation, maintenance and repair." Further: "It reflects a building's continuum over time, through successive occupancies, and the respectful changes and alterations that are made."

Respectful is a relatively subjective term and, as it applies to a discussion about the value, significance or integrity of an architectural detail, more subjective still. Merriam-Webster defines respectful as "marked by or showing respect or deference." So, do respectful changes and alterations show deference to the original building? Perhaps not in style, as many nineteenth century buildings feature juxtaposed styles in the form of major alterations, but in the quality of the craftsmanship and the materials used. The dictionary's definition of deference as "a way of behaving that shows respect for … something" is unhelpful unless we view the term esoterically and, in this context, as meaning that the newer work is of a quality and standard worthy of standing beside the original.

That would be a convenient conclusion, if not for the fact that the historic preservation world possesses a general aversion to the idea of altering historic buildings, and this inference would seem to indicate that new alterations and changes can be viewed as acceptable if the quality of work is very high. Old alterations and changes to buildings, dramatic as they may have been 100 years ago, are now deemed respectful because they, too, are ancient and reverent. The tangible item that is ancient is automatically awarded respect and shown deference because it is old, and as Ruskin would indicate, becomes sacred. Modifications and alterations to the building, no matter how dramatic they may have been then, are acceptable now and protected.

It is the general recommendation of this study that the materials and systems of the building be preserved and changed as little as possible.

COMPONENTS OF THE ROOF SYSTEMS

ROOF COVERING MATERIALS

The slate covering the roof of the main block of the building and Children's Room is commonly referred to as Monson slate and so named for the region of the same name in Maine. The slate is consistently dark charcoal gray in color and hand punched as opposed to machine punched at the quarry. The slate tiles are 16" long and 10" wide. All are nominally 3/16" to ¼" thick. The slate is categorized as ASTM grade S1 and good for 150 years or more. Head lap is 4" throughout the roof and, hence, 6" is exposed to the weather. Monson slate has been examined closely by Dr. Judith Selwyn and its composition is similar to Welsh slate that has lasted two centuries or more. It is unlikely that this is the original roof covering material because slate was not quarried in Monson until 1872. It seems more likely that the roofing was replaced in 1929 when the new wing was added.

The new wing and addition are covered with slate identified in 1998 documents as Vermont Structural "Winchester Black" slate. The slate is characterized by varying strata of dark gray shades (sometimes called "tiger stripe") and were machine punched at the quarry. The slate tiles are 16" long and 10" wide. All are nominally 3/16" to ¼" thick. Vermont black slate is categorized as ASTM grade S1 and good for 150 years or more. Head lap is 4" throughout the roof and, hence, 6" is exposed to the weather. Flat roofs are covered in a ballasted, EPDM membrane system. Low-sloped roofs are covered in copper sheet metal; some are flat-lock soldered while others are standing seam.

The community center is covered in asphalt shingles. They are designed to mimic the texture and appearance of wood shingles and commonly called "architectural shingles." The adjoining "school" building is covered in an EPDM rubber membrane.

FLASHING ASSEMBLIES

At the library, the hips and ridges are coped with cold-rolled copper sheet metal. Sidewall flashing assemblies are also copper. The copings on the rakes of the roof are covered in an architectural sheet metal covering made with ribbed, or crimped, copper. This is consistent with practices in the 1920s and 1930s. The flashings around two chimneys appears to predate the 1929 renovations. At the eaves, flat-locked copper pans provide a snow apron to combat the effects of ice damming. On the main block of the building, this apron and some valleys have a gray coating on them, perhaps to create the appearance of lead-coated copper. Flashing assemblies on the 1999 wing and addition are copper sheet metal that has developed a brown patina.

At the community center, flashing assemblies at sidewalls and protrusions are aluminum with a sheet lead counter-flashing. Protrusions in the EPDM membrane are finished with term bar and clamps.

ROOF DRAINAGE SYSTEMS

The gutters at the main block of the library building are copper sheet metal with an EPDM rubber lining inside of them. At the newer, 1999 wing, copper sheet metal gutters are lapped and soldered. The gutters on the community center are wooden.

CAUSES OF DETERIORATION

The causes of deterioration are age and precipitation. Components of slate roofing systems, particularly sheet metal flashing assemblies have service lives. Traditional masonry construction relies on mortar to unify individual units such as brick into a homogenous whole. The mortar acts as a sacrificial component of the construction by allowing moisture from rain to drain through it and out of the brick. Over time, the mortar joints need routine maintenance in the form of repointing to continue to keep the building envelope water-tight.

According to the Copper Development Association, copper sheet metal used in a roofing application such a flashing assemblies, has an approximate useful service life of 80 to 100 years. Various factors such as thickness or "weight" of the copper as well as atmospheric conditions will directly impact the longevity of the copper materials. As copper ages it weathers and develops a patina. With time the sheet metal will become thinner and more susceptible to puncture or abrasion. The replacement of copper flashing assemblies is considered a normal part of the maintenance of a slate or clay tile roof system.

Paint on wood acts in a similar way in that it protects the wood from moisture and deterioration from UV radiation. The paint film requires routine touch-up to protect the underlying wood. The roof of the library is large and it directs concentrated amounts of water toward the facade and building foundation. It is critical that roof drainage systems are adequate and function properly. Ice damming has caused melt water to wick back under the slate at some locations and water intrusion occurred. It is imperative that this deficiency in the roof system is corrected.

OVERVIEW OF RECOMMENDATIONS FOR REMEDIAL ACTION

The Secretary of the Interior provides four distinct but interrelated approaches to the treatment of historic properties. Each is defined, below, so that the recommendations of this conditions assessment can be weighed and considered in context:

- Preservation focuses on the maintenance and repair of existing historic materials and retention of a property's form as it has evolved over time;
- Rehabilitation acknowledges the need to alter or add to a historic property to meet continuing or changing uses while retaining the property's historic character,
- Restoration is undertaken to depict a property at a particular period of time in its history, while removing evidence of other periods; and,
- Reconstruction re-creates vanished or non-surviving portions of a property for interpretive purposes.

The general recommendation of this report is to preserve and maintain the building as it appears. This means replacement of elements of the various systems that have outlived their useful life, when necessary. For example, the sheet metal flashing assemblies of the chimneys are approximately 100 years old and should be replaced before imminent failure occurs. However, they must be replaced in kind, with new copper sheet metal that is installed in the same form and dimension as the detail and assembly being replaced.

Similarly, slate roofing repairs must be in kind where failing pieces are detected during routine inspections. While the Monson slate that's on the roof is not commercially available new, matching salvaged Monson slate is. Vermont black slate is available in both new and salvaged form and should be sourced when necessary. All recommendations are in accordance with guidelines set forth by the National Park Service of the U.S. Department of the Interior.[2]

[2] Weeks, Kay D., and Grimmer, Anne E. *The Secretary of the Interior's Standards for the Treatment of Historic Properties with Illustrated Guidelines for Preserving, Rehabilitating, Restoring, and Reconstructing Historic Buildings*, Washington, D.C.: U.S. Government Printing Office, 1995

SPECIFIC RECOMMENDATIONS

Slate repairs should be performed with closely matching, salvaged Monson slate or Vermont black slate. There are two acceptable methods of repair: the "nail-and-bib" technique and the slate hook method. Both are illustrated later in this report. In each instance, fasteners specified shall be copper or stainless steel and sheet metal bibs shall be copper.

Ice damming was a major issue this past winter and occurs when heat loss causes snow to melt and slide down the slope of the roof. As it reaches the part of the roof over the soffit, it freezes because there is no heat loss occurring. The result is a buildup of ice that makes it increasingly difficult for melt water to escape as the ice grows in height. Once the melt water begins to pool up it will wick back under the roof covering materials and into the building. Ice dams must be removed without damaging the roof covering materials. This may involve hand tools, chipping guns and steaming equipment. The ice dams may be so extensive that the best and/or most cost effective approach is to open channels in the dams and coat the ice with calcium chloride to accelerate the melting process.

The existing *snow pans* should be maintained to help minimize ice damming. When replacement is necessary, particularly on the main block of the library, they should installed with new 20 oz/sq' copper materials. At the time of work, after removing 3.5 feet of slate from the eaves, visible decking and wood blocking should be inspected for rot and replaced in kind where needed. Ice and water shield is applied to the first three feet of the roof deck that is to be covered with the copper snow pans. Do not be overly concerned if an existing membrane has formed a bond with the sheathing and will not come free. The new membrane is adhered directly to it. 30# felt paper should cover the membrane and act as a break between the sheet metal and ice and water membrane.

Pans are secured to the roof deck with copper clips on the vertical sides and crimped to the existing lead coated copper drip edge at the eave. Before any slate is re-installed, the standing seams are to be hammered flat at the top 6" only. A band of ice and water shield membrane is then applied across the top 4" of the snow pans; the rest is adhered directly to the roof deck. The slate is then filled back in, covering only the part of the snow pan that has ice and water shield and upward. This starting point can be adjusted slightly by the slater so that the coursing looks best. Care must be taken not to perforate the snow pans with any fasteners. The final course should be installed with copper or stainless hooks, not the "nail and bib" method. The remaining slate should be stored on site for future repairs to the roof.

The use of *heating coils* or, "heat tape," is employed on the library to keep the snow and ice in the gutters melted and the drip water flowing. Snow retention systems are also used to control the volume of snow that slides down into the ice dams. *Snow fences* should be installed along the eaves and at the mid-points between the eaves and ridges to control snow slides. Three rail snow fence systems are available in brass and copper as well as cost-effective steel and aluminum which may be painted black. The installation of snow fences on the library is prudent and historically appropriate for several reasons. First, snow fences were available and being used for this exact purpose on similar institutional buildings in the region, thus creating precedence. Second, the roof has a relatively low profile and is not readily visible from many vantage points. And, finally, there is no more cost-effective, sustainable and appropriate method or technology available.

The *flashing assemblies* at most locations are in fair to good condition, performing well, and should be inspected biannually and after any major weather event. The flashings around both chimneys and some valleys have outlived their useful service lives and should be replaced before failure occurs. Replacement must be in kind.

Two *sidewall flashing assemblies*, illustrated in addenda A and H, are odd and potentially problematic. In the bid documents dated 21 April 1998, the detail where the addition meets the main block of the library calls for a 2” isolation/expansion joint with a typical step-flashing assemble at the roof above. The drawings appear to fail to address the detail where the roof above the new wing meets the sidewall of the main block of the library.

An examination of the shop drawings offered by the roofing contractor on 03 November 1998 suggests two options: first, the detail as presented in the bid documents; and, second, the design as built. On the drawing that reflects the as built design, the odd design is circled and a handwritten note says, “Reverse fold so flashing doesn’t catch water.” A crude sketch alongside the note suggests a way that it could be done differently.

Because the design requirements of the building call for as much as 2” of movement between the main block of the building and the additions, an engineer or architect should be consulted. The range of movement anticipated seems at first to be excessive and beyond the pale of this consultant’s experience, but really depends on how the project was designed from the foundation up. A structural engineer familiar with newer additions joined to historic building stock is the proper resource to advise further.

The *gutters on both sides of the new wing* are failing and in poor condition. Hairline cracks have appeared on all solder joints. In some instances, no solder is visible at all. All failing mortar joints should be resoldered with a 50/50 tin/lead mix.

The *gutters on the main block of the library* are lined with a rubber membrane and should be closely monitored. At one location, a failure has allowed water to enter a copper cornice return. This water is draining down the brick masonry wall and causing erosion of the mortar joints. A simple EPDM repair will solve the problem. The outlets in these gutters were clogged with pine needles. Gutters should be inspected and cleaned during the biannual inspection of the roof systems. When the time comes to replace these gutters, it should coincide with replacement of the pans of the snow apron.

The *low-sloped and flat roofs* of the library are all found in good condition. The low-sloped roofs are clad in copper standing seam at some locations and flat-lock, soldered copper sheet metal in others. A “yankee” gutter helps control roof runoff but, because the outlet and conductor pipe passes through the cornice, special care must be taken to ensure that no blockage occurs. The ballasted, flat roofs appear to be in fair condition. However, a build-up of pine needles around internal drains inhibits proper drainage. As a result, runoff at the scupper has caused brick masonry mortar joints to deteriorate.

At the *brick and stone sidewalls* where the roof flashings are secured, there are voids or failing mortar joints that should be repointed as needed. The mortar should be tested for composition and an appropriate recipe specified for repointing according to ASTM C-1324-03 *Standard Test Method for Examination & Analysis of Hardened Masonry Mortar* by a qualified materials conservator. This firm can perform that service at an architectural materials lab. The repointing mortar must be sympathetic in texture, color, strength and appearance to that in adjoining areas.

Prior to wholesale use of the new replacement mortar, a mock-up sample should be installed by a qualified craftsperson who understands the curing and application details of restoration masonry work. Once the mock-up sample is installed, appropriate precautions should be taken to ensure that the mortar is protected from wind, sun, rain and frost to enable slow curing to take place. The sample should be allowed to cure in the wall for a minimum of seven but preferably fourteen days before final color match is approved.

The failing and deteriorated mortar joints should be cleared by skilled masons with hand tools—not with grinders and powered chisels. Power tools MAY be used if the supervising architect approves after the mason is able to demonstrate an adequate level of competence. Joints should be cleared to a depth of roughly twice the height or width of the opening (i.e., a 3/8" joint should be ¾" deep before repointing takes place.) The mortar should be tooled into the joints in ¼" lifts and allowed to set up until pressing with force is required to leave a fingerprint.

Brick joints should be struck with a concave jointer, revealing slightly the edge of the facing brick. The stone joints should be struck flush in a manner that matches the profile of the existing joints in adjacent areas. Any mortar or residue left behind should be cleaned with a brush or sponge and clean, warm water. The new work should be protected from direct sunlight as it cures. Dampened burlap works well to shade the surfaces, and should be wetted regularly to prevent drying out. Alternatively, some architects specify the use of commercial-grade mastic sealants where flashings are cut into masonry.

The *asphalt shingle roofing* atop the community center is relatively new and in very good condition. The single exception is where a white shed end wall meets a roof ridge. Some shingles have slipped and should be refastened. The *EPDM rubber roof* on top of the school portion of the building is in fair condition. If regularly inspected and maintained this roof should be expected to last another ten years or more.

The *wooden gutters* on the community center are failing at most miter and scarf joint locations. They should be replaced with new white aluminum gutters. When calculating drainage capabilities, one square inch of outlet opening is required for each 100 SF area of roof surface being drained. Hence, the 4" outlets are more than adequate as each can service 1,250 SF of roof surface area. Metal wire strainers should be installed at each outlet and checked biannually. If the strainers are maintained and allowed to perform their intended function cleaning the gutters will be limited to the troughs. Otherwise, leaves and debris will find their way into and clog the conductor pipes. If not maintained, gutters will do more harm than good as they require a commitment to maintenance of the system.

The *fascia plate* above the wooden gutters is particularly problematic. The fascia, soffit, frieze, brackets, panels, moldings, and other wood members must be scraped, sanded and primed where failures have occurred. Afterward, the entire cornice should receive a prime and topcoat in the existing color scheme. All actions that involve the handling of wood must be performed in full compliance with the EPA's *Renovation, Repair and Painting* (RRP) regulations by a certified contractor if testing detects the presence of lead.

CONSTRUCTION BUDGET

Estimates of cost assume that all work is performed at prevailing wage rates in compliance with the Davis-Bacon Act. The estimates include the costs to perform the itemized tasks and 20% for a general contractor's fee. An additional 20% has also been identified to account for the costs of an architect and/or engineer's design services but are not included in the overall costs in this construction budget. Design fees can fluctuate by 5% or more and will tend to be higher if the work is phased over time as opposed to a single project.

Similarly, each time a contractor mobilizes there will be associated startup costs and contracting for multiple projects will cost more than a single project. Labor costs were calculated and based on published data in the R.S. Means Guides for commercial construction. Labor rates were then adjusted to the prevailing local wage rates for each task. It should be noted that the Means Guide indicates that a 25% increase in labor pricing should be added for restoration work. Further, there is a scarcity of contractors who are skilled and trained to successfully undertake historic preservation projects.

A 10% contingency was factored in to account for unforeseen conditions that are typically uncovered during the restoration of historic properties. If the decision is later made to open up the cornice and address the soffit plates, that factor should be increased to 25%. Access costs (i.e., lifts, scaffolding) and markup for overhead and profit are collapsed into the prices below. Material and labor costs are not constant and are subject to uncontrollable economic conditions. Tax rates and workers compensation insurance rates show no sign of decline. The costs projected in this construction budget may increase by as much as 3% to 5% with each passing year.

URGENT (0 to 12 months)

Replacement of broken/missing slate, entire library complex … $6400
Resoldering of the gutter joints at the eaves of the 1999 wing … $3200
Cleaning of all library gutters … $1200
Consult with structural engineer re sidewall flashing assemblies … $2400

IMMEDIATE (1 to 3 years)

Replacement of all community center gutters … $7400
Repair and painting of woodwork related to community center gutters … $12,800
Replacement of chimney flashing assemblies at two locations … $8400
Replacement of limited valley flashings, main block of library … $14,600
Repointing of masonry due to runoff, as needed … $9600
Installation of steel/aluminum snow fences … $64,000

MID-RANGE (4 to 6 years)

Replacement of gutters and snow pans, main block of library … $94,000
Replacement of additional flashing assemblies, as needed … $85,000

LONG TERM (7 to 10 years)

Maintenance budget for roofing, masonry and woodwork … $8400
Replacement of community center EPDM roof … $192,000

MAINTENANCE

The most important component of any plan to preserve a historic structure is maintenance. As soon as a building is constructed or rehabilitated, the natural process of deterioration begins. Preservation has been defined as "the act or process of applying measures necessary to sustain the existing form, integrity, and materials of an historic property. Work, including preliminary measures to protect and stabilize the property, generally focuses upon the on-going maintenance and repair of historic materials and features rather than extensive replacement and new construction."[3]

Regular inspection and maintenance of systems will help preserve the integrity of historic building fabric. If that fabric is maintained, deterioration will be minimized or eliminated. Maintenance is the most cost effective method of extending the service life of a building system. By logical extension, maintenance is the key to preservation. While the decay of components of the envelope cannot be avoided, neglect can actually cause this process to increase at an exponential rate. The use of the wrong materials and methods will often cause worse damage to irreplaceable historic building fabric.

When considered in the long term, the cost to maintain historic structures is significantly less than the restoration of historic systems and materials, and it creates far less disruption to building occupants. When a property owner or manager creates a maintenance program for their building, it is strongly recommended that they seek the counsel of a preservation consultant, and/or experienced contractor. The maintenance program should clearly identify and describe courses of action that are specific to the building. Every historic structure, no matter how small, should have a written guide that includes:

- Lists and schedules for periodic inspections of each system. These should be set-up in a 'checklist' format, to ensure uniformity of procedures over time;
- Blank elevations of the building to be marked up during inspections and after any work takes place;
- A full set of actual photographs that comprehensively document the conditions of the entire structure as well as a digital copy of each. This album will grow over time;
- An emergency list of contractors who can be called upon in an emergency, especially HVAC, electrician, plumber, and roofer;
- Individualized procedures for the historically appropriate handling of the individual systems and materials of the building; and,
- Hard copies of completed reports that document all work and inspections. Include copies of estimates, contracts, warranty cards, paint colors, mortar recipes, materials sources, and any other information that will be needed by future stewards of the structure.

Maintenance is the most important preservation treatment for extending the life of an historic property. It will slow the natural process of deterioration and prolong the natural service lives of the historic fabric of the envelope. A written maintenance plan will help preservation planners organize, schedule inspections, and guide the work necessary to for a historic building. When a property owner or manager creates a maintenance program for their building, it is strongly recommended that they seek the counsel of a preservation consultant, and/or experienced contractor. The maintenance program should clearly identify and describe courses of action that are specific to the building. Every historic structure, no matter how small, should have a written guide. When the full life cycle of a building is considered, there is no smarter money spent than on maintenance.

[3] National Park Service, Nationwide Programmatic Agreement Toolkit for Section 106 of the National Historic Preservation Act, glossary of terms

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ADDENDA

Addendum A – Photographic documentation
Addendum B – Flashing assembly details
Addendum C – Aerial measurement report, Thayer Library
Addendum D – MHC building survey form B, Thayer Library
Addendum E – Aerial measurement report, Community Center
Addendum F – Technical Preservation Brief 29
Addendum G – Slate Deposits and Slate Industry, Bulletin No. 275
Addendum H – Sidewall flashing design issue

Addendum A – Photographic documentation

Image 1. Very little breakage was found on the slated portions of the library roof. The vast majority were on the newer sections that are covered in Vermont black slate. Slate repairs should be made with matching slate using either the “hook” or “nail-and-bib” methods only.

Image 2. Solder joints have cracked and failed leaving the building envelope, below, susceptible to water intrusion. This issue is found consistently throughout both gutter troughs on either side of the 1999 wing.

Image 3. A small, rubber-covered roof was added when new wing was joined to the main block of the library. The copper-clad dormer is an important character-defining feature of the building that should be preserved. At left, one of the two chimneys that should be reflashed.

Image 4. Detail view of a brownstone lintel that has held up well over after almost 150 years of service. In the foreground, a cornice return that has been leaking water down the side of the building causing the erosion of brick masonry mortar joint.

Image 5. Detail view of the problematic cornice return. Note the efflorescence on the masonry below. Efflorescence is the appearance of white, cloudy stains caused by the saturation of masonry and resulting release of soluble salts. Once the cause of the moisture intrusion is corrected the masonry will dry out and the efflorescence will dissipate and vanish over time.

Image 6. Detail view of the ornate copper detail work atop the parapet at the rakes of the roof. This detail likely dates to the work that took place in 1929 and the ribbed sheet metal is consistent with practices in the 1920s and 30s. This historic fabric should be preserved as long as possible.

Image 7. Detail view of the gutters on the main block of the library. At some point, an EPDM membrane was added to the gutter troughs. At that time, a copper “counter-flashing” of sorts was added to the curbing to protect the termination of the rubber membrane. This modification should be monitored until such time as the gutters and snow apron are replaced.

Image 8. Detail view of the Monson slate termination to the sidewall of the rakes of the roof. While approaching the end of their useful service lives, the flashing assemblies on the main block of the library and 1929 children's room should last another four to six years without issue. At that time, a proactive restoration of the existing roofing is recommended.

Image 9. Copper sheet metal repair using copper and brass rivets (typ.)

Image 10. Termination of the EPDM gutter lining. Failures in this area are allowing precipitation to migrate into the copper cornice and drain down the brick masonry wall of the building. The result is the erosion of mortar joints.

Image 11. Additional view of gutters and snow apron.


Image 12. Sidewall assembly at the front of the library. Note the “newer” copper hip flashing, dating to the 1999 project. Valleys and flat-lock snow pans are coated in a gray material, perhaps to give the appearance of lead-coated copper.

Image 13. Pine needles and other debris have clogged up the outlets in the gutters. In addition to rainfall overflow, these gutters quickly freeze and exacerbate the issues of ice damming. Gutters should be cleaned biannually during roof inspections.

Image 14. The slate tiles, brick masonry, and brownstone of the building are in very good condition. The sheet metal seen here used for gutters, snow pans and counter-flashing is in fair condition at best.

Image 15. Detail view of the gutters. It appears that lap caulk, used to seal joints in EPDM roofing, was applied to the back of the copper "counter-flashing" used to cover the termination of the rubber membrane lining the gutters. The EPDM lining is a stop gap measure that was employed after failures in the gutter troughs or when failures were deemed to be imminent. This system should be closely monitored until such time as the gutters are replaced.


Image 16. Detail view of a sheet metal repair at the valley/snow pan transition. This repair is indicative of the types of failures that can be expected over the next several years. It is strongly recommended that a capital campaign is initiated and/or grants are pursued that will fund a major overhaul of the traditional roof and gutter system.

Image 17. The sidewalls of the snow aprons are cut into reglets in the brownstone masonry of the façade. Lead wedges that hold the sheet metal in place. The raggle, or groove, should be pointed in with an appropriate strength mortar or commercial grade mastic sealant.

Image 18. The mortar joints where the brownstone coping slabs are joined are covered by a sheet lead detail. The sheet lead is cut into and caulked in a reglet detail. These joints should be monitored biannually and recaulked whenever necessary.

Image 19. Like the brownstone reglet on the other side, the mastic appears to have failed leaving a large void. Left alone and unfilled, this joint could theoretically freeze and expand resulting in the loss of historic fabric.

Image 20. The copper copping at the rakes of the roof has weathered nicely and continues to perform well.

Image 21.   The skirt or apron flashing at this chimney protrusion, like the other, should be replaced in kind soon. As copper ages it goes from a shiny “red” color to brown. Over many years it will turn green. As time passes the vert de gris becomes a lighter and lighter shade of green. Finally black patches appear, indicating that the metal is very old. The black patches seen on both chimney flashing assemblies suggest that they predate the 1929 renovations.

Image 22. The continuous copper counter-flashing behind the primary façade has come free at a few limited locations. The sheet metal should be tucked back in and the entire raggle either repointed or recaulked.

Image 23. Broad view of the wing added in 1999. Several slates have been replaced by units that were painted black.. The slate is Vermont black (called “Winchester Black” in 1998 construction documents) and still commercially available. Repair and replacement units should also be Vermont black slate.

Image 24. A pair of “chimneys” in the rear wing roof are comprised of copper sheet metal and performing well. The copper snow pans and sheet metal cornice also appear to be in good serviceable condition.

Image 25. The new wing and addition are covered with slate identified in 1998 documents as Vermont Structural “Winchester Black” slate. The slate is characterized by varying strata of dark gray shades (sometimes called “tiger stripe”) and were machine punched at the quarry. The slate tiles are 16” long and 10” wide. All are nominally 3/16” to ¼” thick. Vermont black slate is categorized as ASTM grade S1 and good for 150 years or more.

Image 26. Like the gutters and snow pans on the other side of the 1999 wing, all solder joints have cracked and separated. These joints should be cleaned and resoldered to prevent moisture from migrating into the cornice and causing damage.

Image 27. An outlet in the gutter trough, solder joint still intact. The green patina seen in the bottom of the gutter trough is relatively advanced given the age of the materials. This is because black and purple slate are comprised of a variety of minerals and iron that green ad gray slate are not. It is not unlike a galvanic reaction in which rain water running over differential materials will cause the copper to react.

Image 28. A broad view of the area above which water intrusion occurred during the past winter. The flashing assembly, where the newer, 1999 wing's roof meets the sidewall of the main block of the library is highly suspect. If ice damming occurred in this area it is not difficultto believe that melt water had a relatively easy time finding a point of intrusion.

Image 29. This sidewall detail, where the 1999 addition meets the original, main block of the library, is detailed in Addendum H. While no known water intrusion has occurred here, it is this detail that seems to have been somewhat employed in the area depicted in image # 28.

Image 30. No detail exists in the bid or construction documents that indicates what was supposed to happen here. It appears that the designers were anticipating a significant amount of movement between the original library building and new 1999 additions. The variety of caulk solder joints, and sheet metal employed looks like a variety of repairs or post-construction actions employed by the roofer while still in the warranty period or shortly thereafter.

Image 31.   The drawings appear to fail to address this detail where the roof above the new wing meets the sidewall of the main block of the library. An examination of the shop drawings offered by the roofing contractor on 03 November 1998 suggests two options: first, the detail as presented in the bid documents; and, second, the design as built. On the drawing that reflects the as built design, the odd design is circled and a handwritten note says, “Reverse fold so flashing doesn’t catch water.” A crude sketch alongside the note suggests a way that it could be done differently.

Image 32. Slate repairs should be performed with closely matching, salvaged Monson slate or Vermont black slate. There are two acceptable methods of repair: the “nail-and-bib” technique and the slate hook method. Both are illustrated elsewhere in this report. In each instance, fasteners specified shall be copper or stainless steel and sheet metal bibs shall be copper.

Image 33.   A build-up of pine needles around internal drains inhibits proper drainage. Pine needles and other debris should be cleared away during biannual roof inspections.

Image 34. The ballasted, flat roofs appear to be in fair condition. However, a build-up of pine needles around internal drains inhibits proper drainage. As a result, runoff at the scupper has caused brick masonry mortar joints to deteriorate.

Image 35. The low-sloped and flat roofs of the library are all found in good condition. The low-sloped roofs are clad in copper standing seam at some locations and flat-lock, soldered copper sheet metal in others. A “yankee” gutter helps control roof runoff but, because the outlet and conductor pipe passes through the cornice, special care must be taken to ensure that no blockage occurs.

Image 36. A broad view of the roofing at the rear of the library complex.

Image 37. The wooden gutters on the community center are failing at most miter and scarf joint locations. They should be replaced with new white aluminum gutters. When calculating drainage capabilities, one square inch of outlet opening is required for each 100 SF area of roof surface being drained. Hence, the 4” outlets are more than adequate as each can service 1,250 SF of roof surface area

Image 38. Metal wire strainers should be installed at each outlet and checked biannually. If the strainers are maintained and allowed to perform their intended function cleaning the gutters will be limited to the troughs. Otherwise, leaves and debris will find their way into and clog the conductor pipes.   If not maintained, gutters will do more harm than good as they require a commitment to maintenance of the system.

Image 39. At the community center, flashing assemblies at sidewalls and protrusions are aluminum with a sheet lead counter-flashing. All are found to be in good serviceable condition.

Image 40. The wooden gutters on the community center are failing at most miter and scarf joint locations. They should be replaced with new white aluminum gutters.

Image 41. The community center is covered in asphalt shingles. They are designed to mimic the texture and appearance of wood shingles and commonly called “architectural shingles.”

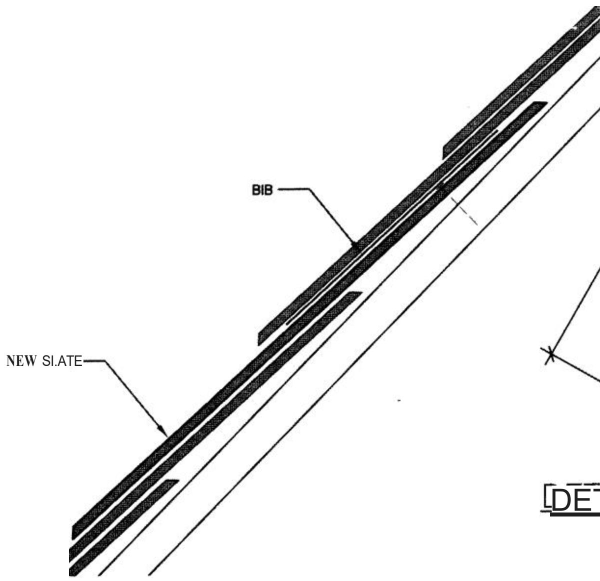

Image 42. The EPDM rubber roof on top of the school portion of the community center is in fair condition. If regularly inspected and maintained this roof should be expected to last another ten years or more.


Image 43. The asphalt shingle roofing atop the community center is relatively new and in very good condition. The single exception is where a white shed end wall meets a roof ridge. Some shingles have slipped and should be refastened.

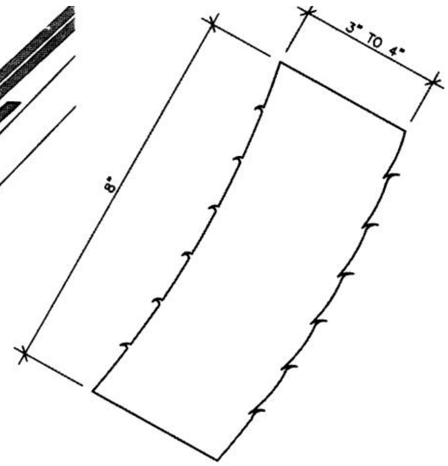
Image 44. The fascia plate above the wooden gutters is particularly problematic. The fascia, soffit, frieze, brackets, panels, moldings, and other wood members must be scraped, sanded and primed where failures have occurred. Afterward, the entire cornice should receive a prime and topcoat in the existing color scheme. All actions that involve the handling of wood must be performed in full compliance with the EPA's Renovation, Repair and Painting (RRP) regulations by a certified contractor if testing detects the presence of lead.

Image 45.   The wooden gutters on the community center are failing at most miter and scarf joint locations. They should be replaced with new white aluminum gutters.

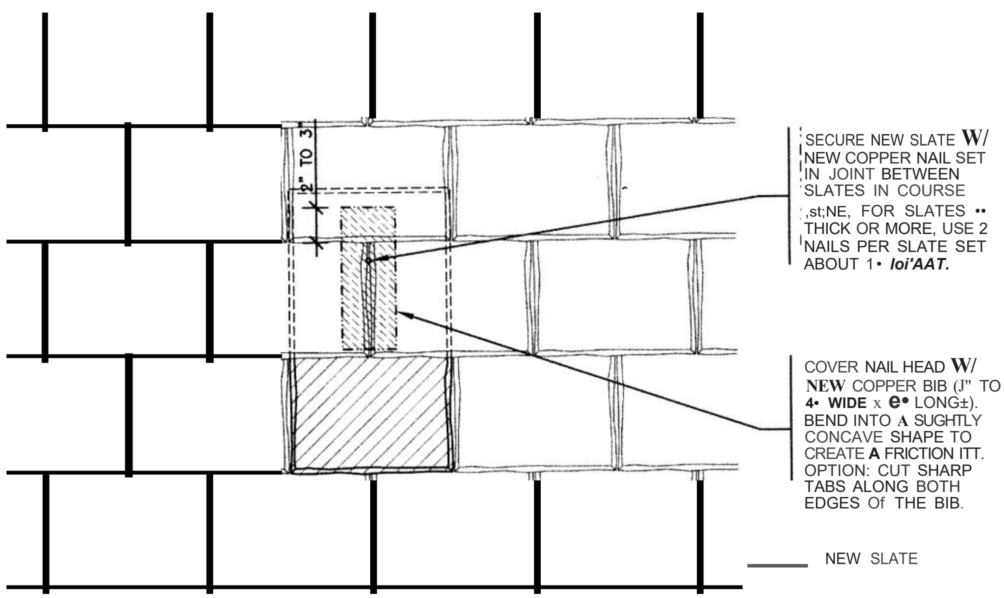
Addendum B – Flashing assembly details



SECTION



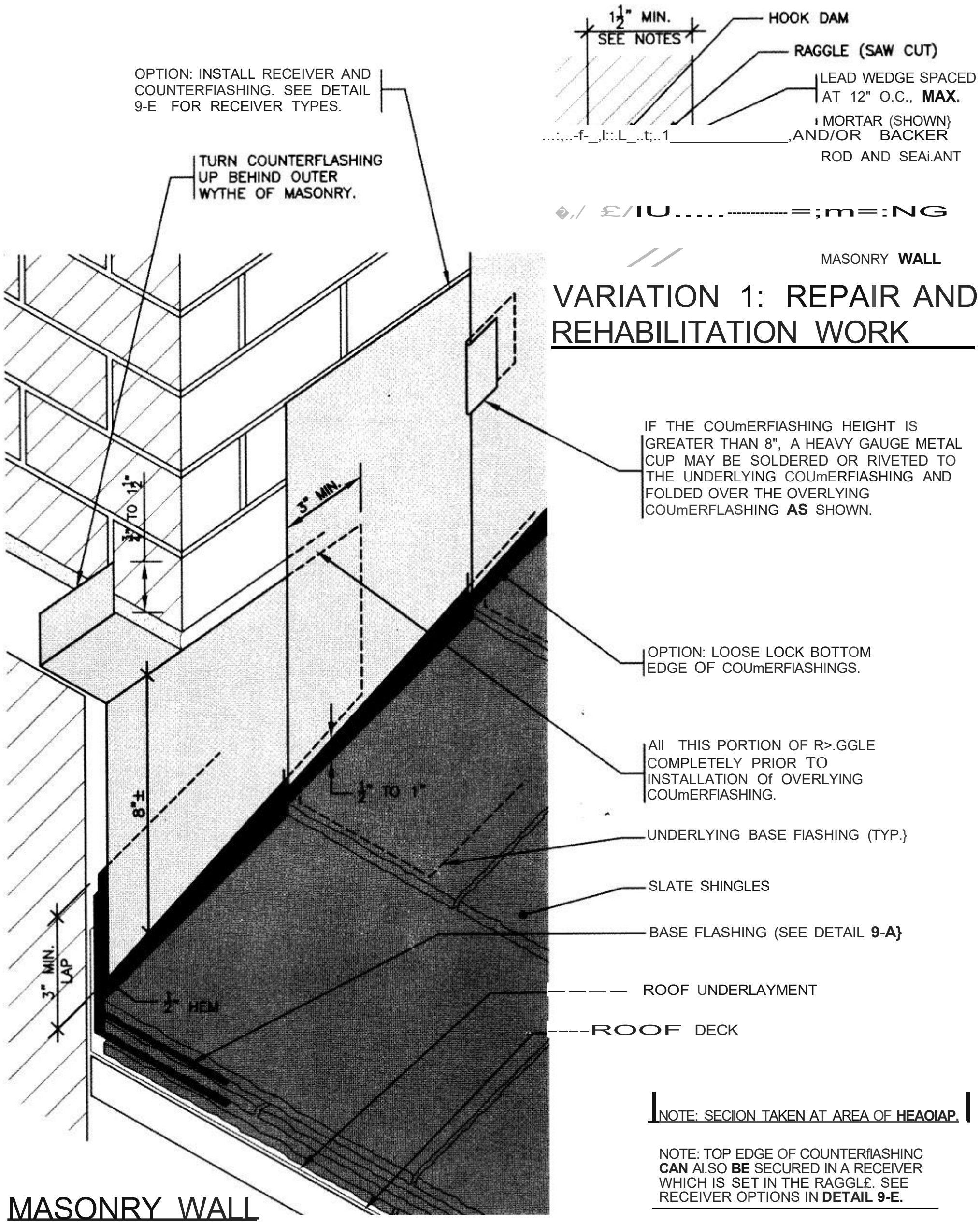
DETAIL: BIB



NAIL-AND-B[B METHOD

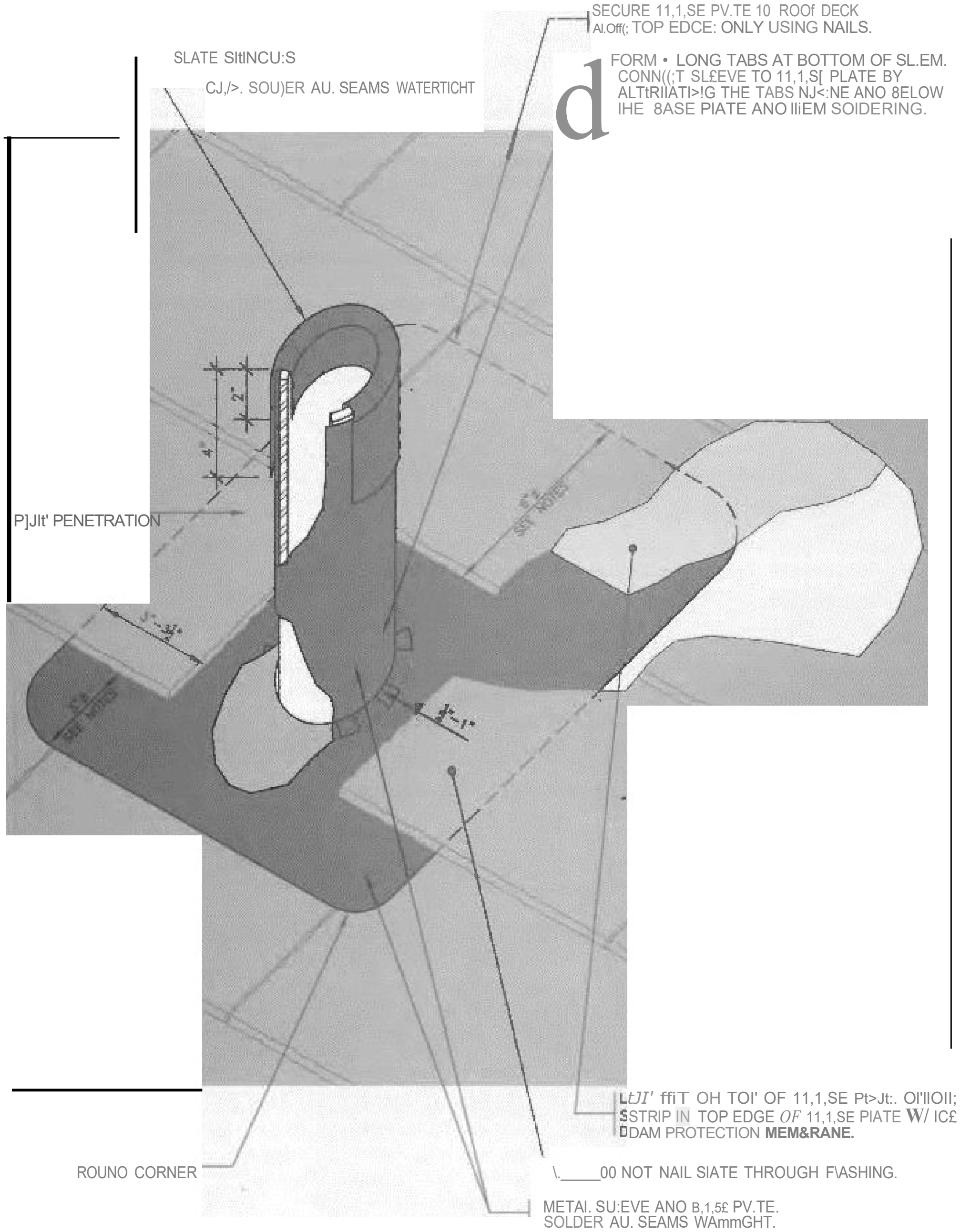
DETAIL 25 SLATE REPAIR

N.T.S.



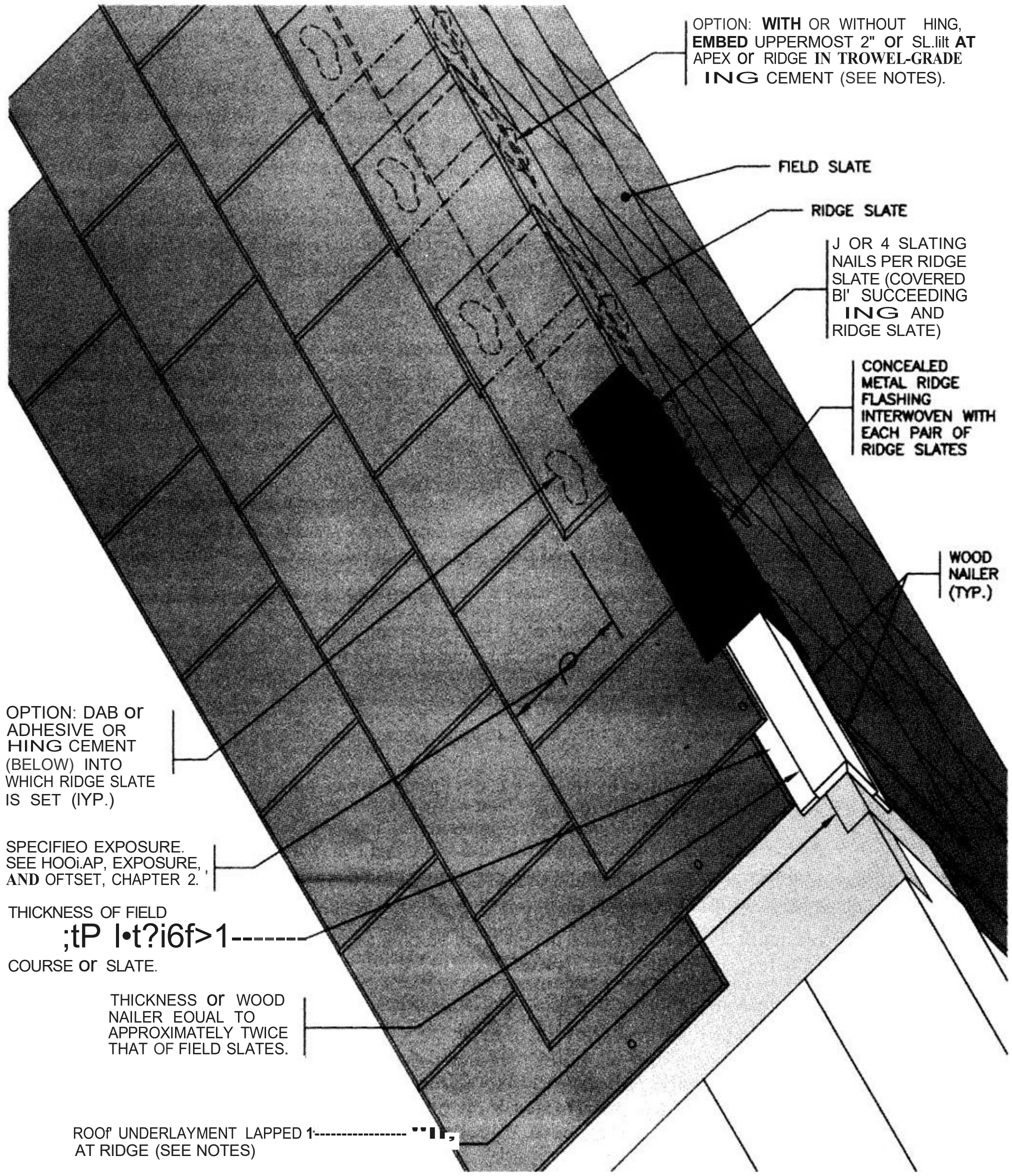
DETAIL 9-8 COUNTERFLASHING (CAP FLASHING) AT VERTICAL SIDE WALL

N.T.S.



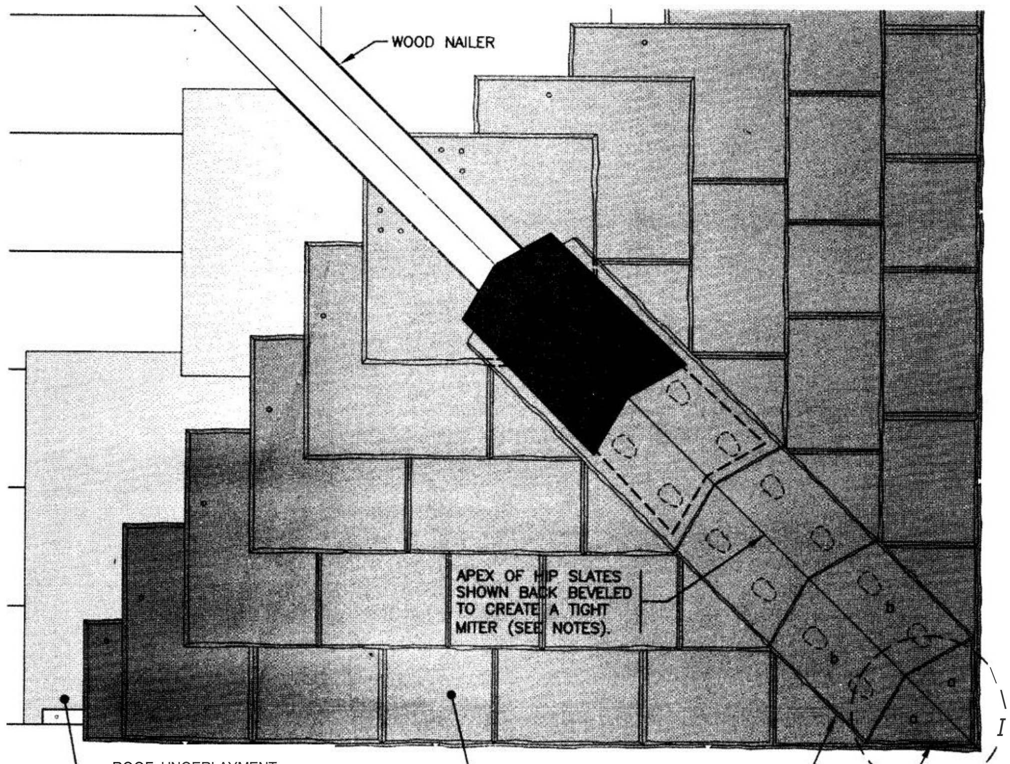
DETAIL 15 VENT PIPE FLASHING

N.T.S.

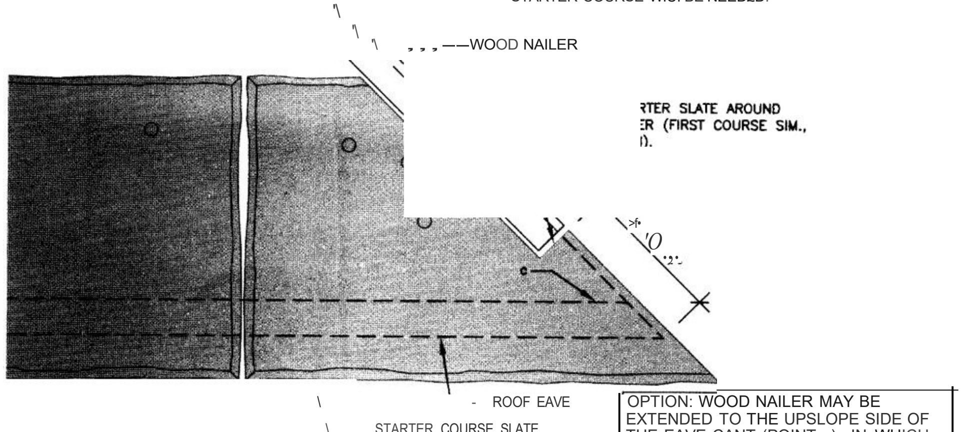


DETAIL 13-A SADDLE RIDGE

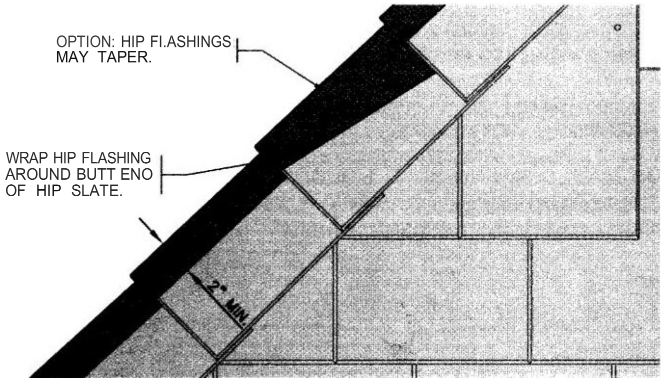
N.T.S.



PLAN: SADDLE HIP
N.T.S.

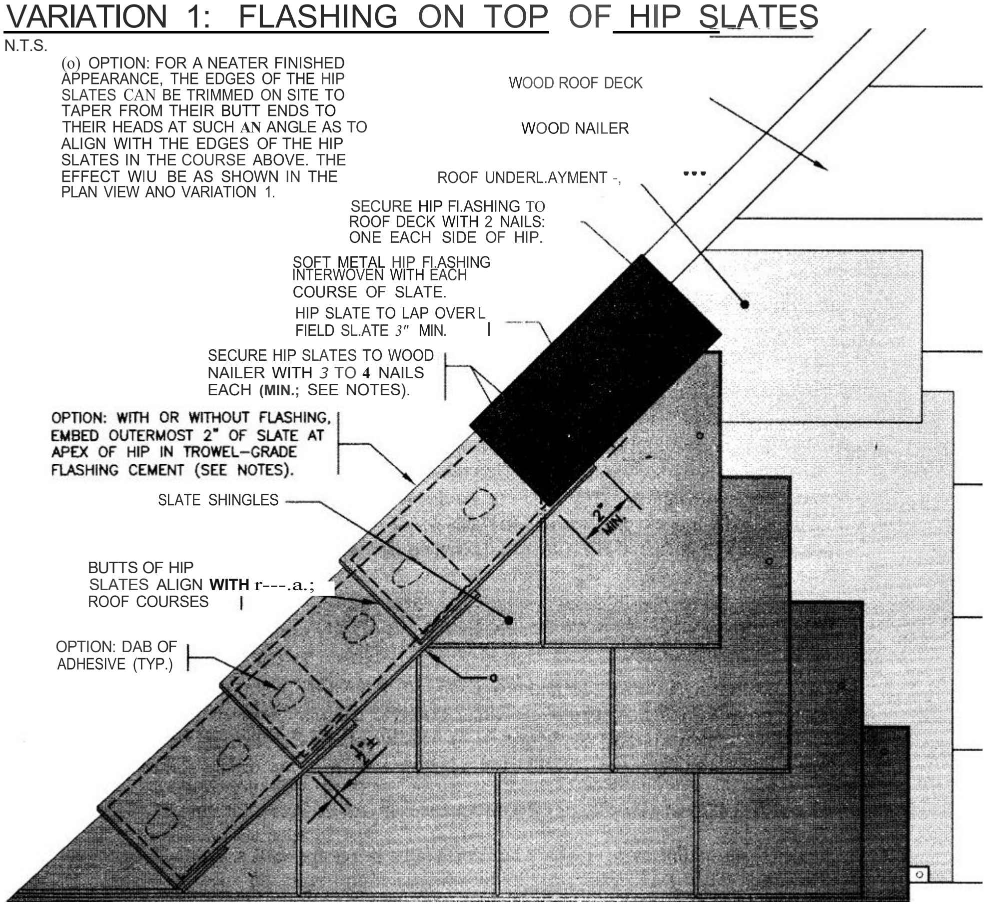


DETAIL A: STARTER COURSE AT HIP
N.T.S.



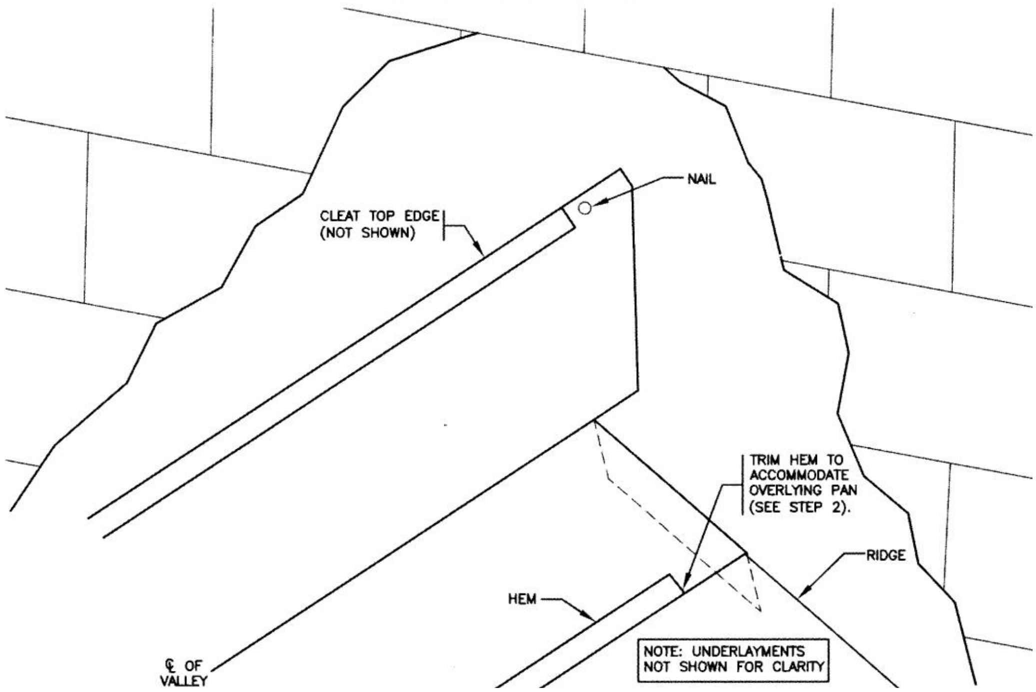
VARIATION 1: FLASHING ON TOP OF HIP SLATES

N.T.S.

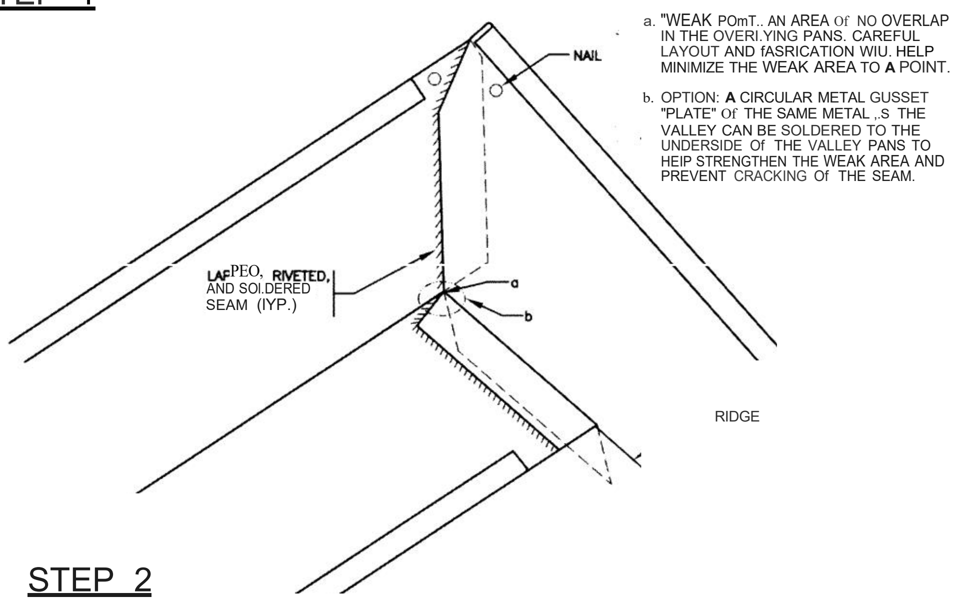


DETAIL 12-A SADDLE HIP

N.T.S.



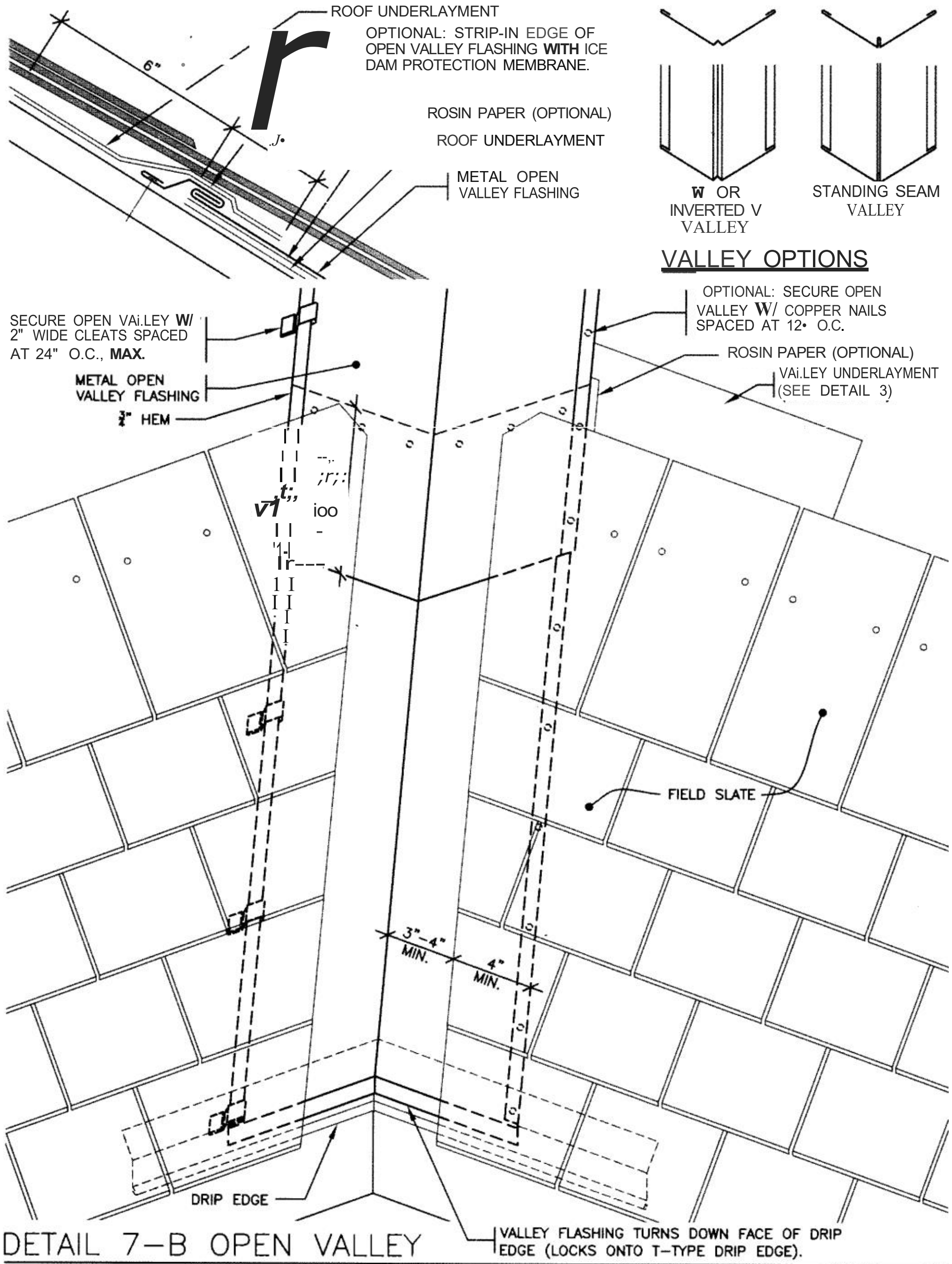
STEP 1



STEP 2

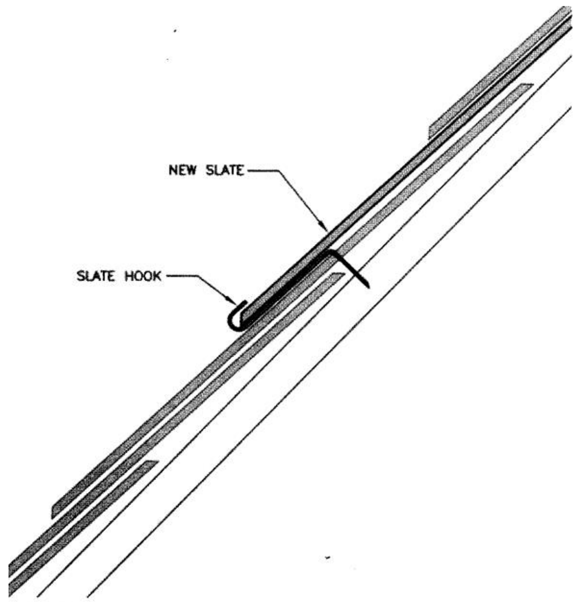
DETAIL 7-C SCHEMATIC PAN LAYOUT AT PEAK OF VALLEY

N.T.S.

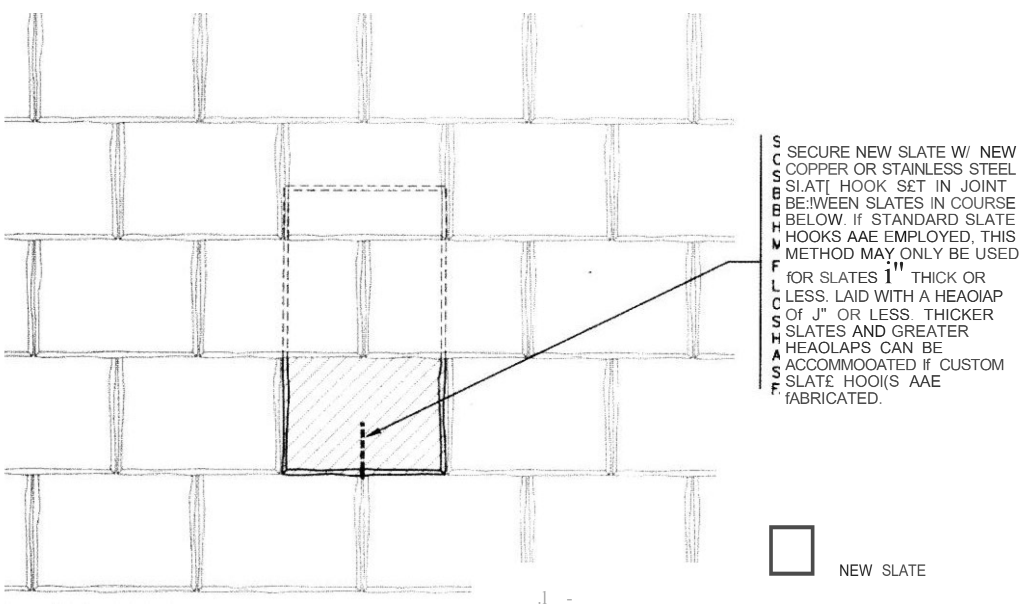


DETAIL 7-B OPEN VALLEY

N.I.S.



SECTION



SLATE HOOK METHOD

Addendum C – Aerial measurement report, Thayer Library

Aerial Measurement Report

Prepared by Olde Mohawk Historic Preservation

717 Main St, Lancaster,MA 01523-2248

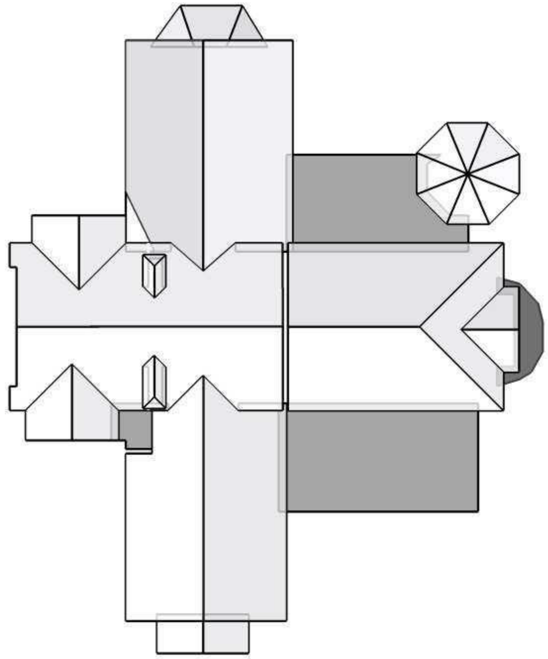
Olde Mohawk Historic Preservation
87 East Emerson Street
Melrose, MA 02176

Ward Hamilton
tel. 877.622.8973
email: OldeMohawkInc@gmail.com
OldeMohawk.com

Olde Mohawk Historic Preservation

Premium Report
July 16, 2015

717 Main St, Lancaster, MA 01523-2248



In this 3D model, facets appear as semi-transparent to reveal overhangs.

Report Details

Report:11507526
Claim: Thayer Memorial Library

Roof Details

Total Roof Area =11,683 sq ft
Total Roof Facets =39
Predominant Pitch =8/12
Number of Stories >1
Total Ridges/Hips =462 ft
Total Valleys =168 ft
Total Rakes =157 ft
Total Eaves =558 ft
Total Penetrations =16
Total Penetrations Perimeter = 313 ft
Total Penetrations Area = 404 sq ft

Report Contents

Contact: Ward Hamilton
Company: Olde Mohawk Historic Preservation
Address: 87 East Emerson Street
Melrose MA 02176
Phone: 781-686-6999

Measurements provided by www.eagleview.com

Certified Accurate

www.eagleview.com/Guarantee.aspx

Images

The following aerial images show different angles of this structure for your reference.

Top View

North Side

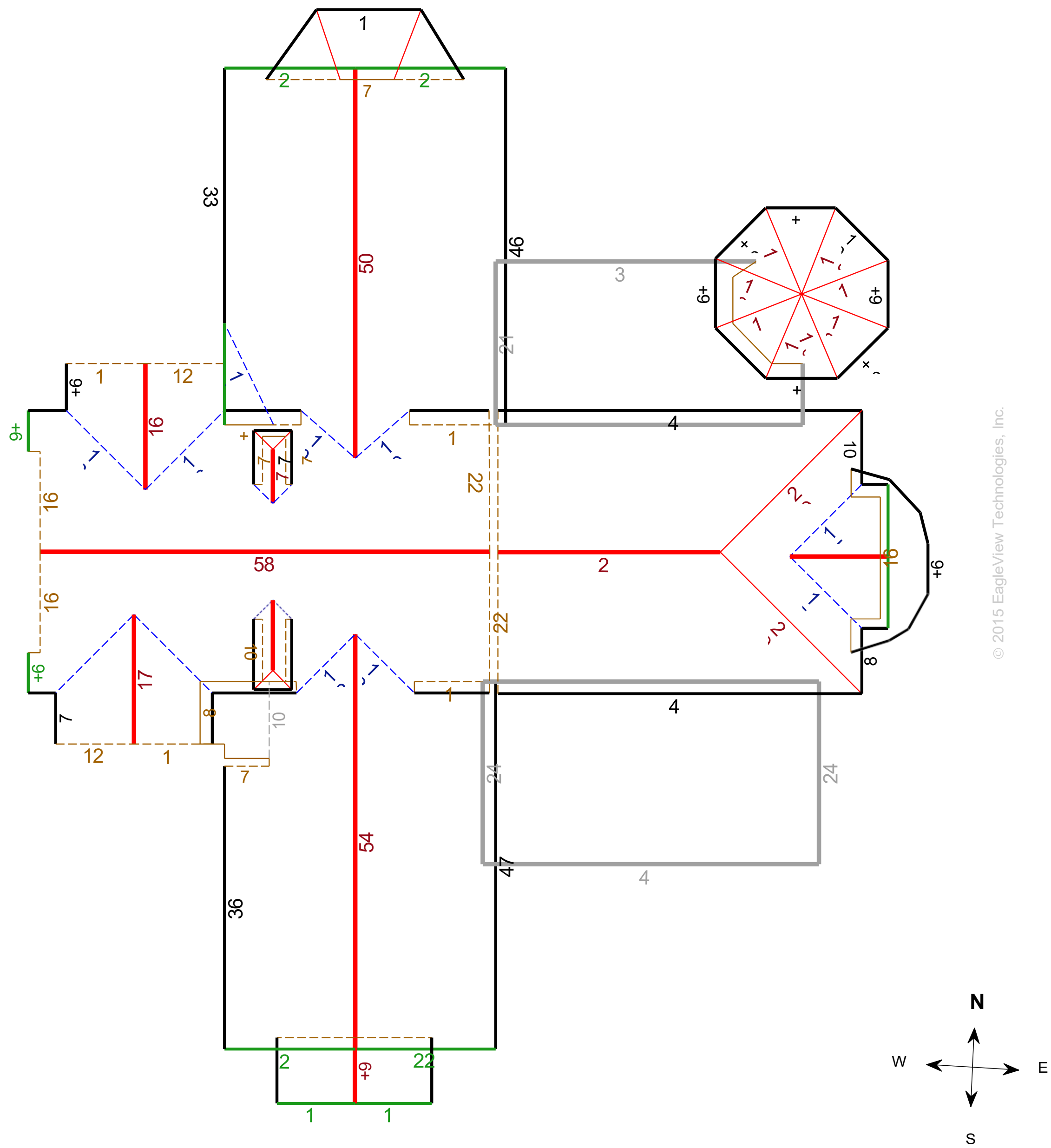
South Side

East Side

West Side

Length Diagram

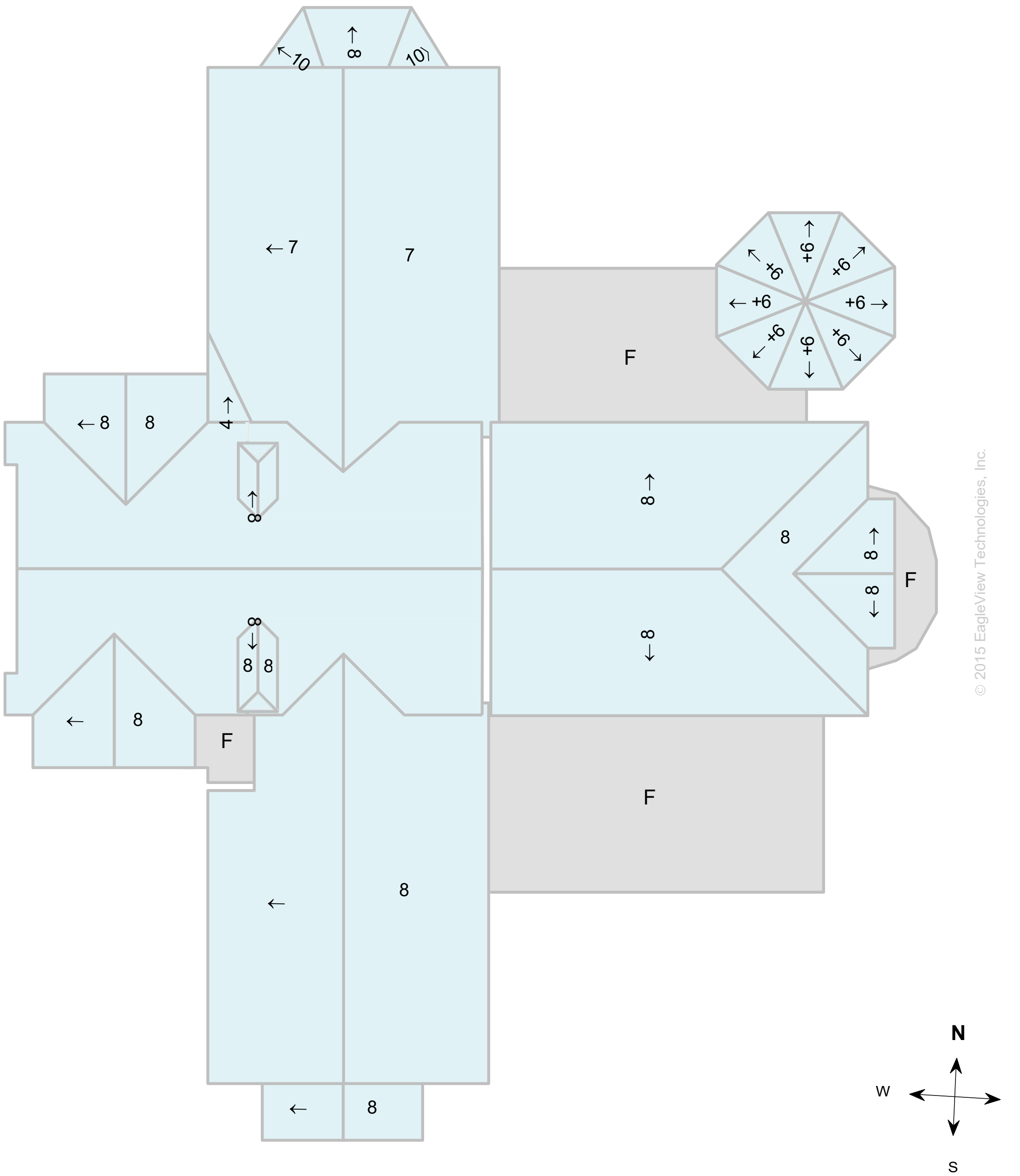
Total Line Lengths:
Ridges = 261 ft
Hips = 201 ft
Valleys = 168 ft
Rakes = 157 ft
Eaves = 558 ft
Flashing = 113 ft
Step flashing = 293 ft
Parapets = 237 ft



Note: This diagram contains segment lengths (rounded to the nearest whole number) over 5 feet. In some cases, segment labels have been removed for readability. Plus signs preface some numbers to avoid confusion when rotated (e.g. +6 and +9).

Pitch Diagram

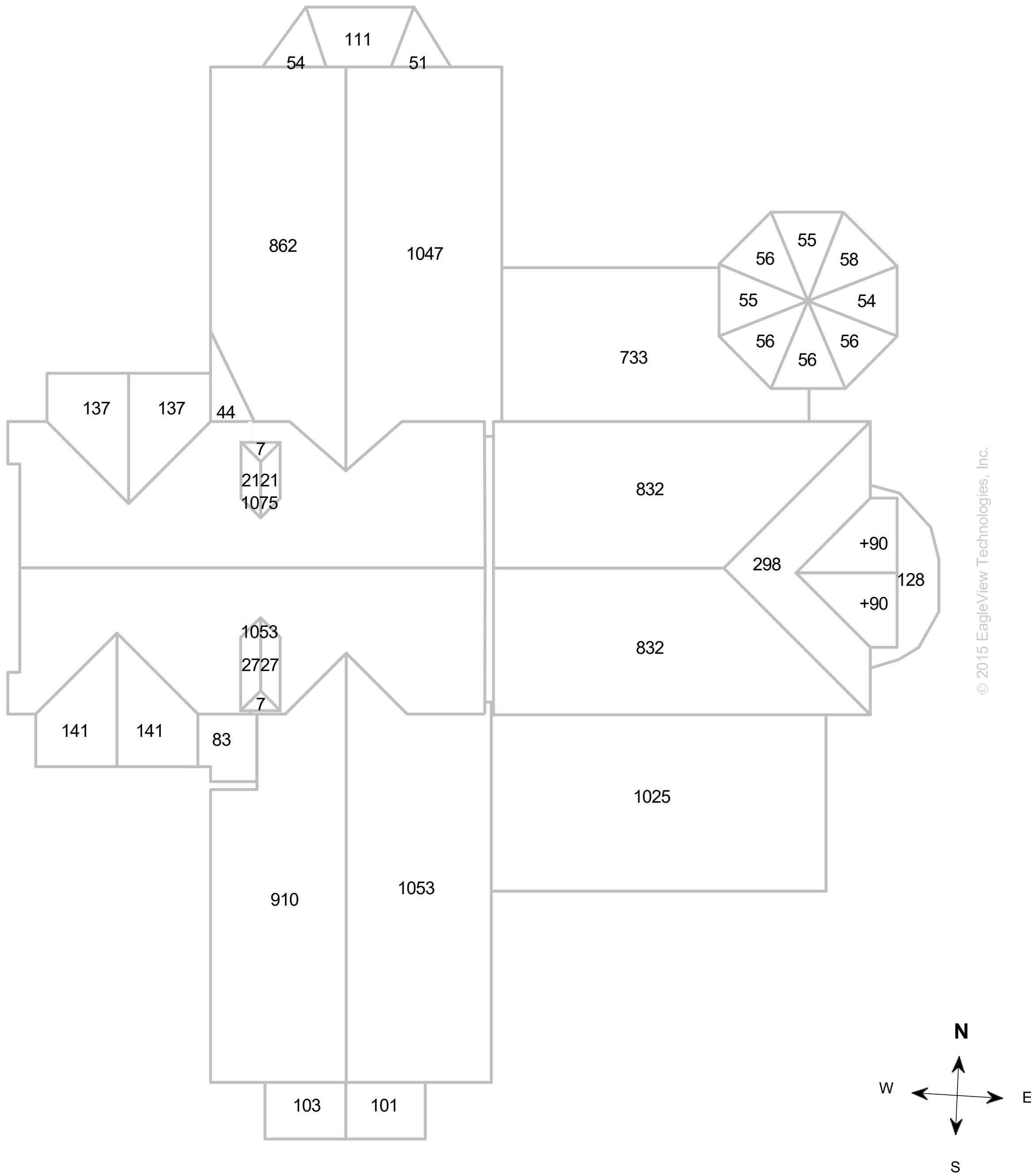
Pitch values are shown in inches per foot, and arrows indicate slope direction. The predominant pitch on this roof is 8/12.



Note: This diagram contains labeled pitches for facet areas larger than 20 square feet. In some cases, pitch labels have been removed for readability. Blue shading indicates a pitch of 3/12 and greater. Gray shading indicates flat, 1/12 or 2/12 pitches. If present, a value of "F" indicates a flat facet (no pitch).

Area Diagram

Total Area = 11,683 sq ft, with 39 facets.

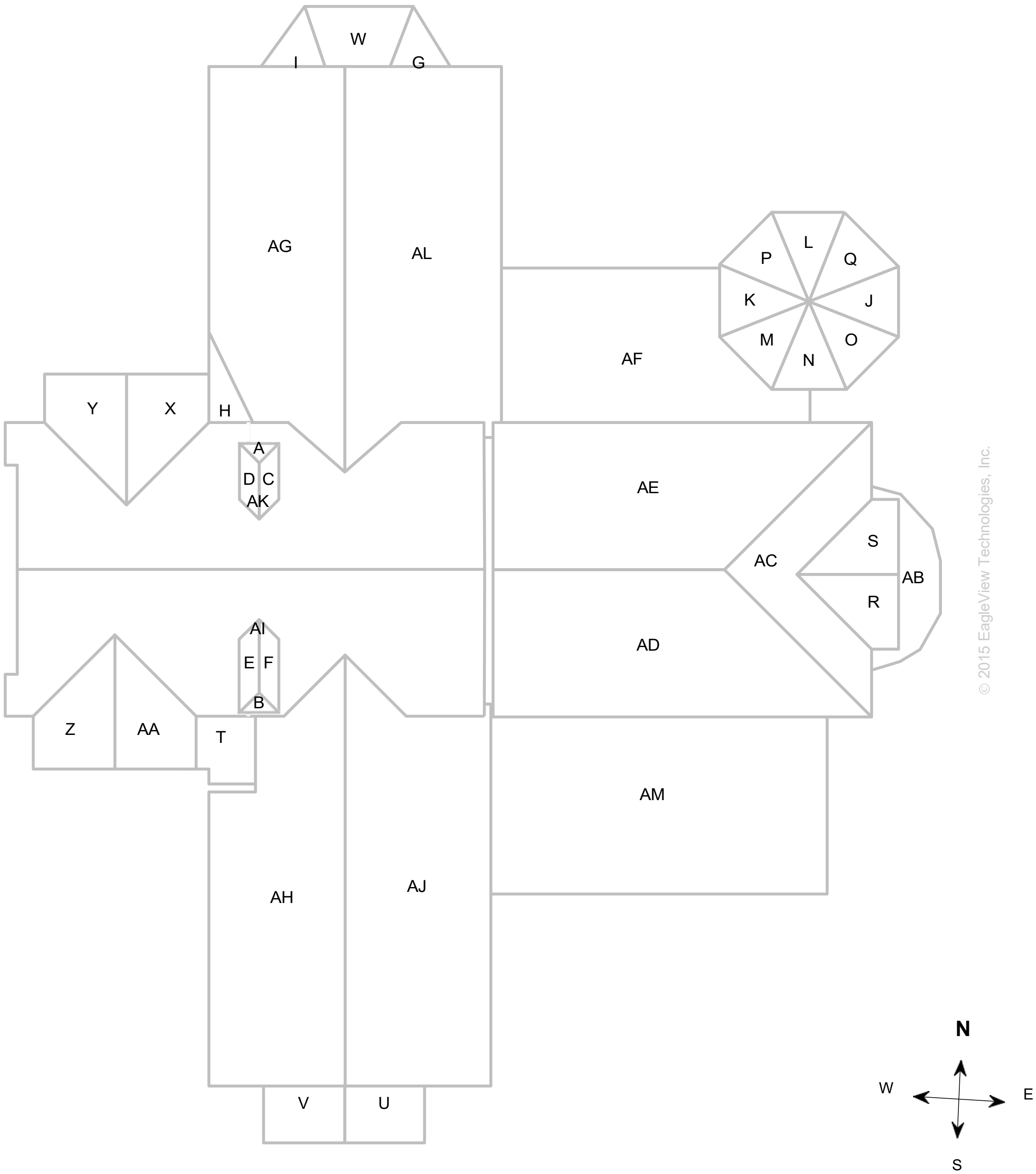


Note: This diagram shows the square feet of each roof facet (rounded to the nearest foot). The total area in square feet, at the top of this page, is based on the non-rounded values of each roof facet (rounded to the nearest square foot after being totaled).

Report: 11507526
Claim: Thayer Memorial Library

Notes Diagram

Roof facets are labeled from smallest to largest (A to Z) for easy reference.



Penetrations Notes Diagram

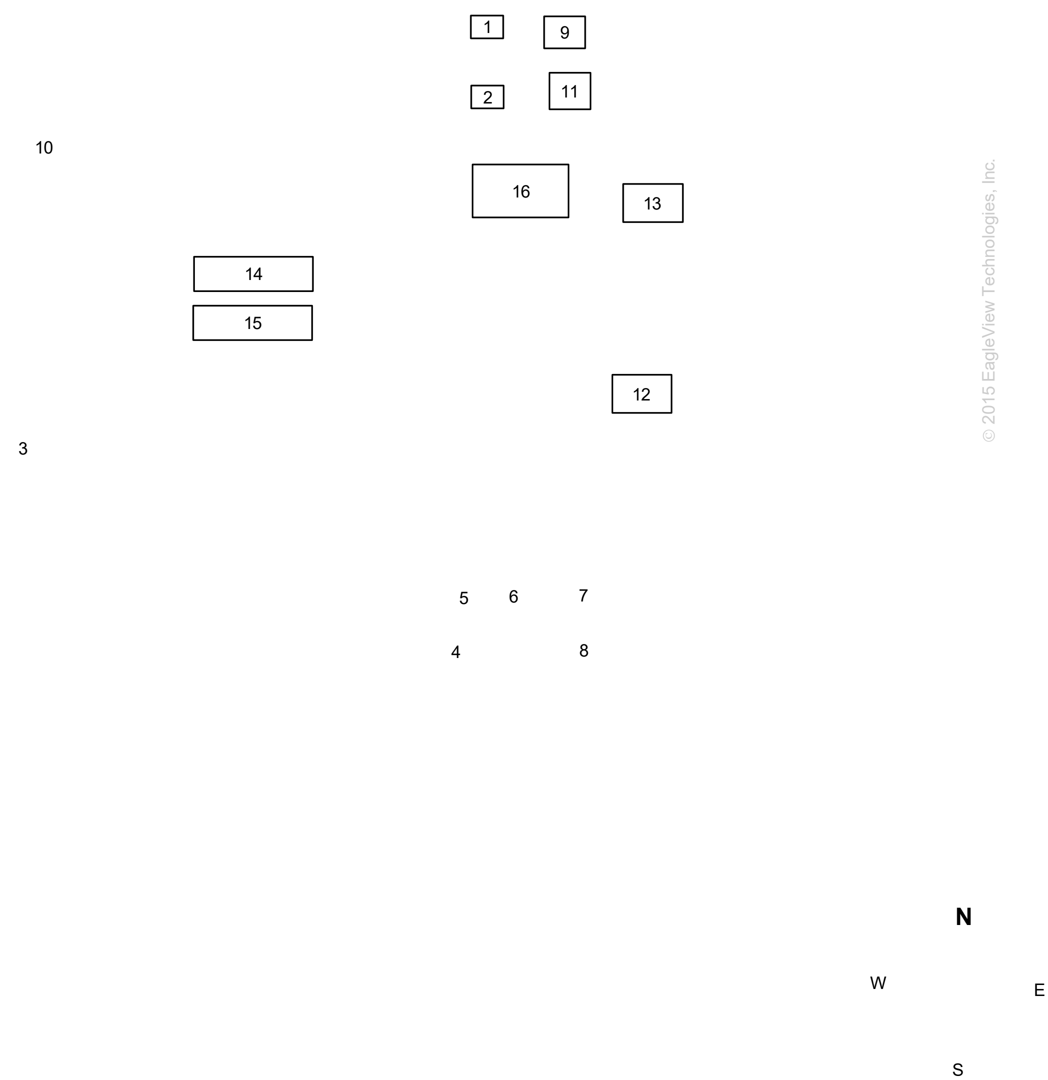
Penetrations are labeled from smallest to largest for easy reference.

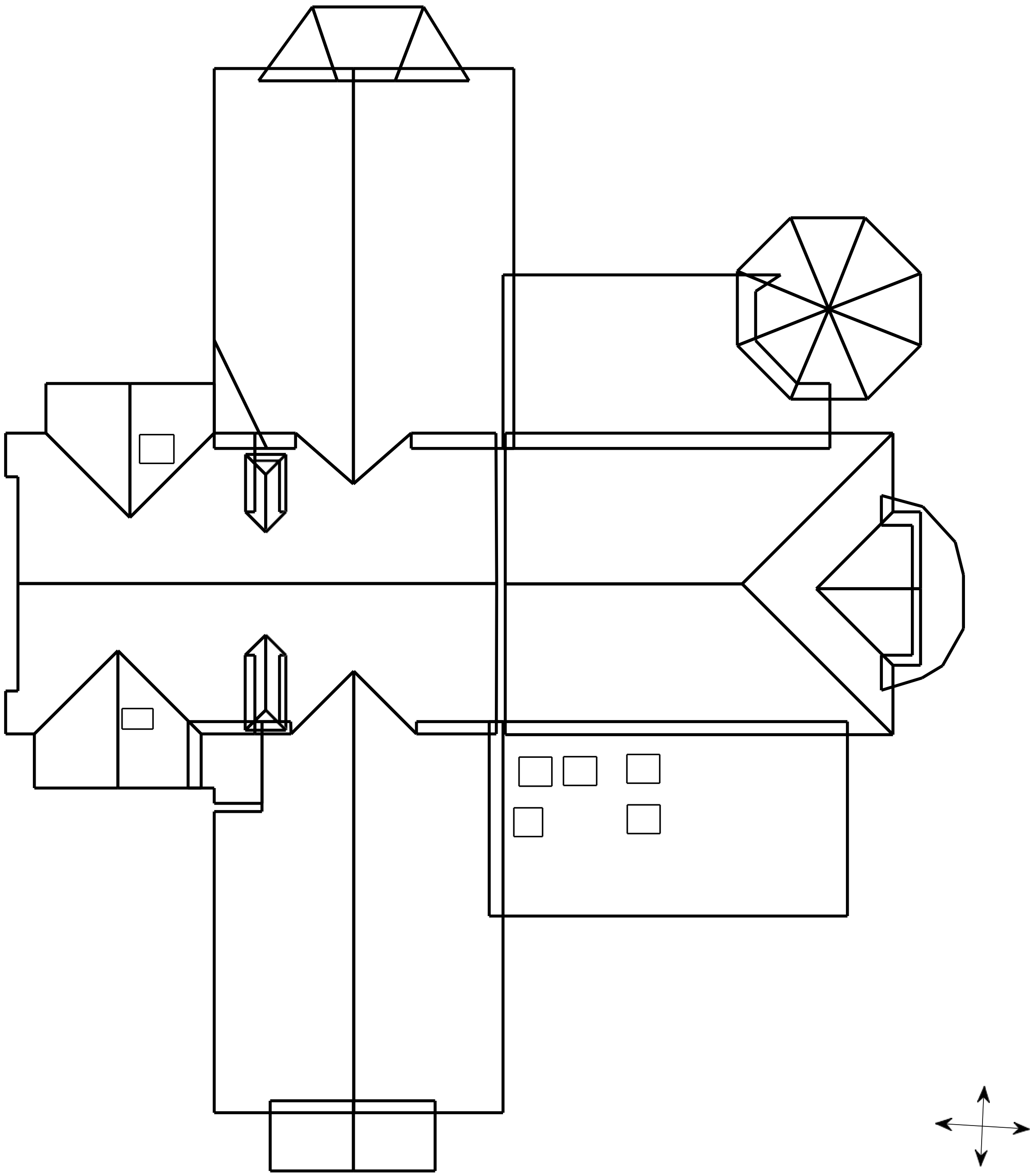
Total Penetrations = 16

Total Penetrations Perimeter = 313 ft

Total Penetrations Area = 404 sq ft

Total Roof Area Less Penetrations = 11,279 sq ft





Report Summary

Below is a measurement summary using the values presented in this report.

Areas per Pitch						
Roof Pitches	0/12	4/12	6/12	7/12	8/12	10/12
Area (sq ft)	1969.3	43.6	444	1910	7210.6	105.7
% of Roof	16.9%	0.4%	3.8%	16.3%	61.7%	0.9%

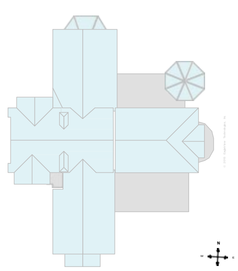
The table above lists each pitch on this roof and the total area and percent (both rounded) of the roof with that pitch.

Waste Calculation Table							
Waste %	0%	10%	12%	15%	17%	20%	22%
Area (sq ft)	11,683	12,851	13,085	13,435	13,669	14,020	14,253
Squares	116.8	128.5	130.8	134.4	136.7	140.2	142.5

This table shows the total roof area and squares (rounded up to the nearest decimal) based upon different waste percentages. The waste factor is subject to the complexity of the roof, individual roofing techniques and your experience. Please consider this when calculating appropriate waste percentages. Note that only roof area is included in these waste calculations. Additional materials needed for ridge, hip, valley, and starter lengths are not included.

Penetrations	1	2	3	4	5-8	9	10	11	12-13	14
Area (sq ft)	8.7	8.8	11.2	12.3	14	15.8	17.5	18	32.5	58.5
Perimeter (ft)	12	12	14	14	15	16	17	17	23	35
	15	16								
Area (sq ft)	58.5	73.5								
Perimeter (ft)	35	35								

Any measured penetration smaller than 3x3 feet may need field verification. Accuracy is not guaranteed. The total penetration area is not subtracted from the total roof area.



Total Roof Facets = 39
Total Penetrations =16

Lengths, Areas and Pitches

Ridges = 261 ft (10 Ridges)
Hips = 201 ft (16 Hips).
Valleys = 168 ft (15 Valleys)
Rakes* = 157 ft (11 Rakes)
Eaves/Starter** = 558 ft (48 Eaves)
Drip Edge (Eaves + Rakes) = 715 ft (59 Lengths)
Parapet Walls = 237 (8 Lengths).
Flashing = 113 ft (28 Lengths)
Step flashing = 293 ft (24 Lengths)
Total Area = 11,683 sq ft
Total Penetrations Area = 404 sq ft
Total Roof Area Less Penetrations = 11,279 sq ft
Total Penetrations Perimeter = 313 ft
Predominant Pitch = 8/12

Property Location

Longitude = -71.6725019
Latitude = 42.4551830

Notes

This was ordered as a commercial property. There were no changes to the structure in the past four years.

Parapet Wall Area Table							
Wall Height (ft)	1	2	3	4	5	6	7

* Rakes are defined as roof edges that are sloped (not level).
** Eaves are defined as roof edges that are not sloped and level.

Vertical Wall Area (sq ft)	237	474	711	948	1185	1422	1659

This table provides common parapet wall heights to aid you in calculating the total vertical area of these walls. Note that these values assume a 90 degree angle at the base of the wall. Allow for extra materials to cover cant strips and tapered edges.

Online Maps

Online map of property
http://maps.google.com/maps?f=q&source=s_q&hl=en&geocode=&q=717+Main+St,Lancaster,MA,01523-2248
Directions from Olde Mohawk Historic Preservation to this property
http://maps.google.com/maps?f=d&source=s_d&saddr=87+East+Emerson+Street,Melrose,MA,02176&daddr=717+Main+St,Lancaster,MA,01523-2248

Addendum D – MHC building survey form B, Thayer Library

Massachusetts Cultural Resource Information System
Scanned Record Cover Page

Inventory No:	LAN.172
Historic Name:	Lancaster Town Library
Common Name:	
Address:	695 Main St Town Green - Thayer Dr
City/Town:	Lancaster
Village/Neighborhood:	Lancaster
Local No:	C77
Year Constructed:	
Architect(s):	Galliher, Baier and Best; Harris, C. H.; Wulff, Charles A.
Architectural Style(s):	Classical Revival
Use(s):	Library; Museum
Significance:	Architecture; Community Planning; Politics Government
Area(s):	LAN.C: Center Village Historic District
Designation(s):	Nat'l Register District (9/15/1977)
Building Materials(s):	Roof: Slate Wall: Brick; Wood

Commonwealth of Massachusetts
Massachusetts Historical Commission
220 Morrissey Boulevard, Boston, Massachusetts 02125
www.sec.state.ma.us/mhc

LAN, 1,"L

C77 NR

This was inventoried and sent to MHC in 1968.

More detailed inform. now

FORM B — BUILDING

In Area no. L'i

Form no. /7//'

MASSACHUSETTS HISTORICAL COMMISSION
Office of the Secretar y, State House, Boston

[redacted]

1. Town: Lancaster, Massachusetts

Address: Thayer::Dr. ~~717~~ Main St. r, To Green

Lancaster Town Library

Present use: Library

Pl-LAN
USGS-CLIN

Present owner: Town of Lancaster

2. Photo (3x3" or 3x5")
Staple to left side of form
Photo number _____

3. Description:

Date: 1868

Source: Plaque in Library

Style: Classic Renaissance

Architect: Mr. Harris

Exterior wall fabric: Brick

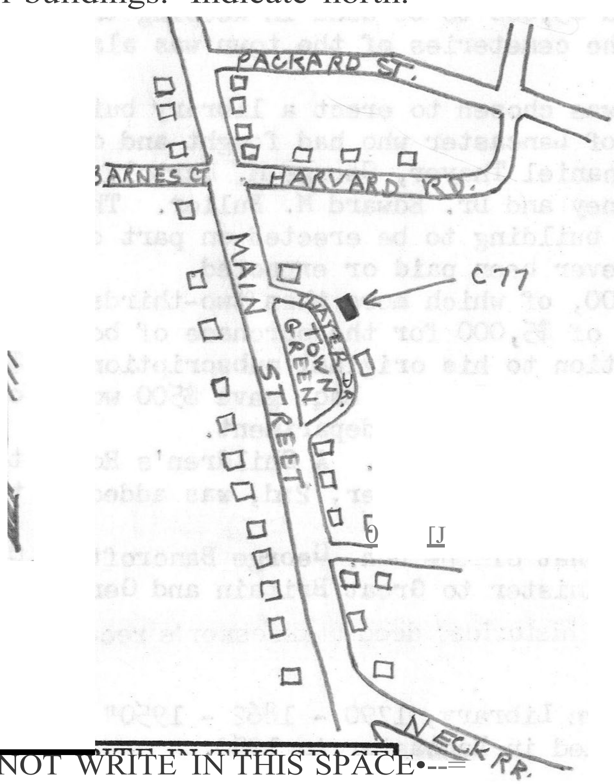
Outbuildings (describe): None

Other features: 2-story, intersect. ridge roof with 2 chimneys, symmetrical front entrance, wing on north side, windows are varied, pediment in front and columns set in at 2nd stor circular iron stairway inside library.

Altered: ::c::W-=i::::n... g a:::.:d::::.:d::.:::e'-"d:.. Date: 1929

Moved: No Date: ______

4. Map. Draw sketch of building location in relation to nearest cross streets and other buildings. Indicate north.



5. Lot size:

Less than one acre X Over one acre ______

Approximate frontage: Part of the sprawling Town Green

Approximate distance of building from street: 12 ft.

DO NOT WRITE IN THIS SPACE
USGS Quadrant ____________
MHC Photo no. ____________

6. Recorded by -;,/:::. 2-£:. ---

Organization: Lancaster Historical Commission

Date: Sept. 19, 1975

(over)

RECEIVED
OC1 2 J 1975
MASS. HiST. COMM.

7. Original owner (if known) Town of Lancaster

Original use Library

Subsequent uses (if any) and dates

8. Themes (check as many as applicable)

Aboriginal		Conservation		Recreation	
Agricultural		Education		Religion	
Architectural	X	Exploration/ settlement		Science/ invention	
The Arts		Industry		Social/ Humanitarian	
Commerce		Military		Transportation	
Communication		Political			
Community development	X				

9. Historical Significance (include explanation of themes checked above)

"The Lancaster Town Library may justly claim the year 1790 as the year of its foundation since the majority of the active officers and members of the Lancaster Social Library (1790-1850) reorganized as the Lancaster Library Club (1851-1862) to continue the life of the Lancaster Library Club after the division of the town in 1850, while the Library Club became the present Lancaster Town Library in 1862 and the Town accepted it as such. The officers and members of the Lancaster Library Club, and most of all Rev. George M. Bartol, were the principal founders of the Lancaster Town Library which began its official existence on April 12, 1862.

In 1866, the town received through Dr. Bartol, a communication from National Thayer, Esq. offeri $p,OOO for a library fund and $3,000 to be used in keeping the cemeteries in order, for from the first, the carf!j:>f the cemeteries of the town was also vested in the board of trustees of the librar.JI.

On Nov.?, 1866, a committee of seven was chosen to erect a library building, which should also be a memorial to the soldiers of Lancaster who had fought-and died in the Civil War. TAe committee consisted of Nathaniel Thayer, Geo ge-KA Bartol, Jacob Fisher, Henry Wilder, J.L.S. Thompson, Quincy Whitney and Dr. F.dward M. Fuller. The First Church of Christ in Lancaster generously allowed the building to be erected on part of its common land for which no compensatioqbr rent has ever been paid or expected.

The eost of building was nearly $30,000, of which more-than two-thirds was paid by Mr. Thayer in addition to his endowment of $5,000 for the purchase of books. At the same tiae, the Hon. Francis B. Fay in addition to his original subscription of $1,000 gave $100 for the purchase of,a clock. George A. Parker, Esq. gave $500 worth of books on art, and also $700 for the further increase of such a department.

Later, stacks were added at the rear of the building. t Children's Room, the girt of Mrs. Bayard Thayer in memory of her son Nathaniel Thayer; 2m, was added to the building in 1929.

One of the earliest funds donated was that of the Hon.-George Bancroft. D.C.L. the eminent historian, Secretary of the Navy, minister to Great Britain and Germ.nay and the

10. Bibliography and/or references (such as local histories, deeds, assessor's records, early maps, etc.)

1 "An Historical Sketcqbf the Lancaster Town Library, ;J.190 - 1862 - 1950" by Frederick Lewis Weis, Th.D. Published in Lancaster in 1950.

first Commandant of the United States Naval Academy at Annapolis. He addressed a letter to the selectmen of the town, dated Newport, Sept.20, 1878 which is on file in the Historical Commission Office and in which he gave $1,000 for the benefit of the Lancaster Town Library, to be called the Captain Samuel Ward Library Fund, the income only to be expended year by year for the purchase of books in the department of History. Other funds have since been given to the library.

The museum of the Library, established in 1863, has continued to grow and now occupies the second floor of the library building. It contains many interesting objects connectee with the history of the town.

The Lancaster Collection, containing the publications of Lancaster natives and residents, was begun in 1905. It contains a fairly complete set of Lancaster imprints, especially those of Carter & Andrews, genealogies of Laneaster families, manuscript sermons of the early ministers and nanuscripts and records of the nany societies and associations of Lancaster's past. Altogether, it contains 681 volumes and forll1S as complete a source of local history as could be desired in a small New England Townf 1

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LAN.172

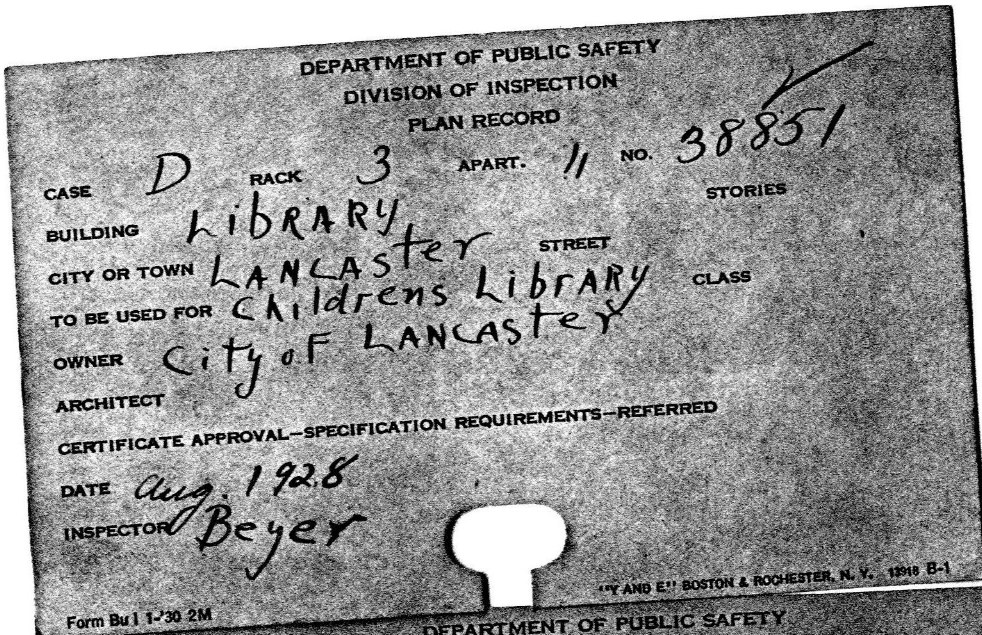
INVENTORY FORM CONTINUATION SHEET

Town: [o&:ce,.>

Property Address: 7(7MCt,h S'-h

MASSACHUSETTS HISTORICAL CO:MMISSION
MASSACHUSETTS ARCHIVES BUILDING
220 MORRISSEY BOULEVARD
BOSTON, MASSACHUSETTS 02125

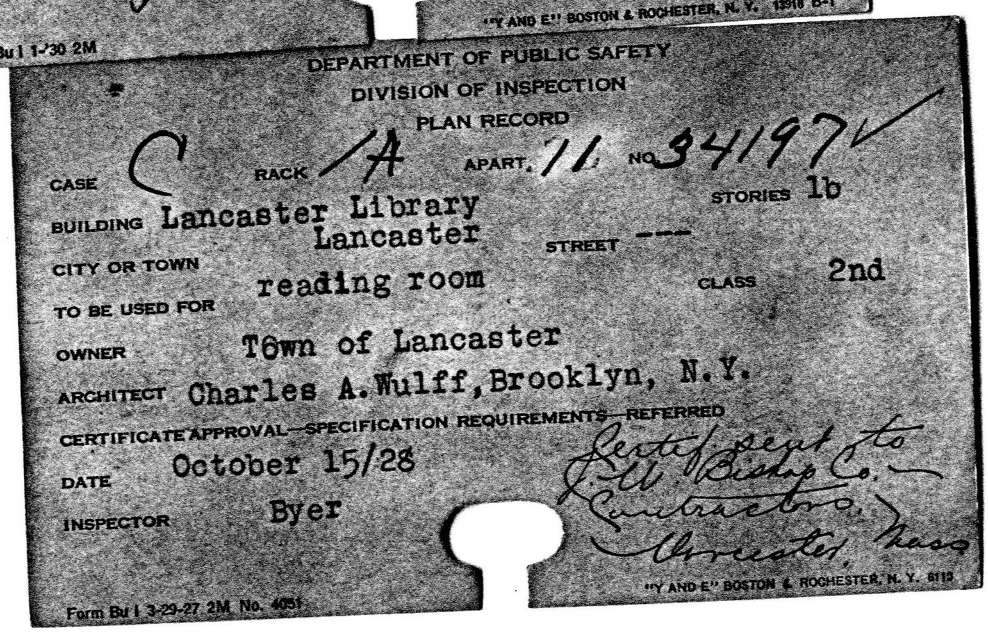
Area(s)	Form No.
LAN	122



DEPARTMENT OF PUBLIC SAFETY
DIVISION OF INSPECTION
PLAN RECORD

CASE D RACK 3 APART. 11 NO. 38851
STORIES
BUILDING Library
CITY OR TOWN Lancaster STREET
TO BE USED FOR Childrens Library CLASS
OWNER City of Lancaster
ARCHITECT
CERTIFICATE APPROVAL—SPECIFICATION REQUIREMENTS—REFERRED
DATE Aug. 1928
INSPECTOR Beyer

Form Bu I 1-30 2M
"Y AND E" BOSTON & ROCHESTER, N. Y. 13918 B-1



DEPARTMENT OF PUBLIC SAFETY
DIVISION OF INSPECTION
PLAN RECORD

CASE C RACK 1A APART. 11 NO. 34197
STORIES 1b
BUILDING Lancaster Library
CITY OR TOWN Lancaster STREET ---
TO BE USED FOR reading room CLASS 2nd
OWNER T6wn of Lancaster
ARCHITECT Charles A. Wulff, Brooklyn, N.Y.
CERTIFICATE APPROVAL—SPECIFICATION REQUIREMENTS—REFERRED
DATE October 15/28
INSPECTOR Byer

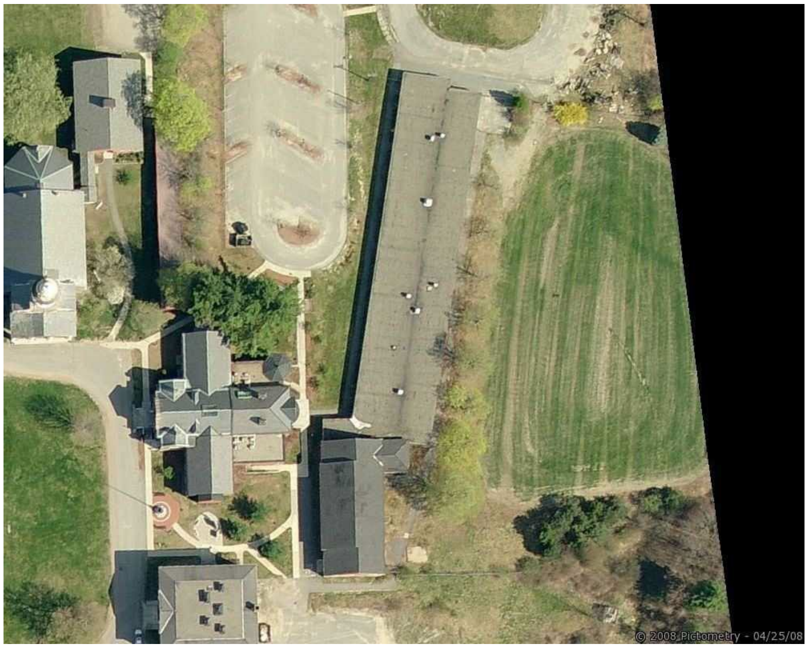
Certif. sent to J. W. Bishop Co. Contractors, Worcester, Mass

Form Bu I 3-29-27 2M No. 4051
"Y AND E" BOSTON & ROCHESTER, N. Y. 6113

Addendum E – Aerial measurement report, Community Center

Aerial Measurement Report

Prepared by Olde Mohawk Historic Preservation

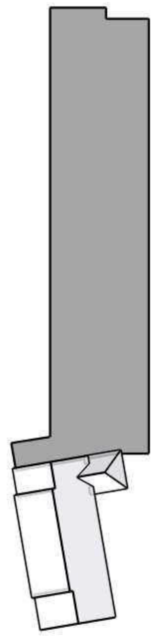


715 Main St, Lancaster,MA 01523-2248

Olde Mohawk Historic Preservation
87 East Emerson Street
Melrose, MA 02176

Ward Hamilton
tel. 877.622.8973
email: OldeMohawkInc@gmail.com
OldeMohawk.com

715 Main St, Lancaster, MA 01523-2248



In this 3D model, facets appear as semi-transparent to reveal overhangs.

Report Details

Report:11507550
Claim: Lancaster Community Center

Roof Details

Total Roof Area =26,645 sq ft
Total Roof Facets =8
Predominant Pitch =0/12
Number of Stories >1
Total Ridges/Hips =168 ft
Total Valleys =28 ft
Total Rakes =184 ft
Total Eaves =980 ft
Total Penetrations =9
Total Penetrations Perimeter = 116 ft
Total Penetrations Area = 95 sq ft

Report Contents

Contact: Ward Hamilton
Company: Olde Mohawk Historic Preservation
Address: 87 East Emerson Street
Melrose MA 02176
Phone: 781-686-6999

Measurements provided by www.eagleview.com

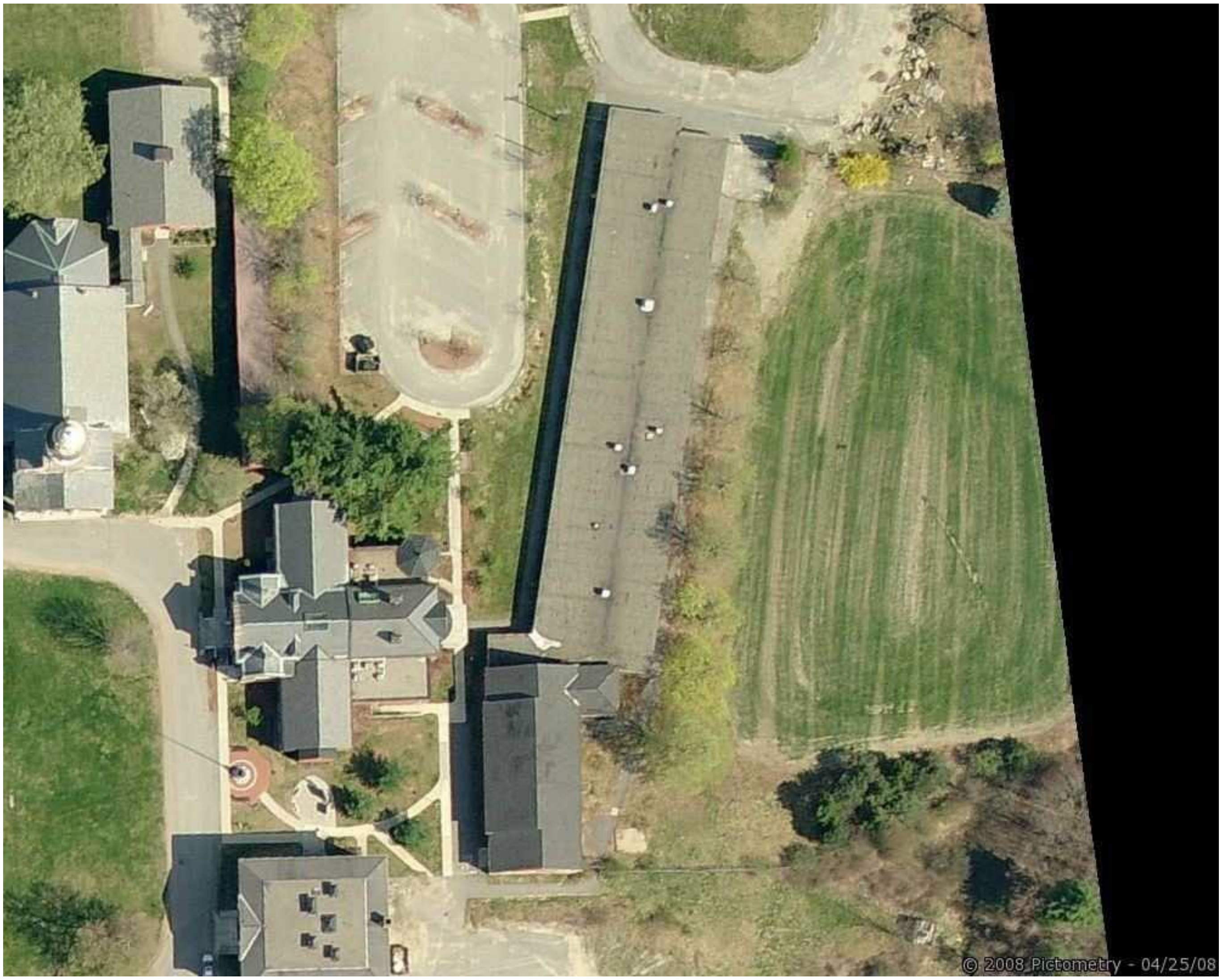
Certified Accurate

www.eagleview.com/Guarantee.aspx

Images

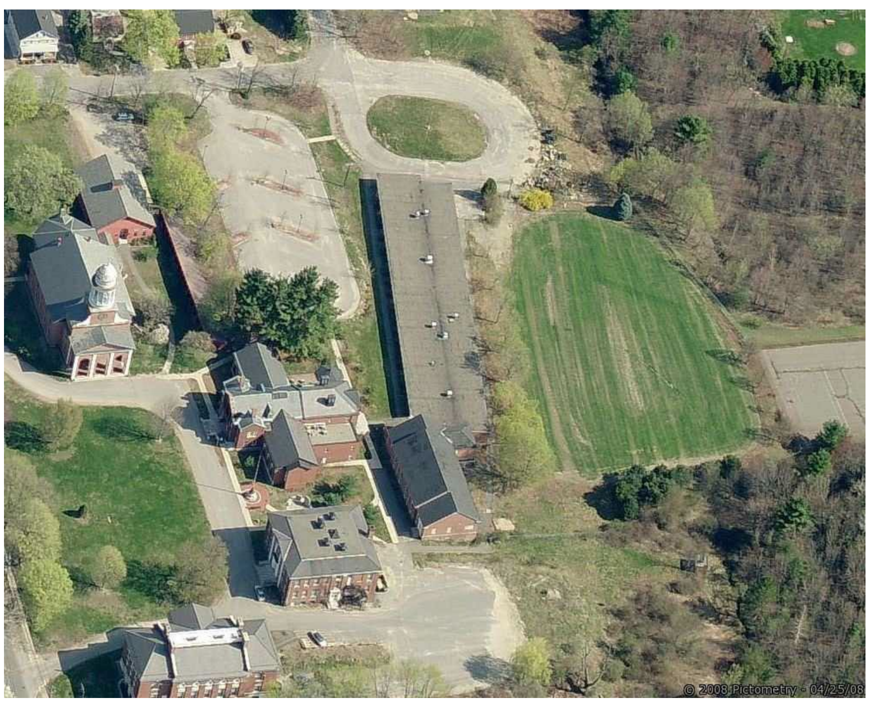
The following aerial images show different angles of this structure for your reference.

Top View



North Side

South Side

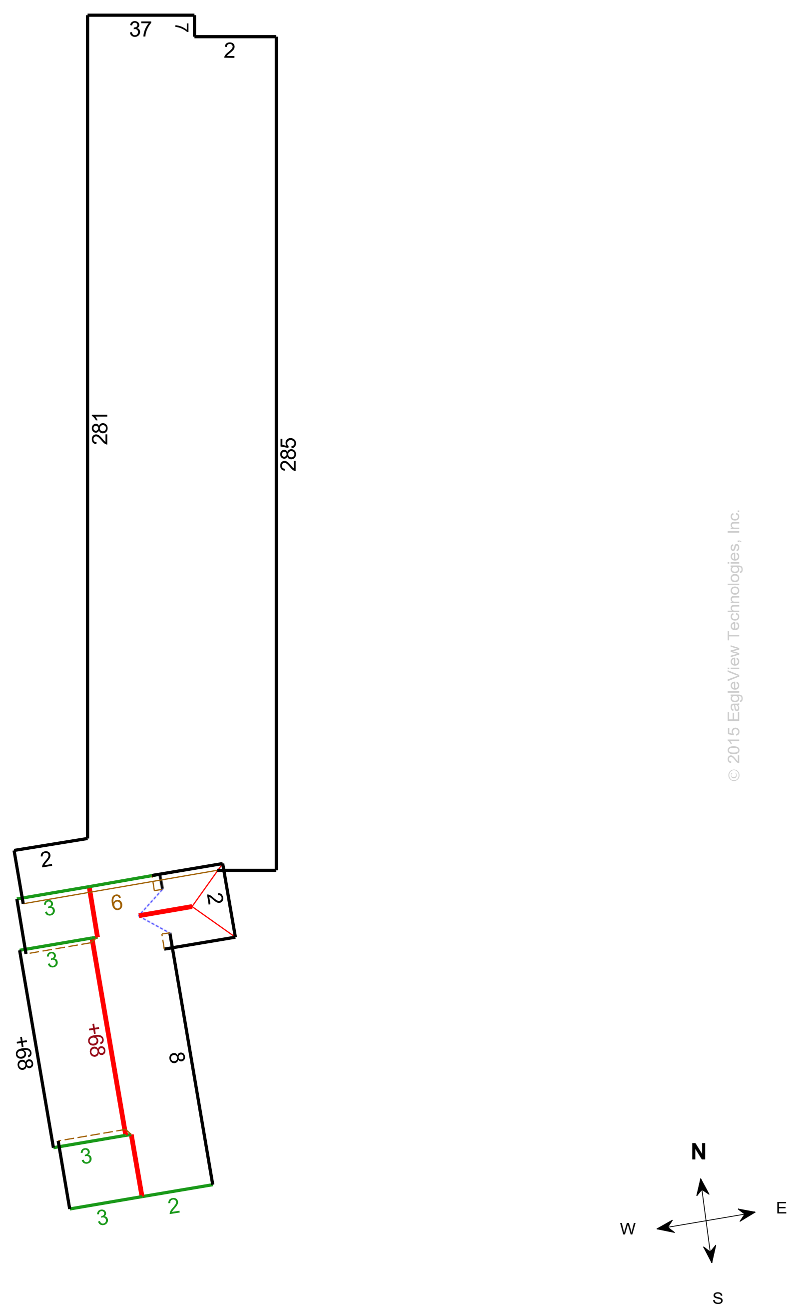


East Side

West Side

Length Diagram

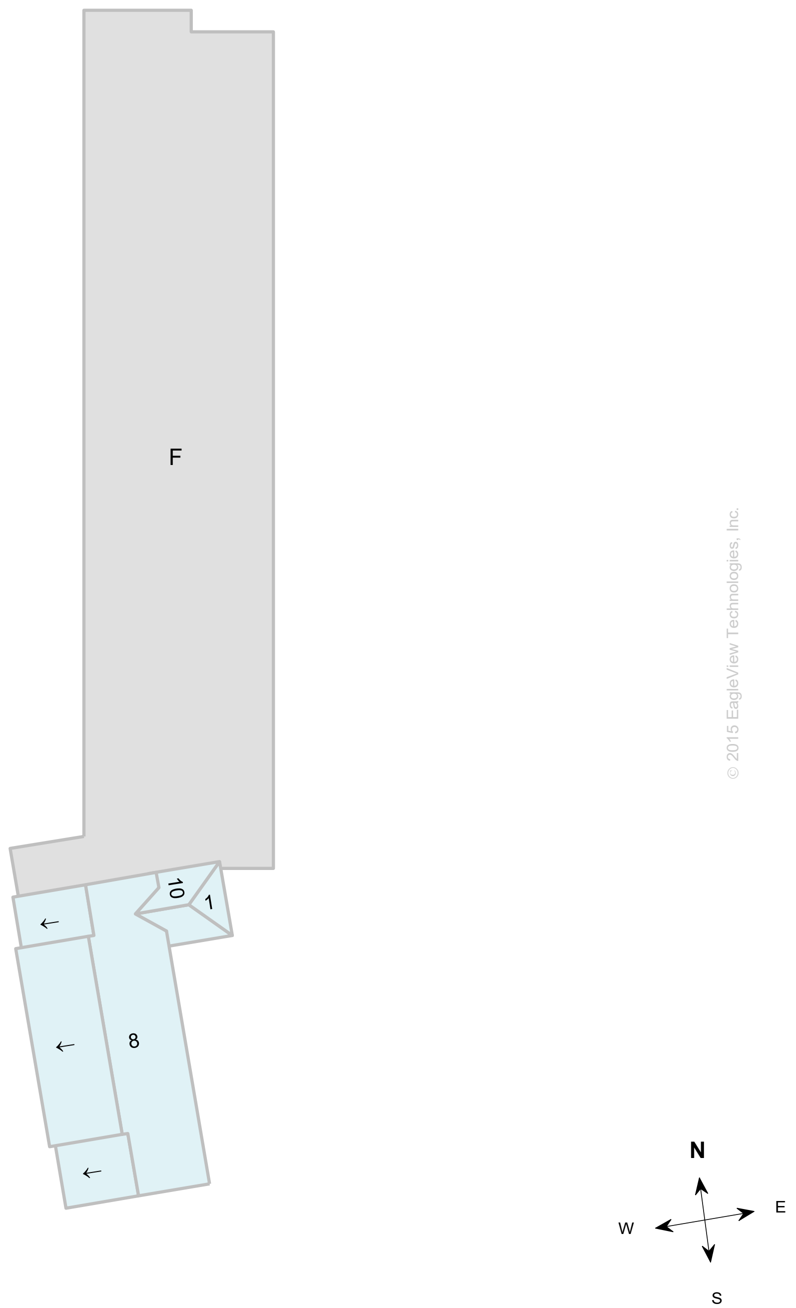
Total Line Lengths:
Ridges = 126 ft
Hips = 42 ft
Valleys = 28 ft
Rakes = 184 ft
Eaves = 980 ft
Flashing = 73 ft
Step flashing = 76 ft
Parapets = 0 ft



Note: This diagram contains segment lengths (rounded to the nearest whole number) over 5 feet. In some cases, segment labels have been removed for readability. Plus signs preface some numbers to avoid confusion when rotated (e.g. +6 and +9).

Pitch Diagram

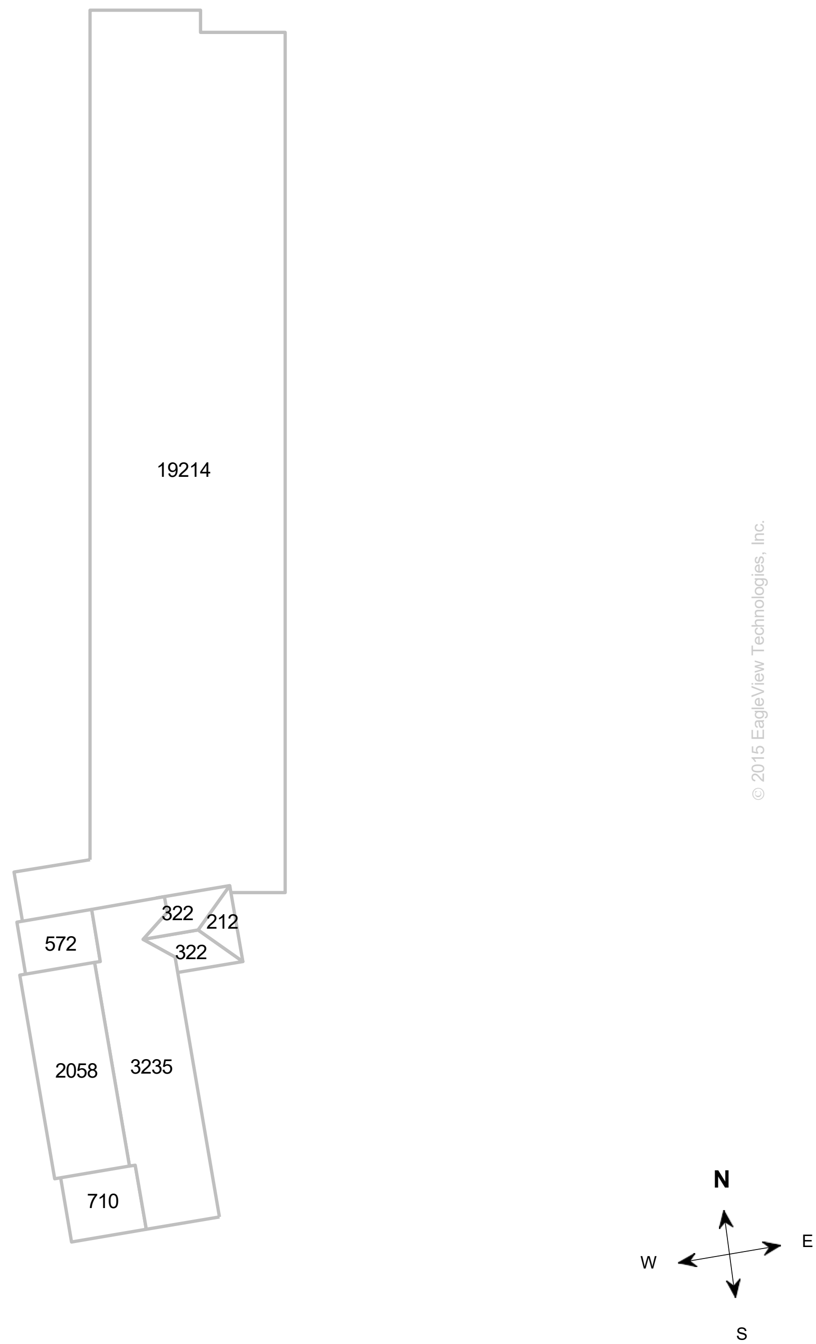
Pitch values are shown in inches per foot, and arrows indicate slope direction. The predominant pitch on this roof is 0/12.



Note: This diagram contains labeled pitches for facet areas larger than 20 square feet. In some cases, pitch labels have been removed for readability. Blue shading indicates a pitch of 3/12 and greater. Gray shading indicates flat, 1/12 or 2/12 pitches. If present, a value of "F" indicates a flat facet (no pitch).

Area Diagram

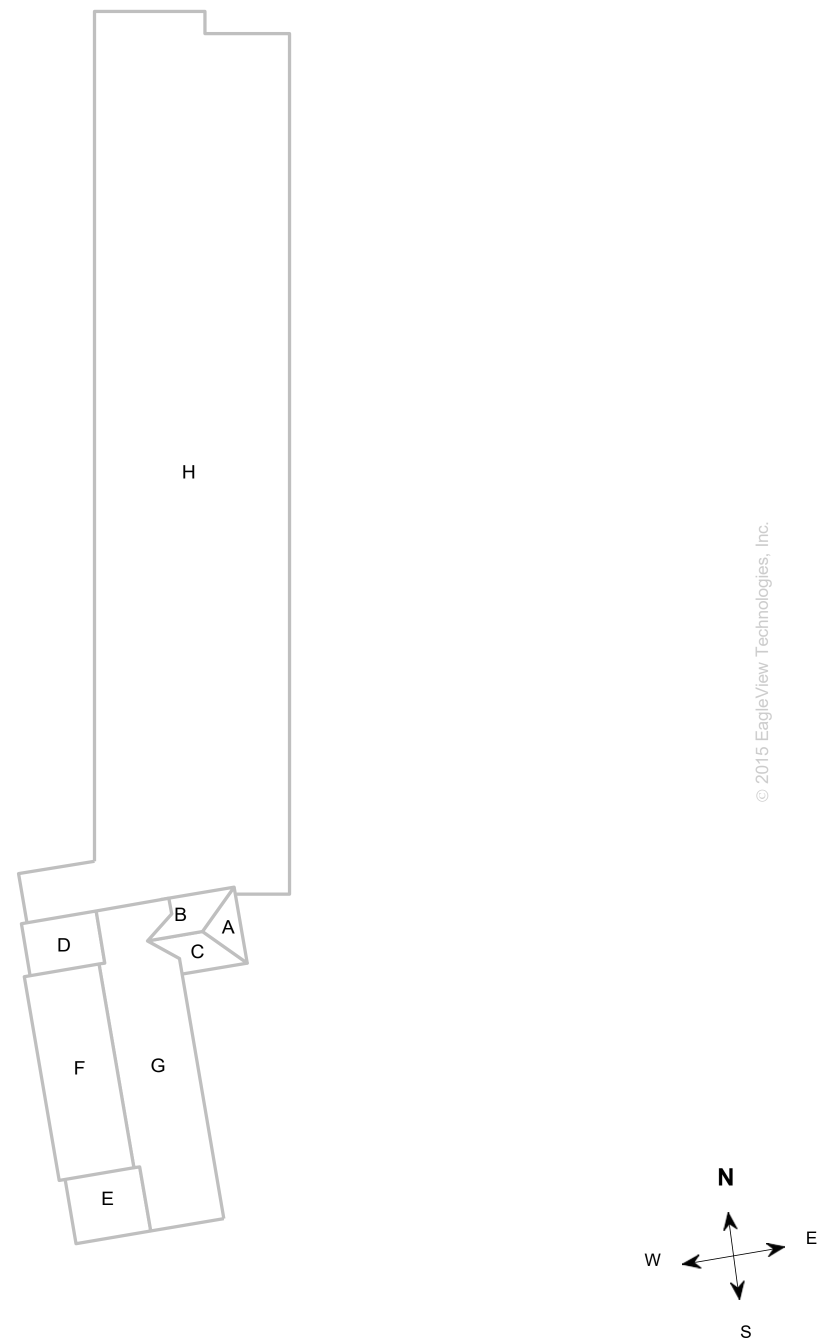
Total Area = 26,645 sq ft, with 8 facets.



Note: This diagram shows the square feet of each roof facet (rounded to the nearest foot). The total area in square feet, at the top of this page, is based on the non-rounded values of each roof facet (rounded to the nearest square foot after being totaled).

Notes Diagram

Roof facets are labeled from smallest to largest (A to Z) for easy reference.



Penetrations Notes Diagram

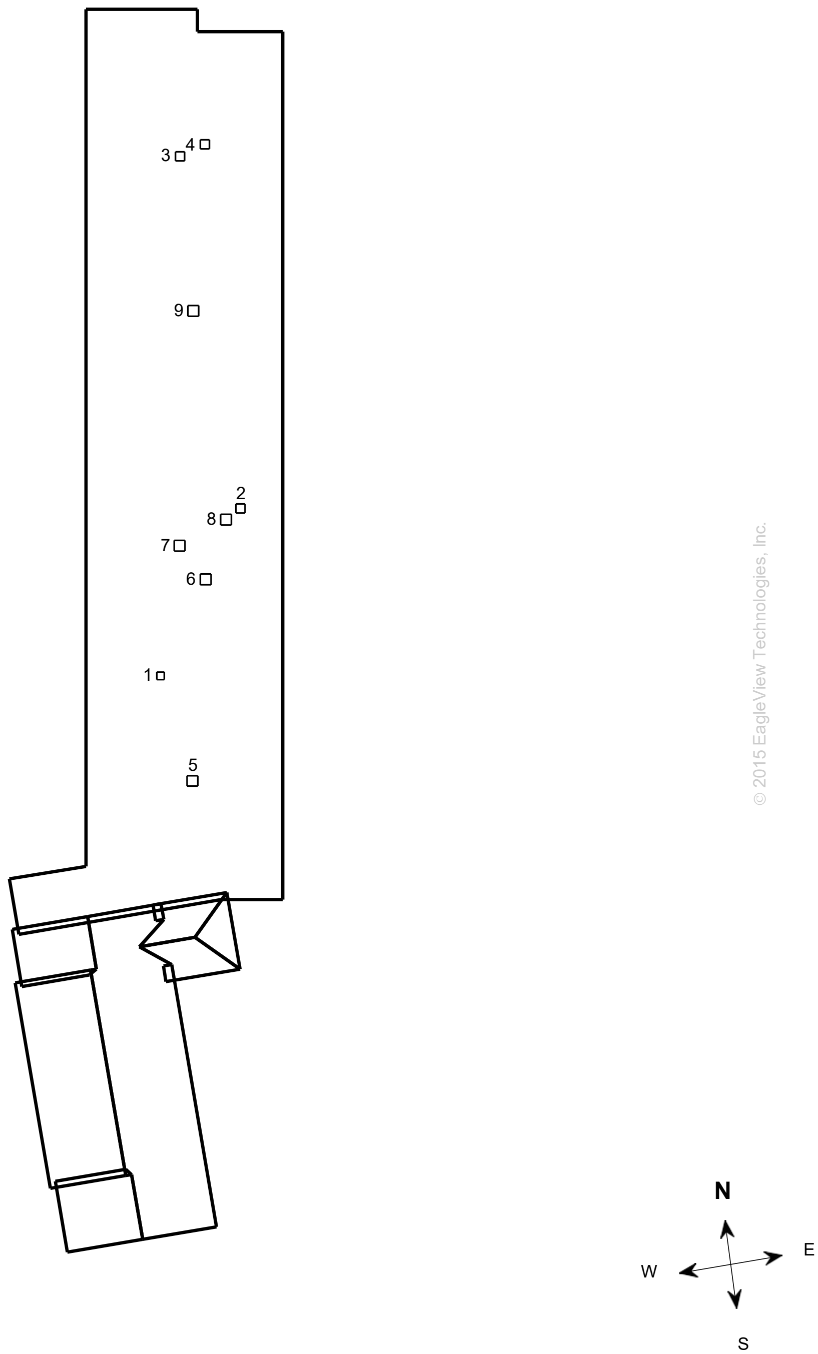
Penetrations are labeled from smallest to largest for easy reference.

Total Penetrations = 9

Total Penetrations Perimeter = 116 ft

Total Penetrations Area = 95 sq ft

Total Roof Area Less Penetrations = 26,550 sq ft



Report Summary

Below is a measurement summary using the values presented in this report.

Areas per Pitch			
Roof Pitches	0/12	8/12	10/12
Area (sq ft)	19214.4	6574.4	856
% of Roof	72.1%	24.7%	3.2%

The table above lists each pitch on this roof and the total area and percent (both rounded) of the roof with that pitch.

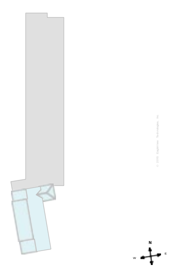
Waste Calculation Table

Waste %	0%	10%	12%	15%	17%	20%	22%
Area (sq ft)	26,645	29,310	29,842	30,642	31,175	31,974	32,507
Squares	266.4	293.1	298.4	306.4	311.7	319.7	325.1

This table shows the total roof area and squares (rounded up to the nearest decimal) based upon different waste percentages. The waste factor is subject to the complexity of the roof, individual roofing techniques and your experience. Please consider this when calculating appropriate waste percentages. Note that only roof area is included in these waste calculations. Additional materials needed for ridge, hip, valley, and starter lengths are not included.

Penetrations	1	2-4	5-9							
Area (sq ft)	6.2	9	12.2							
Perimeter (ft)	10	12	14							

Any measured penetration smaller than 3x3 feet may need field verification. Accuracy is not guaranteed. The total penetration area is not subtracted from the total roof area.



Total Roof Facets = 8
Total Penetrations =9

Lengths, Areas and Pitches

Ridges = 126 ft (4 Ridges)
Hips = 42 ft (2 Hips).
Valleys = 28 ft (2 Valleys)
Rakes* = 184 ft (8 Rakes)
Eaves/Starter** = 980 ft (16 Eaves)
Drip Edge (Eaves + Rakes) = 1,164 ft (24 Lengths)
Parapet Walls = 0 (0 Lengths).
Flashing = 73 ft (3 Lengths)
Step flashing = 76 ft (6 Lengths)
Total Area = 26,645 sq ft
Total Penetrations Area = 95 sq ft
Total Roof Area Less Penetrations = 26,550 sq ft
Total Penetrations Perimeter = 116 ft
Predominant Pitch = 0/12

Property Location

Longitude = -71.6719961
Latitude = 42.4553179

Notes

This was ordered as a commercial property. There were no changes to the structure in the past four years.

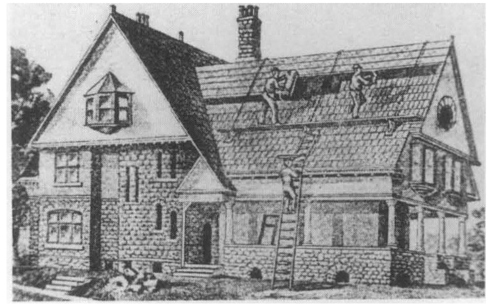
* Rakes are defined as roof edges that are sloped (not level).
** Eaves are defined as roof edges that are not sloped and level.

Online Maps

Online map of property
http://maps.google.com/maps?f=q&source=s_q&hl=en&geocode=&q=715+Main+St,Lancaster,MA,01523-2248
Directions from Olde Mohawk Historic Preservation to this property
http://maps.google.com/maps?f=d&source=s_d&saddr=87+East+Emerson+Street,Melrose,MA,02176&daddr=715+Main+St,Lancaster,MA,01523-2248

Addendum F – Technical Preservation Brief 29

29 PRESERVATION BRIEFS



The Repair, Replacement, and Maintenance of Historic Slate Roofs

Jeffrey S. Levine

U.S. Department of the Interior
National Park Service
Cultural Resources

Heritage Preservation Services

Introduction

Slate is one of the most aesthetically pleasing and durable of all roofing materials. It is indicative at once of the awesome powers of nature which have formed it and the expertise and skill of the craftsman in hand-shaping and laying it on the roof. Installed properly, slate roofs require relatively little maintenance and will last 60 to 125 years or longer depending on the type of slate employed, roof configuration, and the geographical location of the property. Some slates have been known to last over 200 years. Found on virtually every class of structure, slate roofs are perhaps most often associated with institutional, ecclesiastical, and government buildings, where longevity is an especially important consideration in material choices. In the slate quarrying regions of the country, where supply is abundant, slate was often used on farm and agricultural buildings as well.

Because the pattern, detailing, and craftsmanship of slate roofs are important design elements of historic buildings, they should be repaired rather than replaced whenever possible. The purpose of this Preservation Brief is to assist property owners, architects, preservationists, and building managers in understanding the causes of slate roof failures and undertaking the repair and replacement of slate roofs. Details contributing to the character of historic slate roofs are described and guidance is offered on maintenance and the degree of intervention required at various levels of deterioration.

The relatively large percentage of historic buildings roofed with slate during the late nineteenth and early twentieth centuries means that many slate roofs, and the 60 to 125 year life span of the slates most commonly used, may be nearing the end of their serviceable lives at the end of the twentieth century. Too often, these roofs are being improperly repaired or replaced with alternative roofing materials, to the detriment of the historic integrity and appearance of the structure. Increased knowledge of the characteristics of slate and its detailing and installation on the roof can lead to more sensitive interventions in which original material is preserved and the building's historic character maintained. Every effort should be made to replace deteriorated slate roofs with new slate and to develop an effective maintenance and repair program for slate roofs that can be retained.

History of Slate Use in the United States

Although slate quarrying was not common in the United States until the latter half of the nineteenth century, slate roofing is known to have been used prior to the Revolution. Archeological excavations at Jamestown, Virginia,have unearthed roofing slate in strata dating from 1625-1650 and 1640-1670. Slate roofs were introduced in Boston as early as 1654 and Philadelphia in 1699. Seventeenth century building ordinances of New York and Boston recommended the use of slate or tile roofs to ensure fireproof construction.

In the early years of the Colonies, nearly all roofing slate was imported from North Wales. It was not until 1785 that the first commercial slate quarry was opened in the United States, by William Docher in Peach Bottom Township, Pennsylvania. Production was limited to that which could be consumed in local markets until the middle of the nineteenth century. Knowledge of the nation's abundant stone resources was given commercial impetus at this time by several forces, including a rapidly growing population that demanded housing, advances in quarrying technology, and extension of the railroad system to previously inaccessible markets. Two additional factors helped push the slate industry to maturity: the immigration of Welsh slate workers to the United States and the introduction of architectural pattern and style books (Figure 1). Slate production increased dramatically in the years following the Civil War as quarries were opened in Vermont, New York, Virginia, and Lehigh and Northampton Counties, Pennsylvania. By 1876, roofing slate imports had all but dried up and the United States became a net exporter of the commodity.

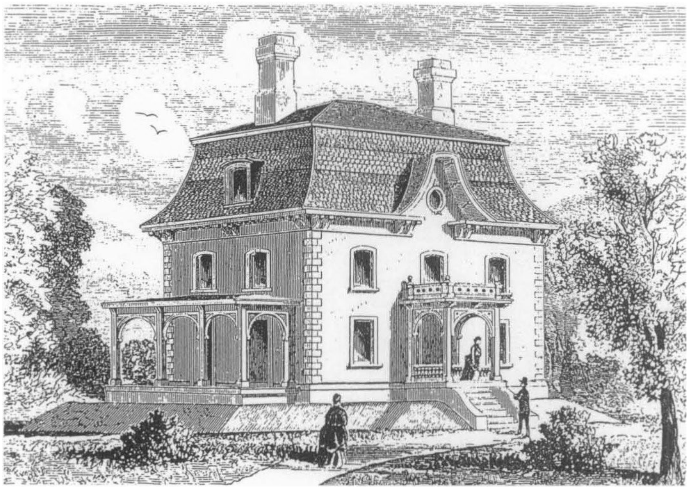


Figure 1. Architectural pattern books of the mid-nineteenth century awakened Americans to the availability and quality of slate for roofing purposes In; incorporating slate roofs in their designs. Design XX, *".4 French Roof House," in A. J. Downing's* Victorian Cottage Residences is *shown.*

The U.S. roofing slate industry reached its highest point in both quantity and value of output in the period from 1897 to 1914. In 1899, there were over 200 slate quarries operating in 13 states, Pennsylvania historically being the largest producer of all. The decline of the U.S. r ofing slate industry began c.1915 and resulted from several factors, including a decline in skilled labor for both the fabrication and installation of slate and competition from substitute materials, such as asphalt shingles, which could be mass produced, transported and installed at a lower cost than slate. Only recently, with the increasing popularity of historic preservation and the recognition of the superiority of slate over other roofing materials, has slate usage begun to increase.

The Character and Detailing of Historic Slate Roofs

During some periods of architectural history, roof design has gone far beyond the merely functional and contributed much to the character of buildings. Roofs, by their compelling forms, have defined styles and, by their decorative patterns and colors, have imparted both dignity and beauty to buildings. The architectural styles prevalent during the latter half of the nineteenth and early twentieth centuries placed strong emphasis on prominent roof lines and greatly influenced the demand for slate. Slate, laid in multi-colored decorative patterns, was particularly well suited to the Mansard roofs of the Second Empire style, the steeply pitch roofs of the Gothic Revival and High Victorian Gothic styles, and the many prominent roof planes and turrets associated with the Queen Anne style. The Tudor style imitated the quaint appearance of some English slates which, because of their granular cleavage, are thick and irregular. These slates were often laid in a graduated pattern, with the largest slates at the eaves and the courses diminishing in size up the roof slope, or a textural pattern (Figure 2). Collegiate Gothic style buildings, found on many university campuses, were often roofed with slate laid in a graduated pattern.

The configuration, massing, and style of historic slate roofs are important design elements that should be preserved. In addition, several types of historic detailing were often employed to add visual interest to the roof, essentially elevating the roof to the level of an ornamental architectural element. When repairing or replacing a slate roof, original details affecting its visual character should be retained.

Before repairing or replacing an existing slate roof, it is important to document the existing conditions and detailing of the roof using written, visual, and physical evidence so that original features can be identified and preserved. Documentation should continue through the repair or replacement process as significant details, long obscured, are often rediscovered while carrying out these activities. Local histories, building records, old receipts and ledgers, historic photographs, sketches, and paintings, shadow lines and nail hole patterns on the roof deck, and bits of historic material left over from previous interventions (often found in eave cavities) are all useful sources of information which can be of help in piecing together the original appearance of the roof. Size, shape, color, texture, exposure, and coursing are among the most important characteristics of the original slates which should be documented and matched when repairing or replacing an historic slate roof.

Historically, three types of slate roofing-standard, textural, and graduated-were available according to the architectural effect desired. St,,mdard grade slate roofs were most common. These are characterized by their uniform appearance, being composed of slates approximately 3/16" (0.5cm) thick, of consistent length and width, and having a smooth cleavage surface. Thirty different standard sizes were available, ranging from 10" (25cm) x 6" to 24" x 14" (15cm x 61cm x 35cm). The slates were laid to break joints and typically had square ends and uniform color and exposure. Patterned and polychromatic roofs were created by laying standard slates of different colors and shapes on the roof in such a way as to create sunbursts, flowers, sawtooth and geometric designs, and even initials and dates (Figure 3). On utilitarian structures, such as barns and sheds, large gaps were sometimes left between each slate within a given course to reduce material and installation costs and provide added ventilation for the interior (Figure 4).

Figure 2. The quaint character of this Tudor sh;le residence is *derived,* i11 *part, from its textural roof.*

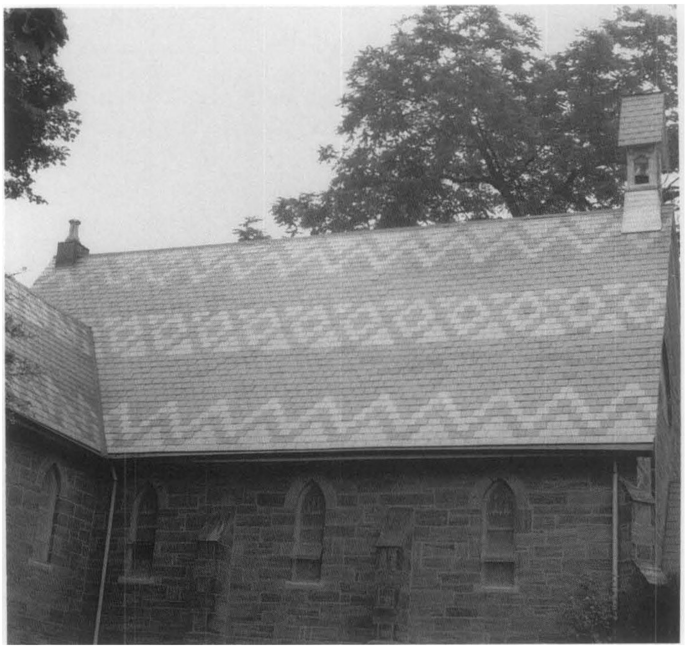


Figure 3. A sawtooth geometric design composed of red, green, and black slates 11lakes this roof the 11lost visually i11lporta11t feature of the building.

Textural slate roofs incorporate slates of different thicknesses, uneven tails, and a rougher texture than standard slates. Textural slate roofs are perhaps most often associated with Tudor style buildings where slates of different colors are used to enhance the effect.

Graduated slate roofs were frequently installed on large institutional and ecclesiastical structures (Figure 5). The slates were graduated according to thickness, size, and exposure, the thickest and largest slates being laid at the eaves and the thinnest and smallest at the ridge. Pleasing architectural effects were achieved by blending sizes and colors.

Detailing at the hips, ridges and valleys provided added opportunity to ornament a slate roof. Hips and ridges can be fashioned out of slate according to various traditional schemes whereby the slates are cut and overlapped to produce a watertight joint of the desired artistic effect. Traditional slate ridge details are the saddle ridge, strip saddle ridge, and comb ridge, and for hips, the saddle hip, mitered hip, Boston hip, and fantail hip (Figure 6). A more linear effect was achieved by cpvering the ridges and hips with flashing called "cresting" or "ridge roll" formed out of sheet metal, terra cotta, or even slate (Figure 7). Snow guards, snow boards, and various types of gutter and rake treatments also contributed to the character of historic slate roofs (Figure 8).

Two types of valleys were traditionally employed, the open valley and the closed valley. The open valley is lined with metal over which slates lap only at the sides. Closed valleys are covered with slate and have either a continuous metal lining or metal flashing built in with each course. Open valleys are easier to install and maintain, and are generally more watertight than closed valleys. Round valleys are a type of closed valley with a concave rather than V-shaped section (Figure 9). Given the broader sweep of the round valley, it was not uncommon for roofers to interweave asphalt saturated felts rather than copper sheet in the coursing in order to cut costs.

Figure 4. Widely spaced open slating was often used on utilitarian structures where ventilation was desirable. It provided an interesting texture and visual pattern to often plain structures.

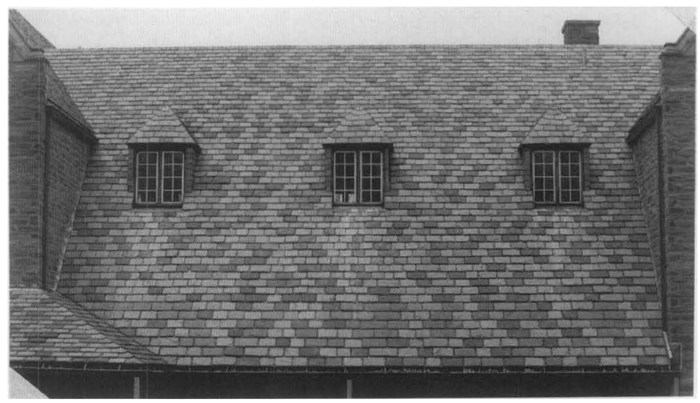


Figure 5. This graduated slate roof is composed of large, thick slates at the eave which are reduced in size and thickness as the slating progresses to the ridge.

Although principally associated with graduated and textural slate roofs, round valleys were infrequently employed due to the difficulty and expense of their installation.

Common types of sheathing used include wood boards, wood battens, and, for fireproof construction on institutional and government buildings, concrete or steel (Figure 10). Solid wood sheathing was typically constructed of tongue and groove, square edged, or shiplapped pine boards of 1" (2.5 cm) or 1 1/4" (3 cm) nominal thickness. Boards from 6" (15 cm) to 8" (20 cm) wide and tongue and groove boards were generally preferred as they were less likely to warp and curl.

Wood battens, or open wood sheathing, consisted of wood strips, measuring from 2" (5 cm) to 3" (7.5 cm) in width, nailed to the roof rafters. Spacing of the battens depended on the length of the slate and equaled the exposure. Slates were nailed to the batten that transected its mid-section. The upper end of the slate rested at least 1/2" (1.25 cm) on the batten next above. Open wood sheathing was employed primarily on utilitarian, farm, and agricultural structures in the North and on residential buildings in the South where the insulating value of solid wood sheathing was not a strict requirement. To help keep out dust and wind driven rain on residential buildings, mortar was often placed along the top and bottom edge of each batten, a practice sometimes referred to as torching.

Various Roofing Details

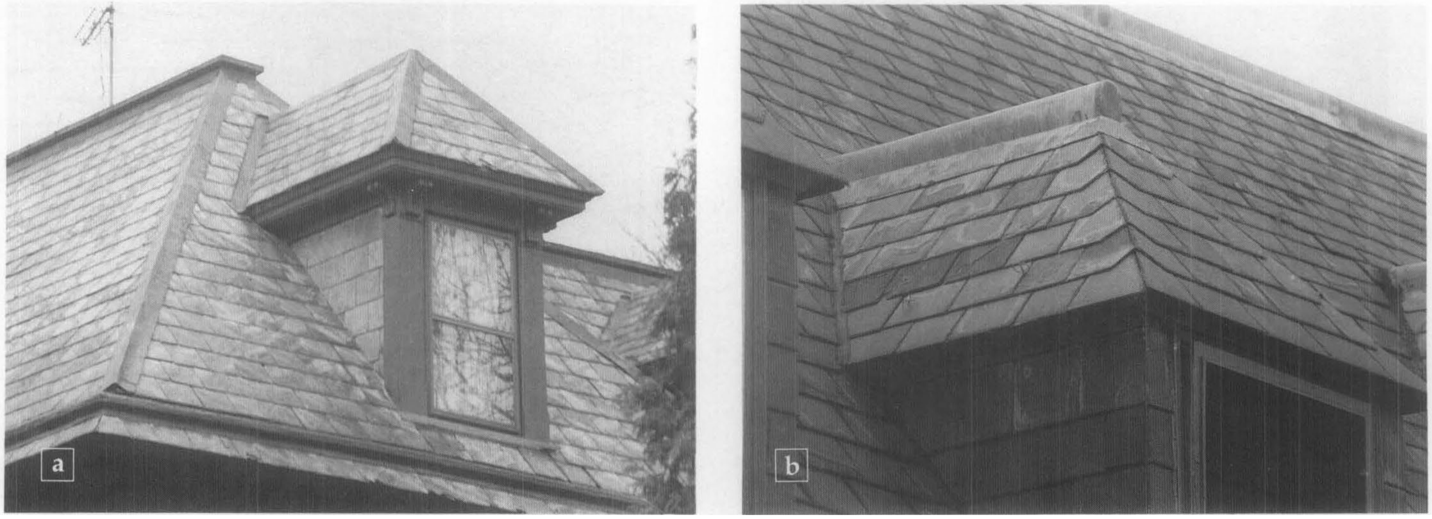


Figure 6. Hips are formed at the external angle of two roofing slopes. In (a), the hips at both the roof and the dormer are covered with metal. Note also the open valley and the built-in gutter. In (b), the dormer hip slates have been laid in a fantail pattern to help shed water. Note also the metal ridge cap.

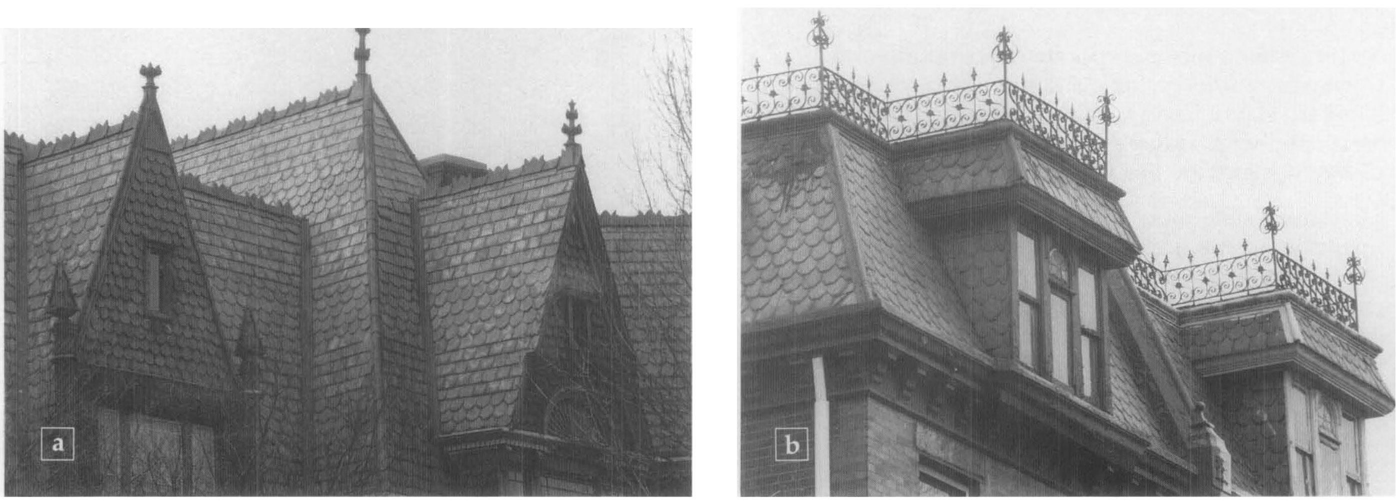


Figure 7. Ridge caps and cresting can be elaborate. Ridges are formed at the long horizontal juncture of two roofing slopes and capping protects this joint from moisture. In (a), a terracotta capping with a decorative profile complements the finial over the various roof peaks. In (b), the mansard roof has a decorative iron cresting at the break between the lower and the upper roof slopes.

Figure 8. Eave details include snow guards, snow boards, gutter treatments. Snow guards are generally used in areas where ice and snow accumulate to avoid dangerous slides from the roof. In (a) the snow guards are set in two staggered rows above a pole gutter. In (b), the copper wire snow guards are set more frequently up a very steep gable.

Figure 9. *Valleys are formed at the internal angle of two roofing slopes. Flashing is often placed under the slate to increase moisture protect at this vulnerable joint. Shown in (a) is a closed valley where the slates are held tight to the valley line. (b) illustrates of a round valley where the transition between the two slopes is a continuous curve. It requires careful workmanship and an experienced roofer.*

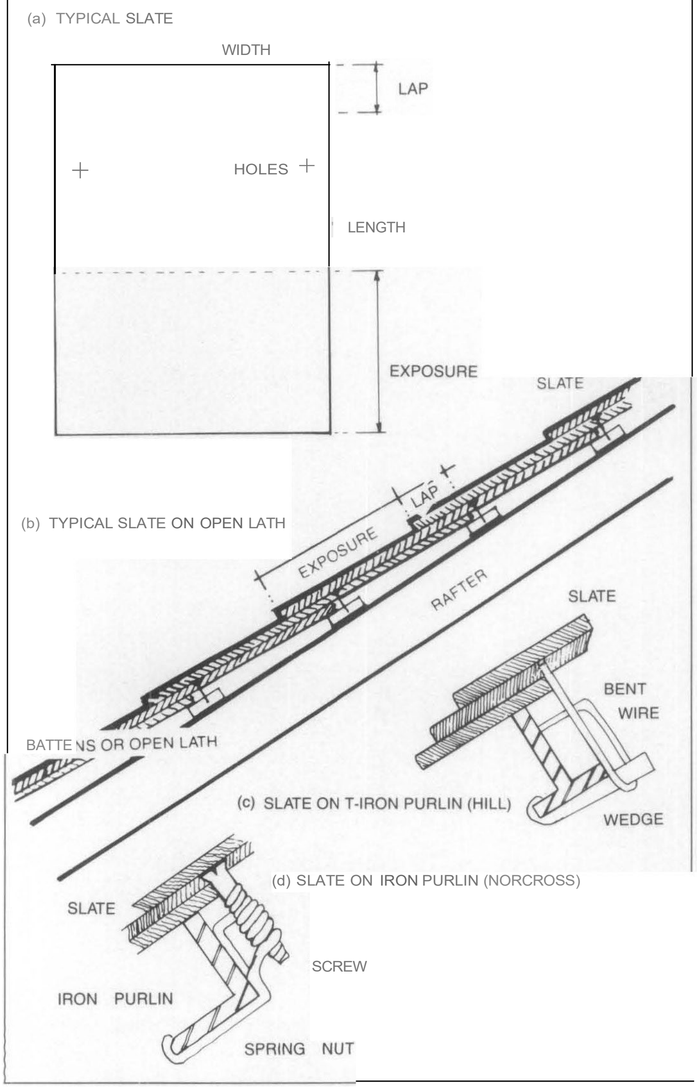


Figure 10. (a) shows a typical slate; exposure may be calculated btj subtracting the headlap from the total length of the slate and dividing btj two. Slates were typically nailed either lo closed wooden decking or to open laths (b). In the late 19th century, with the concem for fireproof construction, special fasteners were developed to secure slate to steel purlins (c) 1881 patent to James G. Hill; (d) 1889 patent to Orlando W Norcross).

Steel angles substituted for the wood battens in fireproof construction. The slates were secured using wire wrapped around the steel angle, where it was twisted-off tight. Alternately, any of a variety of special fasteners patented over the years could have been used to attach the slate to the steel angle (Figure 10). On roofs with concrete decks, slates were typically nailed to wood nailing strips embedded in the concrete.

Beginning in the late nineteenth century, asphalt saturated roofing felt was installed atop solid wood sheathing. The felt provided a temporary, watertight roof until the slate could be installed atop it. Felt also served to cushion the slates, exclude wind driven rain and dust, and ease slight unevenness between the sheathing boards.

Slate was typically laid in horizontal courses starting at the eaves with a standard headlap of 3" (7.5 cm) (Figure 10). Headlap was generally reduced to 2" (5 cm) on Mansard roofs and on particularly steep slopes with more than 20" (50 cm) of rise per 12" (30 cm) of run. Conversely, headlap was increased to 4" (10 cm) or more on low pitched roofs with a rise of 8" (20 cm) or less per 12" (30 cm) of horizontal run. The minimum roof slope necessary for a slate roof was 4" (10 cm) of rise per 12" (30 cm) of run.

Where Does Slate Come From?

Slate is a fine grained, crystalline rock derived from sediments of clay and fine silt which were deposited on ancient sea bottoms. Superimposed materials gradually consolidated the sedimentary particles into bedded deposits of shale. Mountain building forces subsequently folded, crumpled, and compressed the shale. At the same time, intense heat and pressure changed the original clays into new minerals such as mica, chlorite, and quartz. By such mechanical and chemical processes bedded clays were transformed, or metamorphosed, into slate, whole

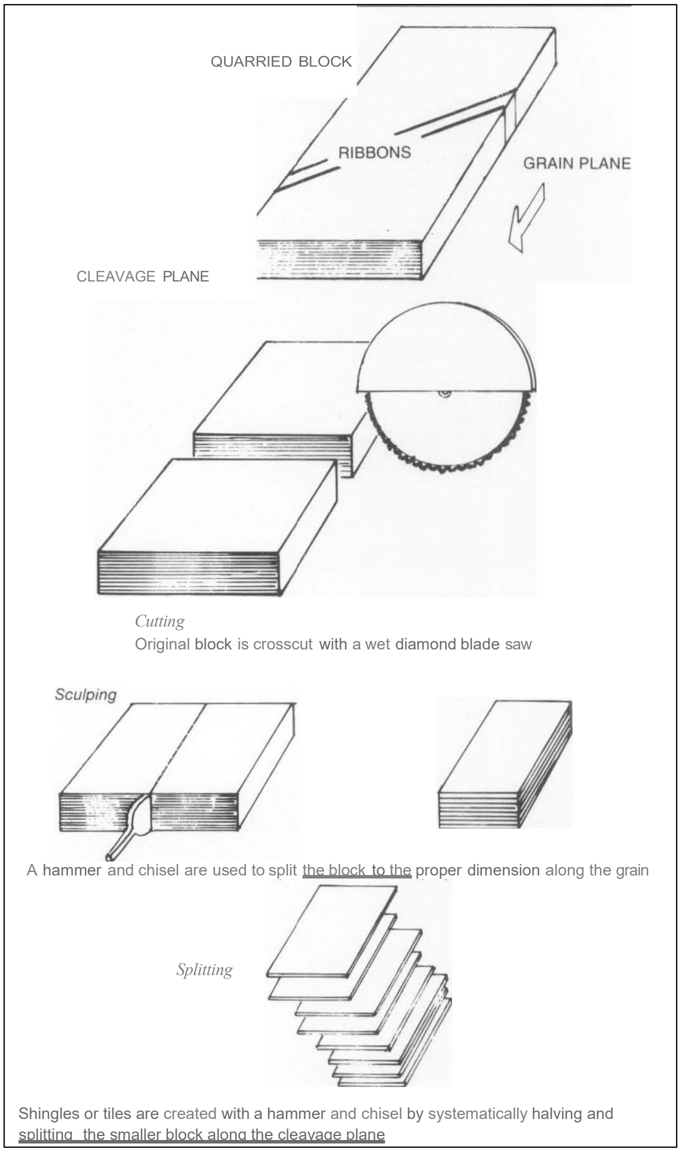


Figure 11. Slate roofing tiles or shingles are still manufactured using traditional methods brought to this countn; by Welsh immigrants in the nineteenth century. Shown above are the first 3 steps of cutting, sculping and splitting. Once the rough slate tile is made it is trimmed and punched for holes.

geologic ages being consumed in the process. Slates vary in composition, structure, and durability because the degree to which their determinant minerals have been altered is neither uniform nor consistent.

The adaptation of slate for roofing purposes is inextricably linked to its genesis. The manufacturing processes of nature have endowed slate with certain commercially amenable properties which have had a profound influence on the methods by which slate is quarried and fabricated (Figure 11), as well as its suitability for use as a roofing tile.

Slate roofing tiles are still manufactured by hand using traditional methods in a five step process: cutting, sculping, splitting, trimming, and hole punching. In the manufacturing process, large, irregular blocks taken from the quarry are first cut with a saw across the grain in sections slightly longer than the length of the finished roofing slate. The blocks are next sculped, or split along the grain of the slate, to widths slightly larger than the widths of finished slates. Sculping is generally accomplished with a mallet and a broad-faced chisel, although some types of slate must be cut along their grain. In the splitting area, the slightly oversized blocks are split along their cleavage planes to the desired shingle thickness. The splitter's tools consist of a wooden mallet and two splitting chisels used for prying the block into halves and repeating this process until the desired thinness is reached (Figure 12). The last two steps involve trimming the tile to the desired size and then punching two nail holes toward the top of the slate using a formula based on the size and exposure of the slate.

Minerals, the building blocks of rocks, through their characteristic crystalline structures define the physical properties of the rocks which they compose. Slate consists of minerals that are stable and resistant to weathering and is, therefore, generally of high strength, low porosity, and low absorption. The low porosity and low absorption of slate mitigate the deleterious action of frost on the stone and make it well adapted for roofing purposes. The two most important structural properties of slate are cleavage and grain.

The metamorphic processes of geologic change necessary to produce slate are dependent upon movements in the earth's crust and the heat and pressure generated thereby. For this reason, slate is found only in certain mountainous regions. The most economically important slate deposits in this country lie in the Mid-Atlantic and Northeastern states transversed by or bordering on the Appalachian Mountain chain. Variations in local chemistry and conditions under which the slate was formed have

Figure 12. In the splitting area, the slightly oversized blocks are split along their cleavage planes. The splitter's tools consist of a wooden mallet and splitting chisels. The process of halving the split portions is repeated until a tile or shingle of appropriate thinness is obtained.

Figure 13. Paper thin lamination can be seen flaking off of this weathered, 120 year piece of Pennsylvania Hard-Vein slate.

produced a wide range of colors and qualities and ultimately determine the character of the slate found in these areas.

Slate is available in a variety of colors. The most common are grey, blue-grey, black, various shades of green, deep purple, brick red, and mottled varieties. The presence of carbonaceous matter, derived from the decay of marine organisms on ancient sea floors, gives rise to the black colored slates. Compounds of iron generate the red, purple, and green colored slates.

Generally, the slates of Maine, Virginia, and the Peach Bottom district of York County, Pennsylvania are deep blue-black in color. Those of Virginia have a distinctive lustrous appearance as well due to their high mica content. The slates of Lehigh and Northampton Counties, Pennsylvania, are grayish-black in color. Green, red, purple, and mottled slates derive from the New York-Vermont district. The slate producing region of New York, which centers around Granville and Middle Granville, is particularly important because it contains one of the few commercial deposits of red slate in the world.

Slates are also classified as fading or unfading according to their color stability. Fading slates change to new shades or may streak within a short time after exposure to the atmosphere due to the presence of fine-grained disseminated pyrite. For example, the "weathering green" or "sea-green" slates of New York and Vermont are grayish green when freshly quarried. Upon exposure, from 20% to 60% of the slates typically weather to soft tones of orange-brown, buff, and gray while the others retain their original shade. Slates designated as unfading maintain their original colors for many years.

Color permanence generally provides no indication of the durability of slate. Rather, time has shown that the Vermont and New York slates will last about 125 years; Buckingham Virginia slates 175 years or more; and Pennsylvania Soft-Vein slates in excess of 60 years; Pennsylvania Hard-Vein slates and Peach Bottom slates, neither of which is still quarried, had life spans of roughly 100 and at least 200 years respectively. The life spans provided should be used only as a general guide in determining whether or not an existing slate roof is nearing the end of its serviceable life.

Ribbons are visible as bands on the cleavage face of slate and represent geologic periods during which greater amounts of carbonaceous matter, calcite, or coarse quartz particles were present in the sediment from which the slate was formed. Ribbons typically weather more and were most common in Pennsylvania slate quarries. As they were not as durable as clear slates, ribbon slate is no longer manufactured for roofing purposes. Mottled grey slates from Vermont are the closest match for Pennsylvania ribbon slate available today.

In recent years, slates from China, Africa, Spain and other countries have begun to be imported into the United States, primarily for distribution on the West Coast. The use of imported slates should probably be limited to new construction since their colors and textures often do not match those of U.S. slate.

Deterioration of Slate and Slate Roofs

The durability of a slate roof depends primarily on four factors: the physical and mineralogical properties of the slate; the way in which it is fabricated; installation techniques employed; and, regular and timely maintenance. The first three of these factors are examined below. The maintenance and repair of slate roofs are discussed in later sections of this Brief.

The natural weathering of roofing slate manifests itself as a slow process of chipping and scaling along the cleavage planes (Figure 13). Paper thin laminations flake off the surface of the slate and the slate becomes soft and spongy as the inner layers begin to come apart, or delaminate. The nature of the sound given off by a slate when tapped with one's knuckles or slating hammer is a fair indication of its condition. High-grade slate, when poised upon the fingertips and struck, will emit a clear, solid sound. Severely weathered slates are much less sonorous, and give off a dull thud when tapped.

The weathering of slate is chiefly due to mineral impurities (primarily calcite and iron sulfides) in the slate which, in concert with alternating wet/dry and hot/cold cycles, react to form gypsum (Figure 14). Because gypsum

Figure 14. The white blotches on these Pennsylvania Soft-Vein slates indicate areas where gypsum is leaching out onto the surface of the slates.

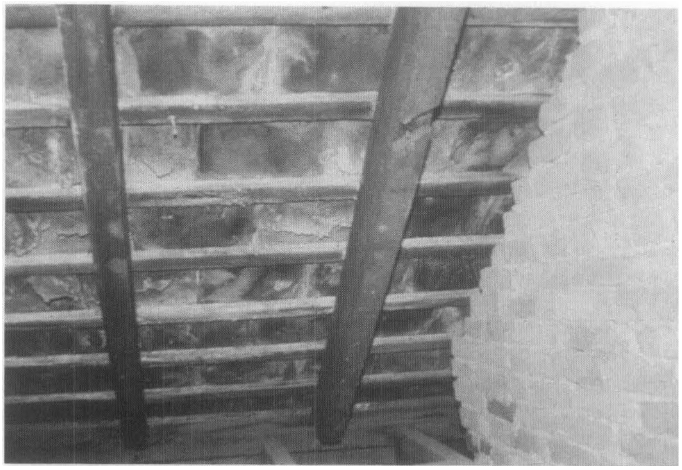


Figure 15. View of the underside of slates laid on open sheathing shows that delamination and flaking is just as bad or worse on the underside of slates as on the exposed surface. This is why most slates cannot be flipped over for reuse.

molecules take up about twice as much volume as calcite molecules, internal stresses result from the reaction, causing the slate to delaminate. This type of deterioration is as prominent on the underside of the roof as on the exposed surface due to the leaching and subsequent concentration of gypsum in this area (Figure 15). Consequently, deteriorated roofing slates typically cannot be flipped over and re-used.

The chemical and physical changes which accompany slate weathering cause an increase in absorption and a decrease in both strength and toughness. The tendency of old, weathered slates to absorb and hold moisture can lead to rot in underlying areas of wood sheathing. Such rot can go undetected for long periods of time since, often, there is no accompanying leak. Due to their loss of strength, weathered slates are more prone to breakage, loss of corners, and cracking.

Slates with low calcite content tend to weather slowly. Dense slates, with low porosity, likewise decay slower than slates with equal calcite, but with a greater porosity. The pitch of a roof can also affect its longevity. The steeper the pitch, the longer the slate can be expected to last as water will run off faster and will be less likely to be drawn under the slates by capillary action or driven under by wind forces. Spires and the steep slopes of Mansard roofs often retain their original slate long after other portions of the roof have been replaced. Areas of a roof subject to concentrated water flows and ice damming, such as along eaves and valleys, also tend to deteriorate more rapidly than other areas of the roof.

Mechanical agents, such as thermal expansion and contraction and the action of frost, are subordinate in the weathering of slate, coming into play only after the slate has been materially altered from its original state by the chemical transformation of calcite to gypsum. The more rapid deterioration of slates found on roof slopes with the most severe exposure to the sun, wind, and rain (typically, but not always, a southern exposure) may be attributable to the combined result of the deleterious effects of impurities in the slate and mechanical agents. Atmospheric acids produce only negligible deterioration in roofing slate.

It is difficult to assess the procedures by which a piece of slate has been fabricated without visiting the quarry and observing the process first hand. The location and size of nail holes, grain orientation, the condition of corners, and the number of broken pieces are all things which may be observed in a shipment of slate to judge the quality of its fabrication. Nail holes should be clean and with a shallow countersink on the face of the slate for the nail head; grain oriented along the length of the slate; and, corners left whole. An allowance for 10% breakage in shipment is typically provided for by the quarry.

Installation problems often involve the improper nailing and lapping of slates. The nailing of slates differs from that of other roofing materials. Slate nails should not be driven tight as is the case with asphalt and wood shingles. Rather, they should be set such that the slate is permitted to hang freely on the nail shank. Nails driven too far will crack the slate and those left projecting will puncture the overlying slate (Figure 16). Nail heads left exposed accelerate roof deterioration by providing a point for water entry. Non-ferrous slater's nails, such as solid copper or stainless steel, should always be used since plain steel and galvanized nails will usually rust out long before the slate itself begins to deteriorate. The rusting of nineteenth century cut nails is a common cause of slate loss on historic roofs.

When joints are improperly broken (i.e., when slates lap the joints in the course below by less than 3" (7.5 cm]), it is possible for water to pass between the joints, through the nail holes and ultimately to the underlying felt, where it will cause deterioration and leaks to develop. Insufficient headlap can also result in leaks as water entering the joints between slates may have a greater tendency to be wind blown beyond the heads of the slates in the course below.

Occasionally, individual slates are damaged. This may be caused by falling tree limbs, ice dams in gutters, valleys, and chimney crickets, the weight of a workman walking on the roof, or a naturally occurring fault in the slate unit. Whatever the form of damage, if it is caught soon enough, the roof can usually be repaired or selectively replaced and deterioration mitigated.

The ability to lay slate properly so as to produce a water-tight and aesthetically pleasing roof requires training, much practice, and the right tools (Figure 17). The

Figure 16. Detail view of a slate which has been punctured by the head of a nail used to secure the slate in the course below. Likely, the nail was not hammered in far enough when originally installed.

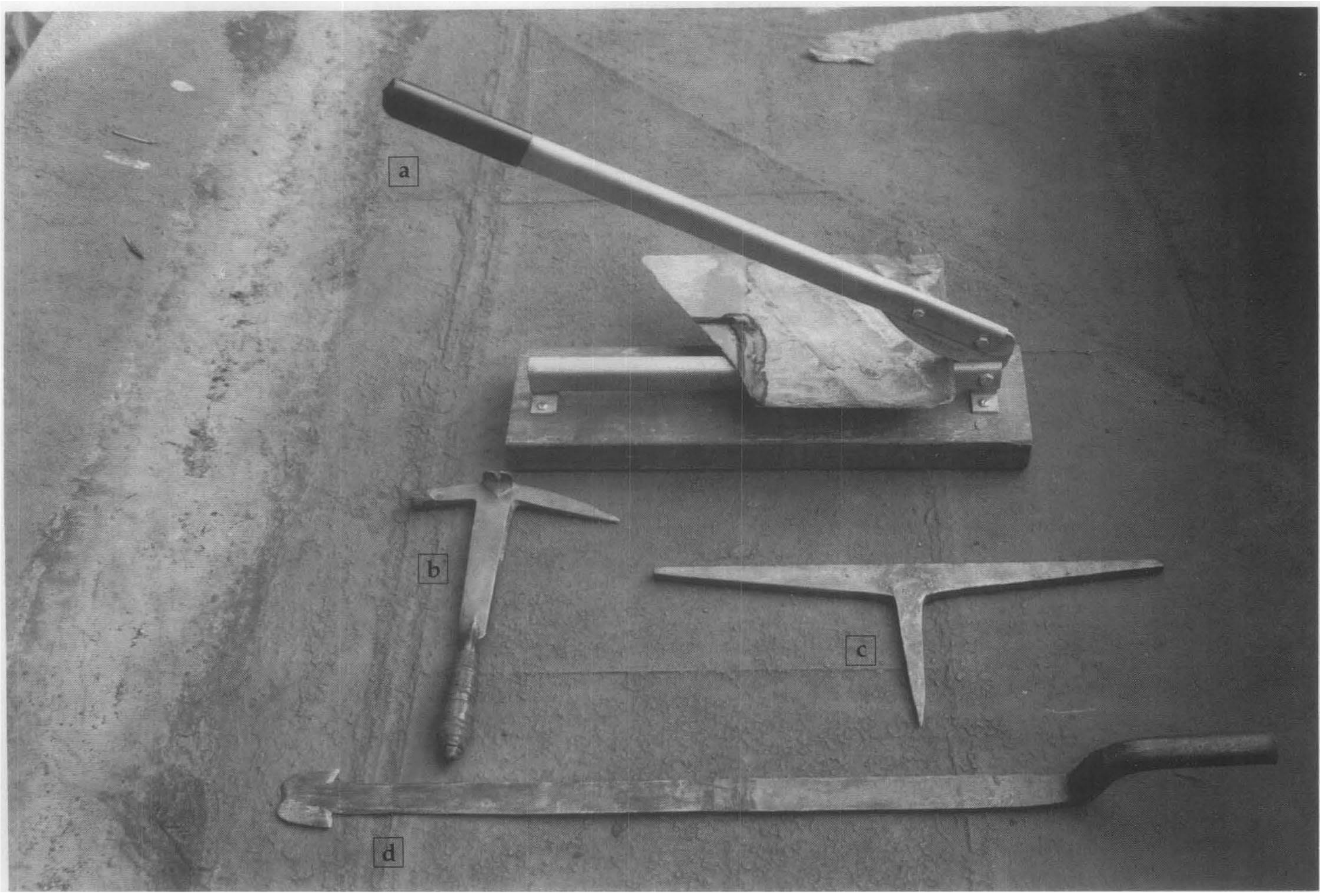


Figure 17. Slater's Tools. The cutter (a) is used to trim slate edges; the slate hammer (b) is used for hammering nails, trimming, cutting and punching holes in slates, and pulling roofing nails; the steak (c) is a T-shaped piece of iron upon which the slater places the edge of a slate to be trimmed; and the ripper (d) is slid under the slates to pull out the nails.

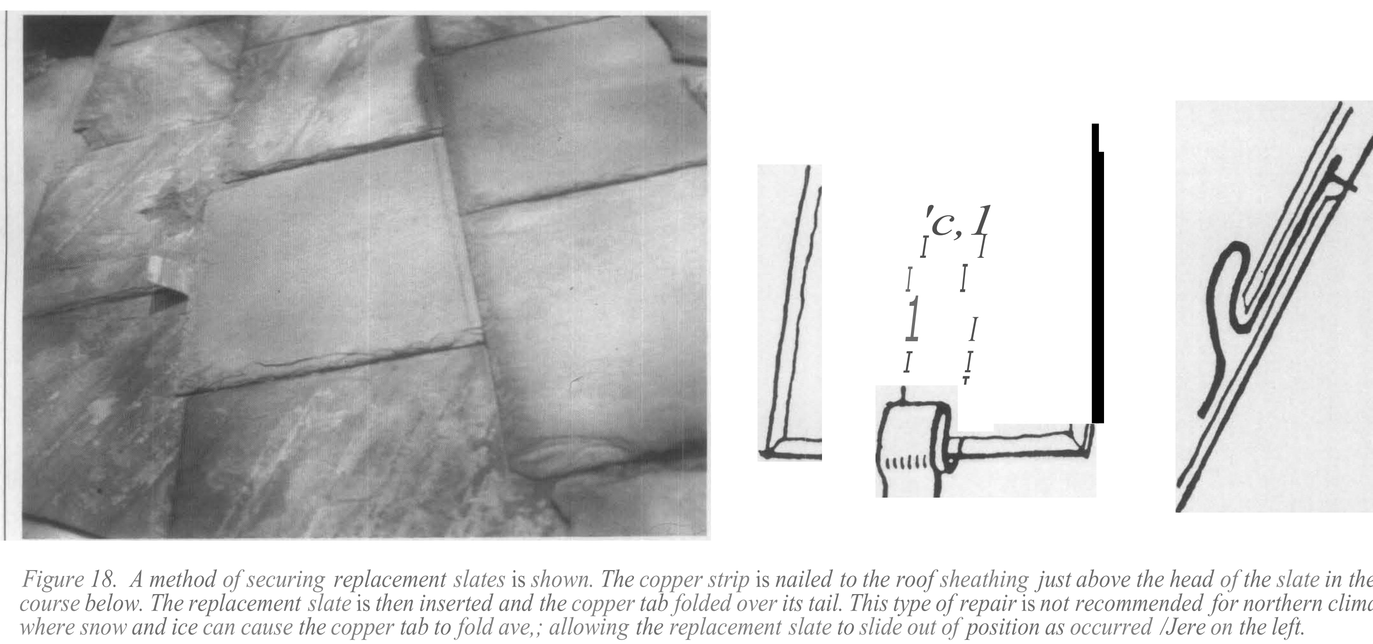
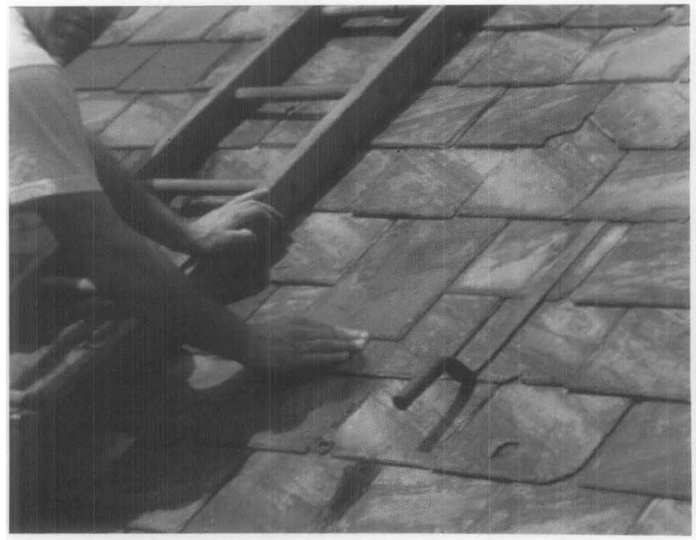


Figure 18. A method of securing replacement slates is shown. The copper strip is nailed to the roof sheathing just above the head of the slate in the course below. The replacement slate is then inserted and the copper tab folded over its tail. This type of repair is not recommended for northern climates where snow and ice can cause the copper tab to fold ave,; allowing the replacement slate to slide out of position as occurred /Jere on the left.

Repair Sequence

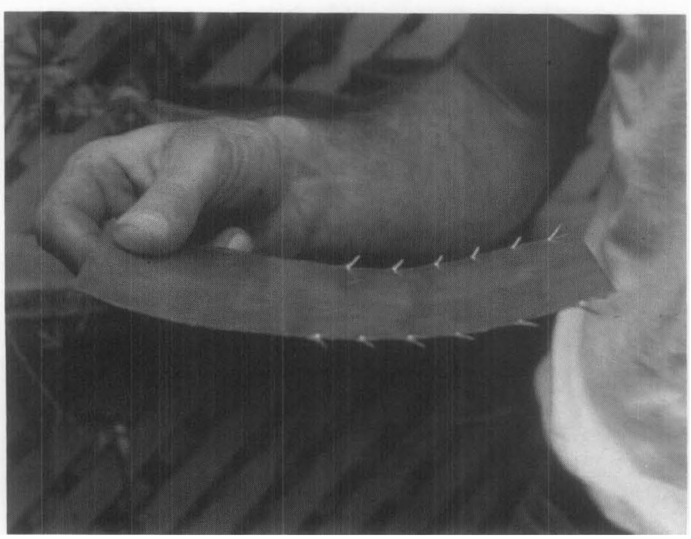
(a) A ripper is used to remove the nails from the deteriorated slate.



(b) A replacement slate is slid into place.

(c) A new slate is secured in place with a copper nail.

(d) A copper bib is formed to protect the newly created nail hole.



(e) The bib is cut along its edges and bent into a concave shape to create a friction fit.

(f) The slate hammer is used to push the bib in place over tile nail head.

Figure 19. Above is a repair sequence for replacing a damaged slate.

The installation and repair of slate roofs should be entrusted only to experienced slaters.

Repairing Slate Roofs

Broken, cracked, and missing slates should be repaired promptly by an experienced slater in order to prevent water damage to interior finishes, accelerated deterioration of the roof and roof sheathing, and possible structural degradation to framing members (Figures 18 and 19).

The damaged slate is first removed by cutting or pulling out its nails with a ripper. If steel cut nails, rather than copper nails, were used in laying the roof, adjacent slates may be inadvertently damaged or displaced in the ripping process, and these, too, will have to be repaired. If the slate does not slide out by itself, the pointed end of the slate hammer can be punched into the slate and the slate dragged out. A new slate, or salvaged slate, which should match the size, shape, texture, and weathered color of the old slate, is then slid into place and held in position by one nail inserted through the vertical joint between the slates in the course above and approximately one inch below the tail of the slate two courses above. To prevent water penetration through the newly created nail hole, a piece of copper with a friction fit, measuring roughly 3" (7.5 cm) in width and 8" (20 cm) in length, is slid lengthwise under the joint between the two slates located directly above the new slate and over the nail. Alternate methods for securing the replacement slate include the use of metal hooks, clips, and straps that are bent over the tail end of the slate. The application of roofing mastic or sealants to damaged slates should *not* be considered a viable repair alternative because these materials, though effective at first, will eventually harden and crack, thereby allowing water to enter (Figure 20). Mastic also makes future repairs more difficult to execute, is unsightly, and, when applied to metal flashings, accelerates their corrosion.

When two or more broken slates lie adjacent to each other in the same course, or when replacing leaky valley flashings, it is best to form pyramids (i.e., to remove a diminishing number of slates from higher courses) to keep the number of bibs required to a minimum. When re-installing the slates, only the top slate in each pyramid will need a bib. Slates along the sides of the pyramid will receive two nails, one above the other, along the upper part of its exposed edge.

When many slates must be removed to effect a repair, the sheathing should be checked for rotted areas and projecting nails. Plywood is generally not a good replacement material for deteriorated wood sheathing due to the relative difficulty of driving a nail through it (the bounce produced can loosen adjacent slates). Instead, new wood boards of similar width and thickness to those being replaced should be used. Because the nominal thickness of today's dimension lumber is slightly thinner than that produced in the past, it may be necessary to shim the new wood boards so that they lie flush with the top surface of adjacent existing sheathing boards. Pressure treated lumber is not recommended due to its tendency to shrink. This can cause the slates to crack and become displaced.

To permit proper re-laying of the slate, the new roof sheathing must be of smooth and solid construction. At least two nails should be placed through the new boards at every rafter and joints between the ends of the boards should occur over rafters. Insufficient nailing will cause the boards to be springy, making nailing of the slates difficult and causing adjacent slates to loosen in the process. Unevenness in the sheathing will show in the finished roof surface and may cause premature cracking of the slate. Roof sheathing in valleys and along hips, ridges, and eaves may be covered with waterproof membrane underlayment rather than roofing felt for added protection against leakage.

In emergency situations, such as when severe hurricanes or tornadoes blow numerous slates off the roof, a temporary roof covering should be installed immediately after the storm to prevent further water damage to the interior of the building and to permit the drying out process to begin. Heavy gauge plastic and vinyl tarpaulins are often used for this purpose, though they are difficult to secure in place and can be blown off in high winds. Roll roofing, carefully stitched in to areas of the remaining roof, is a somewhat more functional solution that will allow sufficient time to document the existing roof conditions, plan repairs, and order materials (Figure 21).

Slate roof repair is viable for localized problems and damaged roofs with reasonably long serviceable lives remaining. If 20% or more of the slates on a roof or roof slope are broken, cracked, missing, or sliding out of position, it is usually less expensive to replace the roof than to execute individual repairs. This is especially true of older roofs nearing the end of their serviceable lives

Figure 20. This roof has been poorly repaired numerous times in the past. The installation of mastic to seal out moisture has only exacerbated the problem. A timely repair and good maintenance could have extended the life of this roof.

Figure 21. As a result of hurricanes and other disasters, it may be necessanJ to tempomrily stabilize a roof until materials can be obtained and a qualified rooftns. contractor hired. Heauy roofing felt was stitched into this slate roof to stop moisture penetration until matching slate was obtained for repair. Significant slate roofs should not be stripped off and replaced with asphalt shingles. Photograph courtesy of the National Park Service.

because even the most experienced slater will likely damage additional slates while attempting repairs. Depending on the age of the slate, its expected serviceable life, and the cause(s) of deterioration, it may or may not be cost effective to salvage slates. Where deteriorated nails or flashings are the cause of the roof failure, salvage of at least some slates should be possible for use in repairs. When salvaging slates, each must be sounded to discover cracks and faults and the degree to which it has weathered. It is usually wise to salvage slates when only a portion of the roof is to be replaced. In this way, the salvaged slates may be used for future repairs to the remaining sections of the roof.

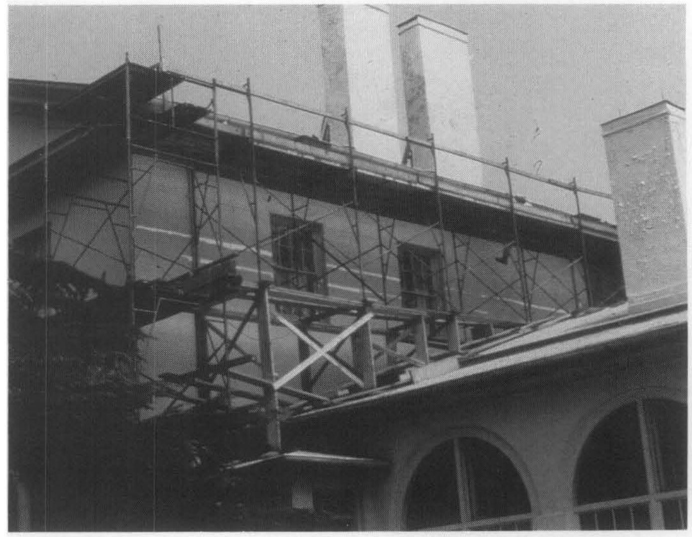
The Replacement of Deteriorated Roofs

Historic slate roofs should be repaired rather than replaced whenever possible. Before replacing a slate roof, check for isolated damage, corroded and worn flashings, leaky gutters, poor ventilation in the attic, and other possible sources of moisture. All too often slate roofs are mistakenly replaced when, in fact, they could have been effectively repaired. Deciding whether an historic slate roof should be repaired or replaced can be difficult and each roof must be judged separately (see guidance in shaded box on page 16).

If repair is not possible and a new slate roof must be installed, it is important to remember that more than just the replacement of the slate is involved (Figure 22). The old slate should be removed to prevent overloading of the roof timbers. Stripping should be done in sections, with felt installed, to avoid exposing the entire sub-roof to the weather. In the process, rotted wood sheathing should be replaced and the roof timbers checked for signs of stress, including deflection, cracking, and twisting. If such conditions are found, a structural engineer experienced in working with older buildings should be consulted. Other repairs, such as chimney repainting, which may require access to the roof should be completed before the new roof is put on.

Drawings and specifications for a new slate roof should be prepared by a restoration architect, especially if the project is going to be competitively bid or if the roof is particularly complex. Standard specifications, like those published in 1926 by the National Slate Association may be used as a basis for developing specifications appropriate for a particular project. The specifications and drawings should contain all the information necessary to replicate the original appearance of the roof as closely as possible. Certain changes may have to be accepted, however, since several types of slate once prominent in this country, such as ribbon slate, are no longer quarried. It is wise to

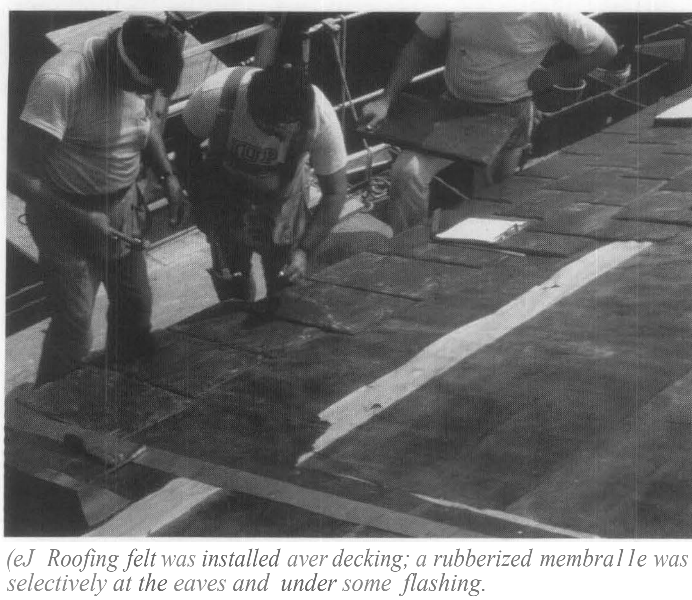
(a) Historic documentation was necessary to determine the historic configuration.



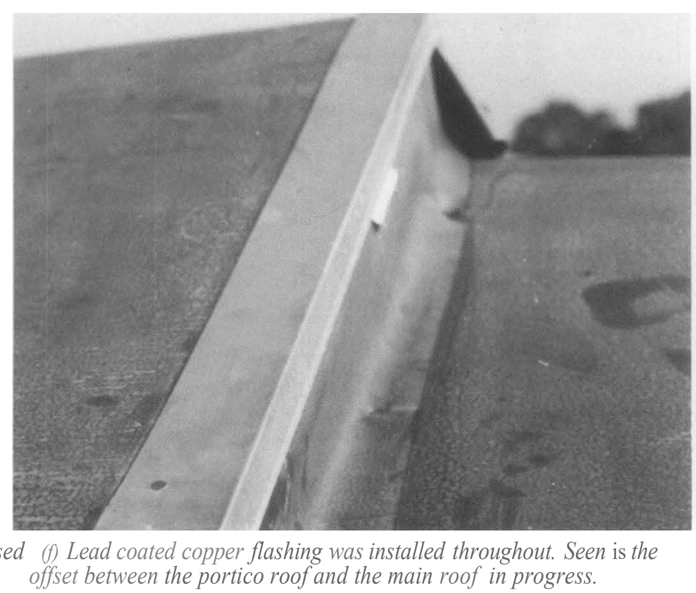
(b) Scaffolding was installed early to document existing conditions to determine extent of work.

(c) Slate was removed in sections to avoid stress on timber framing.

(d) Deteriorated sheathing was replaced and rafter tails were reinforced.

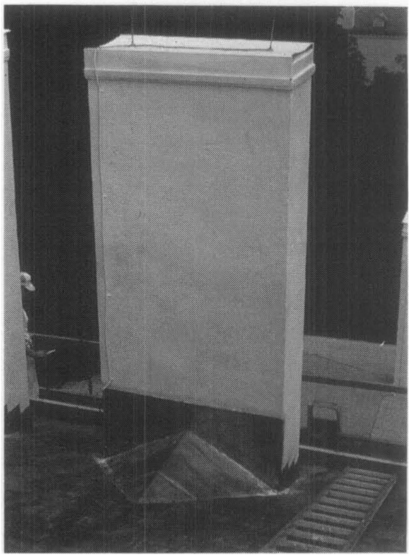


(eJ Roofing felt was installed aver decking; a rubberized membra1 1e was used selectively at the eaves and under some flashing.

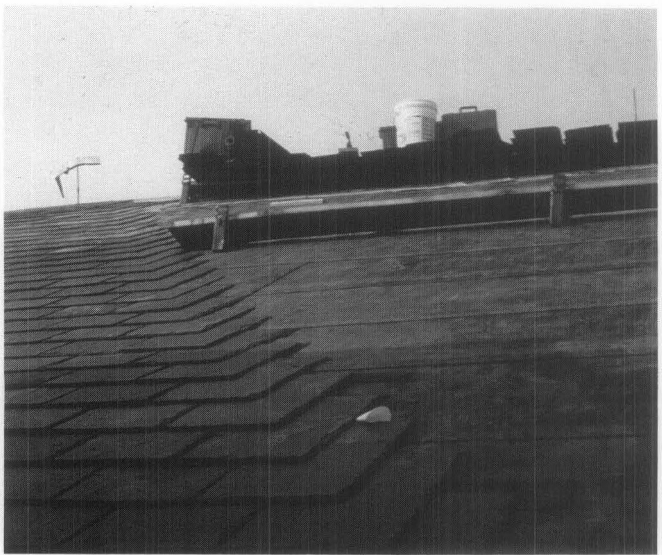


(f) Lead coated copper flashing was installed throughout. Seen is the offset between the portico roof and the main roof in progress.

Figure 22. Installing a new roof involves more than just slate. Above is a sequence of views of the roof replacement at Arlington House. Photographs courtesy of the National Park Service. *(Sequence continued 011 page 14.)*



(g) MasonnJ chimneys were repaired and metal crickets were fabricated at the chimnetJS.



(h) This installation pattern allows the slates to be laid in courses leaving a temporary path of travel to avoid stepping on installed slates.

(i) Although the gutters and snow boards were the last elements installed, their support brackets were installed as the slates were laid.

anticipate the replacement of older roofs so that proper planning can be undertaken and financial resources set aside, thereby, reducing the likelihood of rash last minute decisions.

Roofing slate is sold by the square in the United States. One square is enough to cover 100 square feet (13.3 square meters) of plain roof surface when laid with a standard headlap of 3" (7.5cm). When ordering slate, considerable lead time should be allowed as delivery may take anywhere from 4 to 12 weeks and even as long as 1 year for special orders. Orders for random widths of a particular slate can generally be filled more quickly than orders for fixed widths. Once on site, slates should be stored on edge, under cover on pallets.

A roof and its associated flashings, gutters, and downspouts function as a system to shed water. Material choices should be made with this in mind. For example, use a single type of metal for all flashings and the rainwater conductor system to avoid galvanic action. Choose materials with life spans comparable to that of the slate, such as non-ferrous nails. Use heavier gauge flashings or sacrificial flashings in areas that are difficult to access or subject to concentrated water flows.

Flashings are the weakest point in any roof. Given the permanence of slate, it is poor economy to use anything but the most durable of metals and the best workmanship for installing flashings. Copper is one of the best flashing materials, and along with terne, is most often associated with historic slate roofs. Copper is extremely durable, easily worked and soldered, and requires little maintenance. Sixteen-ounce copper sheet is the minimum weight recommended for flashings. Lighter weights will not endure the erosive action of dust and grit carried over the roof by rain water. Heavier weight, 20 oz. (565 grams) or 24 oz. (680 grams), copper should be used in gutters, valleys, and areas with limited accessibility. Lead coated copper has properties similar to copper and is even more durable due to its additional lead coating. Lead coated copper is often used in restoration work.

Terne is a less desirable flashing material since it must be painted periodically. Terne coated stainless steel (TCS) is a modern-day substitute for terne. Although more difficult to work than terne, TCS will not corrode if left unpainted; a great advantage, especially in areas that are difficult to access.

Once a metal is chosen, it is important to use it throughout for all flashings, gutters, downspouts, and metal roofs. Mixing of dissimilar metals can lead to rapid corrosion of the more electronegative metal by galvanic action. Where flashings turn up a vertical surface, they should be covered with a cap flashing. Slates which overlap metal flashings should be nailed in such a manner as to avoid puncturing the metal. This may be accomplished by punching a second hole about 2" (5cm) above the existing hole on the side of the slate not overlapping the metal flashing. It is important that holes be punched from the back side of the slate. In this way, a shallow countersink is created on the face of the slate in which the head of the nail may sit.

◄ *Continuation of the roof repair sequence of Arlington House from page* 13.

Figure 23. Slate roofs should not be walked on if at all possible. For large projects, lifts can be used to inspect roofs periodically to assess 111aintena11ce needs. Photograph courtesy of the National Park Service.

The use of artificial, mineral fiber slate is not recommended for restoration work since its rigid appearance is that of a man-made material and not one of nature. Artificial slates may also have a tendency to fade over time. And, although artificial slate costs less than natural slate, the total initial cost of an artificial slate roof is only marginally less than a natural slate roof. This is because all the other costs associated with replacing a slate roof, such as the cost of labor, flashings, and tearing-off the old roof, are equal in both cases. Over the long term, natural slate tends to be a better investment because several artificial slate roofs will have to be installed during the life span of one natural slate roof.

Clear roof expanses can be covered by an experienced slater and one helper at the rate of about two to three squares per day. More complex roofs and the presence of chimneys, dormers, and valleys can bring this rate down to below one square per day. One square per day is a good average rate to use in figuring how long a job will take to complete. This takes into account the installation of flashings and gutters and the set-up and break-down of scaffolding. Tear-off of the existing roof will require additional time.

Maintenance

Given the relatively high initial cost of installing a new slate roof, it pays to inspect its overall condition annually and after severe storms. For safety reasons, it is recommended that building owners and maintenance personnel carry out roof surveys from the ground using binoculars or from a cherry picker (Figure 23). Cracked, broken, misaligned, and missing slates and the degree to which delamination has occurred should be noted, along with failed flashings (pin holes, open seams, loose and misaligned elements, etc.) and broken or clogged downspouts. A roof plan or sketch and a camera can aid in recording problems and discussing them with contractors. In the attic, wood rafters and sheathing should be checked for water stains and rot. Critical areas are typically near the roof plate and at the intersection of roof planes, such as at valleys and hips. Regular maintenance should include cleaning gutters at least twice during the fall and once in early spring, and replacing damaged slates promptly. Every five to seven years inspections should be conducted by professionals experienced in working with slate and steep slopes. Good record keeping, in the form of a log book and the systematic filing of all bills and samples, can help in piecing together a roof's repair history and is an important part of maintenance.

As part of regular maintenance, an attempt should be made to keep foot traffic off the roof. If maintenance personnel, chimney sweeps, painters, or others must walk on the roof, it is recommended that ladders be hooked over the ridge and that the workmen walk on the ladders to better distribute their weight. If slates are to be walked on, it is best to wear soft soled shoes and to step on the lower-middle of the exposed portion of the slate unit.

Conclusion

Slate roofs are a critical design feature of many historic buildings that cannot be duplicated using substitute materials (Figure 24). Slate roofs can, and should be, maintained and repaired to effectively extend their serviceable lives. When replacement is necessary, details contributing to the appearance of the roof should be retained. High quality slate is still available from reputable quarries and, while a significant investment, can be a cost effective solution over the long term.

Further Reading

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Repair/Replacement Guideline

The following guideline is **provided to assist** in the **repair/replace decision making process:**

1. **Consider the age and condition** of the roof versus **its expected serviceable life given the type of** slate **employed.**

2. **Calculate the number of damaged and missing slates. Is the number less than about 20%?** Is **the roof generally** in **good condition?** If so, **the** roof **should be evaluated for repair rather than replacement. Also, keep** in **mind that the older** a **roof becomes, the more maintenance** it will **likely require.**

3. **Determine** if **there are active leaks and what** their **source may be. Do not assume the slates are leaking. Gutters, valleys and flashings are more likely candidates. "False leaks" can be caused by moisture condensation** in **the attic due to improper ventilation.**

4. **Check the** roof **rafters and sheathing for moisture stains. Poke an awl into the wood to determine** if it **is rotted. Remember that very old, delaminating slates will hold** moisture **and cause** adjacent wood **members to deteriorate even** if **there are no apparent leaks.**

5. **Are many slates sliding out of position?** If so, it **may be that ferrous metal fasteners were used and that these are corroding, while the slates are** still in **good condition. Salvage the slates and re-lay them on the roof.** If **the slates have worn around** the **nails holes, it may be necessary to punch new holes before re-laying them.**

6. **Consider the condition of the roof's flashings. Because slate** is **so durable, metal flashings often wear out before the slate does. Examine the flashings carefully. Even the smallest pinhole** can **permit large quantities of water to enter the** building.

7. Is **the deterioration of the slate uniform? Often** this is **not the case.** It **may be that only one slope needs replacement and the other slopes** can be **repaired.** In **this way, the cost** of **replacement can be spread over many years.**

8. **Press down hard on the slates with your hand. Sound slates will be unaffected by the pressure. Deteriorated slates will feel brittle and will crack. Tap on slates that have fallen out or been removed. A full, deep sound indicates a slate in** good **condition, while a dull thud suggests a slate** in **poor condition.**

9. **Are new slates readily available? Even** if **replacement** is **determined** to **be necessary, the existing** roof **may have** to be **repaired** to allow time for **documentation and the ordering** of **appropriate replacement slates.**

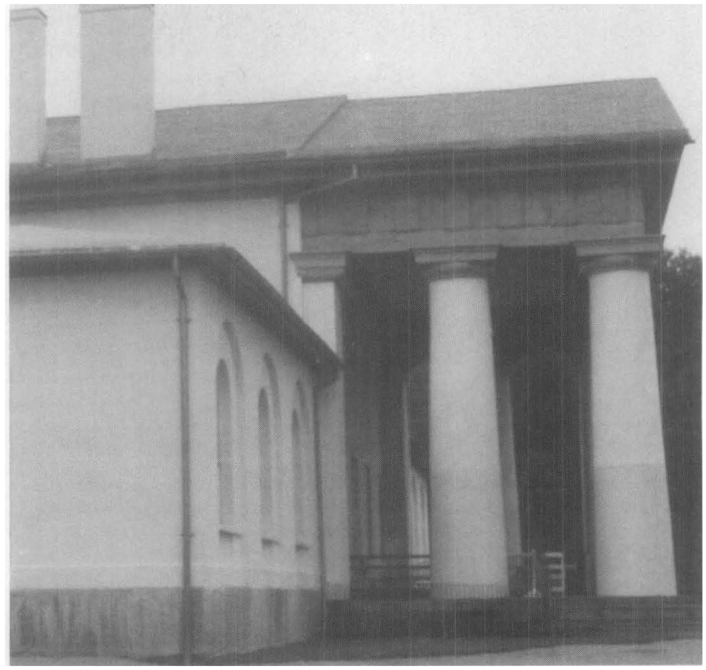

Figure 24. Although slate replacement roofs are expensive, the superiorihJ of materials and craftsmanship will give years of continued service. If amortized over the life of the roof, the replacement cost can be very reasonable. Photograph courtesy of the National Park Service.

Note: measurements in this publication are given in both U.S. Customary System and International (Metric) System for comparative purposes. Metric conversions are in some cases approximate and should not be relied upon in preparing technical specifications.

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Sharon C. **Park,** AIA, Senior Historical Architect, Preservation Assistance Division, National Park Service, is credited with directing the development of this publication and with its technical editorship. This publication has been prepared pursuant to the National Preservation Act of 1966, as amended, which directs the Secretary of the Interior to develop and make available information concerning historic properties. Comments on the usefulness of this publication may be directed to 1-1. Ward Jandl, Chief, Technical Preservation Services Branch, Preservation Assistance Division, National Park Service, P.O. Box 37127, Washington, D.C. 20013-7127. Drawings for this publication were prepared by Karin Murr Link. This publication is not copyrighted and can be reproduced without penalty. Normal procedures for credit to the author and the National Park Service are appreciated.

ISSN: 0885-7016 **Spring 1993**

Cover Photograph: A portion of a1l advertisement for Slatington-Bangor Slate Syndicate (Slatington, PA) which appeared in the July 1910 issue of Building Age *(Vol.32 No.7).*

Addendum G - Slate Deposits and Slate Industry, Bulletin No. 275

Slate Deposits and Slate Industry of the United States
Bulletin No. 275

By T. Nelson Dale

With sections by E. C. Eckel, W. F. Hillebrand, and A. T. Coons
Department of the Interior, United States Geological Survey
Government Printing Office, Washington 1906

The slate region in Maine lies about in the center of the State, in the southern part of Piscataquis County, south and southeast of Moosehead Lake and east and west of Sebec Lake, in the towns of Monson, Blanchard, and Brownville. (See map, fig. 4.) Commercial slate occurs also in the town of Forks, Somerset County.

Geological relations.-The slate occurs in a belt consisting largely of slaty rocks, represented by Prof. Charles H. Hitchcock as from 15 to 20 miles wide, and extending from the Kennebec River, between Bingham and Dead Rivers, northeastward to the sources of the Mattawamkeag River. The rocks are probably of early Paleozoic age.

The portion of this belt now yielding commercial slate lies south of the central granitic area of the State. The general structure of this belt is unknown. At North Blanchard on the west the strike of the bedding is N. 25°-39° E. dip 80° ESE. Near Blanchard and the Piscataquis River the strike is N. 55°-60° E. and the dip, 40 feet below the surface, is south-southeast at about 80°; but at the top, owing either to the glacier, which moved here S. 20-40° E., or else to the beginning of an anticline, the dip curves over to the north-northwest. Within 1 1/2 miles southwest of Monson the strike is N. 60° E., dip 90°. At Monson the strike is N. 47°-54° E., dip 80° SE; but at Brownville, 20 miles east of Monson, the strike is N. 78° E., dip 75° NNW. As the grain is horizontal at Brownville and at points 3 1/2 miles west-southwest and 1 1/2 miles southwest of Monson, a nearly vertical pitch may be assumed for the folds, but it is singular that the jointing in the quartzite beds should not furnish any clue to this pitch.

Monson.-In 1904 three quarries were in full operation in the town of Monson. The Monson Pond quarry of the Monson Maine Slate Company; the newly opened one of the Maine Slate Company, of Monson, about 3 1/2 miles west-southwest of the village; and the West Monson quarry, about 1 1/2 miles southwest of it, operated by the Monson Consolidated Slate Company.

At the Monson Pond quarry the following series is exposed: 15 beds of slate, measuring altogether from 79 feet to 93 feet 6 inches, alternating with 15 beds of dark gray or black quartzite ("hards"), measuring altogether from 48 feet 5 inches to 49 feet 5 inches, both slate and quartzite amounting to from about 127 to about 142 feet. The deposit has been prospected for 200 feet farther southeast, but the slate beds r

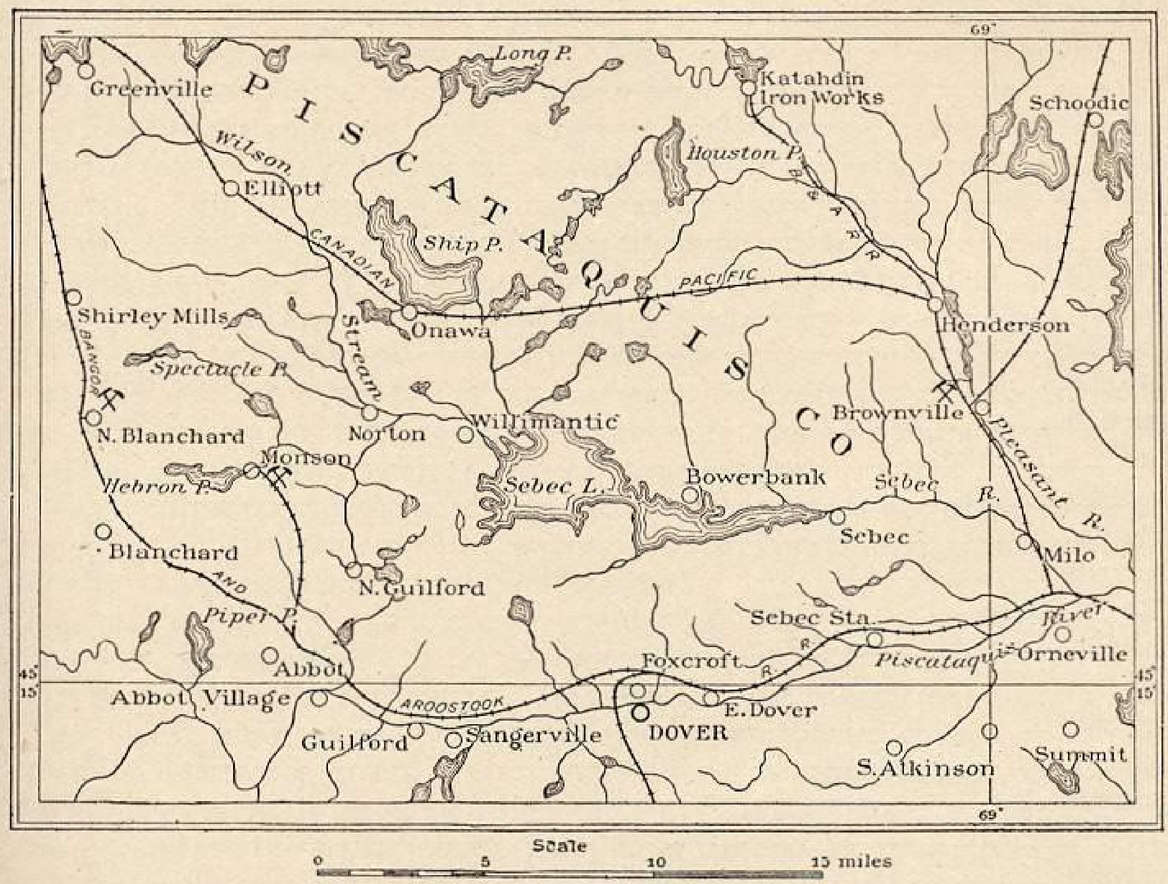


FIG. 4.—Map of slate region in Maine. From Post-route map. The chief quarrying centers are shown by crossed hammers.

ange only from 4 inches to 2 feet in thickness and the quartzite beds vary considerably. The entire thickness explored here thus measures from 327 to 342 feet, and in that thickness there are no indications of duplication. This quartzite is usually very fine grained, and under the microscope proves to be biotite and pyritiferous, with a little magnetite and muscovite and a few grains of zircon.

There is sometimes a transition from the quartzite to the slate, a quartzitic slate intervening. In the above lists such beds are classified as quartzite. The Pond quarry measures about 500 feet along the strike and nearly 10 feet across it at the top, and from 250 to 300 feet in depth. The beds strike N. 47° E., dips 78°-80° SE, without any indication of turning, and the cleavage strikes N. 45° E., dips 90°, thus intersecting the bedding at a very acute angle. The grain strikes N. 45°-50° W. and dips 90°. The slate is traversed at intervals by horizontal joints, which are more frequent in the quartzite-in places from 1 to 4 feet apart. The quartzite also has joints, striking N. 65° W. and dipping 25° N. 65° E., which often are veined with quartz. There are also vertical diagonal joints striking about northwest thus parallel to the grain. The northeast half of the quarry is much broken up by diagonal jointing and faulting, but in the southwest half conditions are more normal, although veining is there more frequent. The difference between the jointing of the quartzite and the slate results from the differences in their rigidity. Their behavior under the same stress must needs have been very dissimilar. The quartz veins traversing the slate sometimes contain biotite, chlorite, and a little calcite. The surface of the formation is glaciated and covered with from 5 to 10 feet of glacial clay and pebbles.

The slate itself is very dark gray, but at the glaciated surface some of the beds have in bright sunlight a very slightly purplish hue. The fifth bed from the north edge is slightly brownish. To the unaided eye both texture and surface are fine, but the latter is almost lusterless. It is slightly carbonaceous or graphitic, and has very little magnetite. The sawn edge shows a little pyrite. No effervescence in cold dilute hydrochloric acid. It is very sonorous.

Under the microscope this slate shows a matrix of muscovite (sericite) with a brilliant aggregate polarization, but there is considerable irregularity in the size of the particles. Quartz fragments measure up to 0.017 by 0.008 mm. Occasional quartz lenses measure 0.094 by 0.047 mm. There are to each square millimeter from 30 to 40 scales of chlorite (interleaved with muscovite, rarely with biotite) measuring up to 0.047 by 0.03 mm. and lying transverse to the cleavage; also about ten scales of biotite to each square millimeter measuring up to 0.086 by 0.02 mm., lying both across and with the cleavage, and longish crystals and lenses of pyrite with their long axes parallel to the grain, numbering about fifty to the square millimeter and measuring up to 0.075 by 0.028 mm. These crystals are mostly distorted cubes, but mingled with them are probably some distorted octahedra of magnetite. Scattered throughout is dark-gray carbonaceous or graphitic matter in extremely minute particles, to which and to the biotite the slate owes its blackness. Finally, a few delicate rutile prisms, 0.001 mm. long, some specks of hematite, and a few tourmaline prisms up to 0.036 by 0.004 mm. No carbonate detected.

The constituents of this slate, arranged in the order of their decreasing abundance, appear to be muscovite (sericite), quartz, chlorite, biotite, pyrite, carbonaceous or graphitic matter, magnetite, rutile, and apatite.

The only available chemical analysis of this slate is that by L. M. Norton,[2] which shows 56.42 per cent of SiO_2, 24.14 per cent of Al_2O_3, and 0.52 per cent of CaO. This small percentage of lime, taken in connection with the occurrence of a little calcite in the quartz veins, points to the presence of an insignificant amount of carbonate, which the microscope fails to detect. But a little of this lime belongs to the apatite. The specific gravity is given by Bailey as 2.851. Tests of the crushing weight and strength made at the Massachusetts Institute of Technology show that a cubic inch of this slate yields to the pressure of 30,425 pounds when applied at right angles to the cleavage, and that a slab, 12 by 6 by 1 inches, supported on knife edges 10 inches apart, breaks under a stress of from 3,950 to 4,000 pounds applied at the center of a steel rod, five-sixteenth inch in diameter, placed between the slate and the pressure block. This gives a modulus of rupture of 9,937; pounds per square inch.

This slate is split to seven thirty-seconds of an inch for roofing. It is also used for electric purposes, register borders, blackboards, refrigerator shelves, etc.

At the quarry of the Maine Slate Company of Monson, 3 1/2 miles west-southwest of the village, opened in 1903, there are about 30 feet of slate and interbedded quartzite exposed. The thickest bed of slate measures about 8 feet. In 1904, the quarry measured about 100 feet across the strike, 30 feet across it, and 40 feet in depth. The bedding strikes N. 55°-60° E., and dips about 80° SSE., but at the surface curves over steeply north-northwest. The cleavage strikes about the same, but dips 90°. There are vertical dip joints, horizontal jointing, so that the slate has to be sawn in a northwest and southeast vertical direction and split ("sculped") in a horizontal one.

Section at Monson Pond quarry, Monson, Me.

[Furnished by the courtesy of Mr. F. H. Crane, superintendent.]

	Feet.	*Inches.*
Slate	7–18	0
Quartzite	0	6
Slate	1	8
Quartzite	0	2– 8
Slate	1	10
Quartzite	0	8
Slate	2	0
Quartzite	0	3
Slate	4	0
Quartzite	1	6
Slate	4	0
Quartzite	0	8
Slate	4	0
Quartzite	0	6
Slate	15–18	0
Quartzite	4	0
Slate	5	0
Quartzite	1	4
Slate	7– 8	0
Quartzite	4	0
Slate	3	0
Quartzite	1	2– 4
Slate	3	0
Quartzite	0	8–12
Slate	8	0
Quartzite	20	0
Slate	7	0
Quartzite	2	0
Slate	6	0
Quartzite	11	0

The slate is very dark gray; to the unaided eye has a finer texture and finer cleavage surface than that of the Monson Pond quarry, and also more luster. It is slightly graphitic, has very little magnetite, but the sawn edges show considerable pyrite. It does not effervesce with cold dilute hydrochloric acid, and is very sonorous.

Under the microscope this slate shows a matrix of muscovite (sericite), with a very brilliant aggregate polarization. There are lenses of biotite and quartz, or of quartz with a nucleus of pyrite, measuring up to 0.565 by 0.14 mm., rarely 1 by 0.075. Quartz fragments, usually abundant in sections parallel to cleavage, measure up to 0.064 mm.; biotite scales, about 18 to each square millimeter, measuring up to 0.13 by 0.028 mm., lie across as well as in the cleavage. Little less abundant than these are scales of chlorite interleaved with muscovite, lying across the cleavage and measuring up to 0.13 by 2 mm. There are also about 300 lenses of pyrite to each square millimeter, with their long axes in the cleavage, and measuring from 0.002 up to 0.094 mm. in length, and up to 0.047 in width and breadth. This number probably includes a few crystals of magnetite. These lenses are sometimes surrounded by secondary muscovite. Generally distributed is a dark grayish or black material, probably graphitic, to which the slate owes its blackness. Tourmaline prisms up to 0.047 by 0.009 mm. No carbonate was detected.

The product is at present being prepared exclusively for roofing.

West Monson-At the quarry of the Monson Consolidated Slate Company a bed of black slate 9 feet thick, with a bed of quartzite 15 feet thick on its north side, and small alternating beds of quartzite and slate on its south side are exposed, the whole series measuring perhaps 50 feet. The quarry in 1904 measured 300 feet along the strike, 15 across it, and 160 in depth. The walls are supported by three pillars of slate. Bedding and cleavage both strike N. 60° E., and dip 90° E. There are vertical dip joints striking N. 15° W.; also horizontal joints to which the grain is parallel. there are about 15 feet of till on the edges of the glaciated slate. As only one bed of slate is worked, the percentage of waste at this quarry is very small.

The slate is a very dark gray. To the unaided eye texture and cleavage surface are very fine. It has more luster than the Pond quarry slate, but not as much as that of the Maine Slate Company of Monson. It is slightly graphitic, but has no magnetite, but shows pyrite on sawn edges; does not effervesce with cold dilute hydrochloric acid, and is very sonorous.

Under the microscope this slate shows a matrix of muscovite (sericite) with a brilliant aggregate polarization. There are a few lenses of quartz biotite, measuring from 0.17 to 0.13 by 0.034 mm., some lying in the cleavage, others in the direction of the grain. The quartz fragments measure up to 0.02 by 0.012. There are about nine biotite scales to each square millimeter, measuring up to 0.08 by 0.02 mm.; also about fourteen chlorite scales, measuring 0047 by 0.02mm., but sometimes 0.085 by 0.03, with their longer axes and laminæ usually parallel to the cleavage and across the grain; and finally, twenty to fifty lenses and crystals of pyrite to each square millimeter, measuring, in sections across the cleavage, up to 0.066 by 0.02, with their longer axes parallel to the cleavage, and the usual finely disseminated carbonaceous matter; also tourmaline prisms up to 0.007 by 0.008 mm. No carbonate was detected.

The probable relative abundance of these constituents, in descending order, is muscovite (sericite), quartz, chlorite, pyrite, biotite, and carbonaceous matter or graphite. Professor Merriman's tests of this slate are given on page 123. This slate is used both for roofing and mill stock, particularly for electric purposes.

North Blanchard.-There are two quarries at North Blanchard, both operated by the Lowell Slate Company. At the State of Maine or Blanchard quarry 50 feet of slate and quartzite, ten beds of each, in alternation, are exposed, and 200 or 300 feet more have been prospected east of the quarry. The quarry measures between 250 and 300 feet along the strike, 40 to 50 feet across it, and 200 feet in depth. Both bedding and cleavage strike N. 25° E. and dip east-southeast at 80°. The slate has vertical dip joints striking N. 70° W. and diagonal ones striking N. 40° W., dipping 32° SSW. There are also joints confined to the quartzite, dipping 65° to 70° SSW., and also 65° to 70° NNE. The grain strikes N. 65° W. and dips 90°, almost like the dip joints. The surface of the deposit is glaciated and covered with 10 feet of till. Some of the quartzite surfaces show faint traces of marine life. At the Moosehead quarry, which lies one-half mile southwest or south-southwest of the last, more than 65 feet of slate and quartzite are exposed. The thickest beds of slate measure 4 and 7 feet. The quarry measures about 500 feet along the strike, 50 feet across it, and 125 feet in depth. Bedding and cleavage both strike about N. 37° E. and dip east-southeast at 80°. Dip joints strike N. 55° W. and dip 90°. The quartzite on the west side of the quarry is broken up by undulating horizontal joints from 1 to 4 feet apart. The grain corresponds to the dip joints.

The slate from these quarries is a very dark gray. To the unaided eye the texture and cleavage surface are fine, but the latter is only slightly lustrous. The slate contains a little carbonaceous or graphitic matter and no magnetite, but the sawn edges show pyrite. No effervescence in cold dilute hydrochloric acid. It is very sonorous and very fissile.

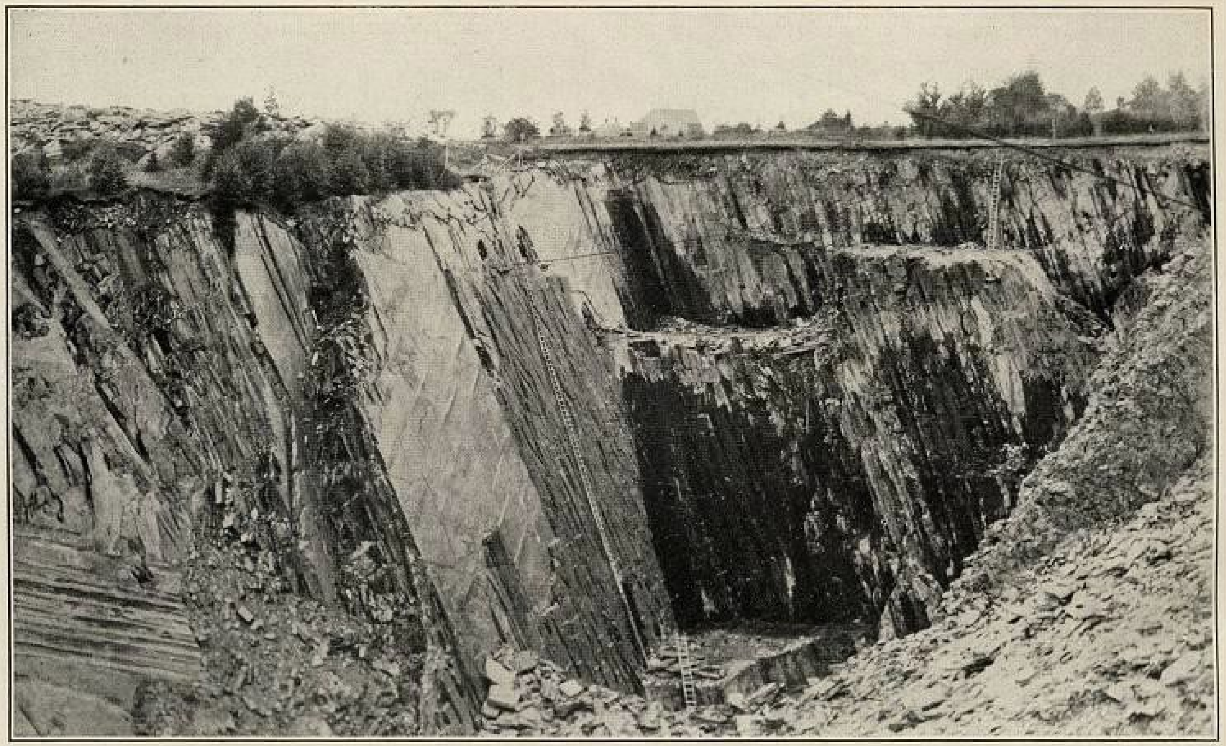
Under the microscope this slate shows a matrix of muscovite (sericite), with brilliant aggregate polarization. A thin section parallel to the cleavage shows muscovite scales sufficiently numerous and parallel to produce a slight aggregate polarization. This may be due to an unusually pronounced grain. The quartz fragments occasionally measure 0.028 mm., and are not abundant. There are about one hundred scales of chlorite, interleaved with muscovite or sometimes biotite, to each square millimeter, with their laminæ across the cleavage and measuring up to 0.066 by 0.028; also, about seven biotite scales to each square millimeter, measuring up to 0.085 by 0.047 mm., often bordered by secondary quartz or muscovite in the direction of the slaty cleavage, but with their laminæ transverse to it. There are about two hundred lenses of pyrite to each square millimeter, measuring from 0.004 to 0.03 mm. in length and up to 0.01 in width; much dark-gray carbonaceous or graphitic matter in exceedingly fine particles; tourmaline prisms up to 0.07 by 0.009 mm. are plentiful. No carbonate or slate needles found. The chief constituents, arranged in descending order of abundance, appear to be muscovite, chlorite, quartz, pyrite, carbonaceous matter or graphite, and biotite.

This slate is used for roofing and mill stock, including electric appliances.

Brownville.-Only one quarry is now in operation at Brownville, the "Old Merrill," operated by the Merrill Brownville Slate Company. This quarry lies less than a mile about northeast of the station (see Pl. XII). Here are exposed 42 beds of slate alternating with as many of quartzite, and measuring altogether 165 feet in thickness. The slate beds range from 6 inches to 6 feet, and the quartzite beds from 6 inches to 5 feet 6 inches. Any quartzitic slate is considered quartzite in these calculations.[3]

At the Hughes quarry, owned by the same company, but now idle, and situated a mile northwest of the Merrill, there are 28 beds of slate alternating with 28 of quartzite, measuring in all 161 feet 6 inches. The slate beds range from 1 to 9 feet and the quartzite from 4 inches to 20 feet in thickness. There is no evidence of duplication in these series of beds. Some of the quartzite is grayish and medium grained. Under the microscope it proves to be chloritic, pyritiferous, and slightly biotitic, with rare grains of zircon.

The Merrill quarry measures about 450 feet along the strike, between 165 and 200 feet across it, and 250 in depth. The bedding strikes N. 78° E., dips 75° NNW.; the cleavage strikes N. 68° E., and dips 70° NNW. Dip joints strike N. 20° E., dip 82 WNW.; diagonal joints strike N. 60° W., dip 90°. There are also horizontal joints, to which the grain is parallel. Quartz veins are not conspicuous, but there are some quartz lenses from 2 to 3 feet in diameter. These veins contain a little biotite. The south wall of the quarry (see Pl. XII), which is formed by a quartzite bed, is divided into rhombic blocks about 10 feet in their longer diameter, owing to the intersection of joints dipping 25° W. and 30° E. respectively. The surface of this bed has also what resembles a coarse ripple marking, but is probably a minor effect of the rhombic jointing.



MERRILL SLATE QUARRY, BROWNVILLE, ME.

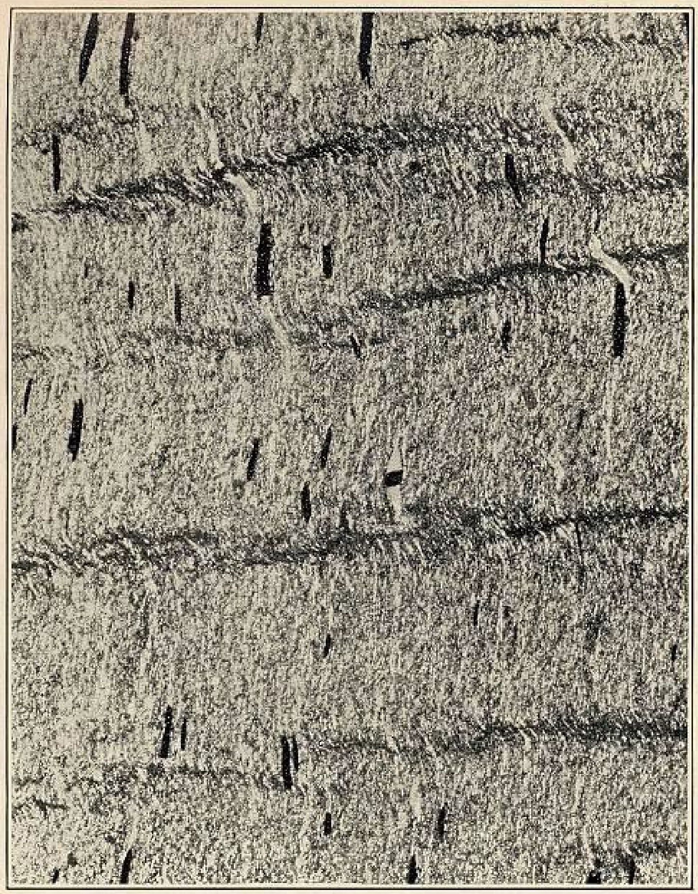
Looking S. 60° W. The end wall, working face, has 42 beds of slate alternating with quartzite. The left wall is quartzite that is diagonally jointed.

The slate is a very dark gray. To the unaided eye it has a very fine texture and a very smooth cleavage surface, with a very bright luster. It is slightly carbonaceous or graphitic. When powdered, it yields considerable magnetite to the magnet. The sawn edges show lenses of pyrite a millimeter and less in length. Some of the cleavage and other surfaces on the dumps show a very dark purplish coating. There is no effervescence in cold dilute hydrochloric acid nor any discoloration whatever. It is very sonorous.

Under the microscope it shows a very fine grained matrix of muscovite (sericite), with a very brilliant aggregate polarization. It contains much quartz in fragments up to 0.076 by 0.02 mm.; about 5 biotite plates to each square millimeter, measuring up to 0.076 by 0.03 mm., lying across the slaty cleavage. These often form the nuclei of quartz lenses which measure up to 0.4 by 0.03 mm. But the most conspicuous feature, next to the brilliant matrix, is the abundance of magnetite in tabular crystals, probably distorted octahedra, lying parallel to the cleavage, about 43 to each square millimeter, and measuring from 0.009 to 0.141 mm. in length and up to 0.02 in width, rarely 0.17 by 0.04. These crystals are sometimes bordered by secondary quartz and muscovite or chlorite, on one or both sides, particularly whenever they happen to diverge from the cleavage direction. These secondary minerals occupy spaces resulting from a movement of the crystals after the commencement of slaty cleavage. There are also, but in less abundance, lenses of pyrite, up to 0.62 long, but sometimes 0.75 and 0.12 wide, and consisting of a nucleus of pyrite surrounded by secondary quartz or by this and biotite, these minerals forming the tapering part of the lens. There is also the usual abundance of dark gray graphitic? material in extremely fine particles. Not a few prisms of tourmaline occur, up to 0.043 by 0.008 mm. No carbonate.

Pl. XI-A will give some idea of the distribution of the magnetite crystals in this slate, but the "false cleavage" of the specimen is not typical of the product of the Merrill quarry-indeed it is quite exceptional. The specimen was selected to illustrate "false cleavage" as well the fineness of slaty cleavage. The principal constituents, arranged in descending order of abundance, appear to be muscovite (sericite), quartz, magnetite, pyrite, carbonaceous matter or graphite, biotite, chlorite, tourmaline. Prof. W. O. Crosby found that the slate of the East Brownville Slate Company had an average crushing strength of 29,270 pounds to the square inch, the weight being applied perpendicular to the cleavage, and that it required 3,550 pounds to break a slab 6 inches wide, 1 inch thick, and 11 inches long between supports, the load being applied at the middle. This would give a modulus of rupture of 9,762 pounds per square inch. The results of Professor Merriman's recent tests of Brownville slate will be found on page 123.

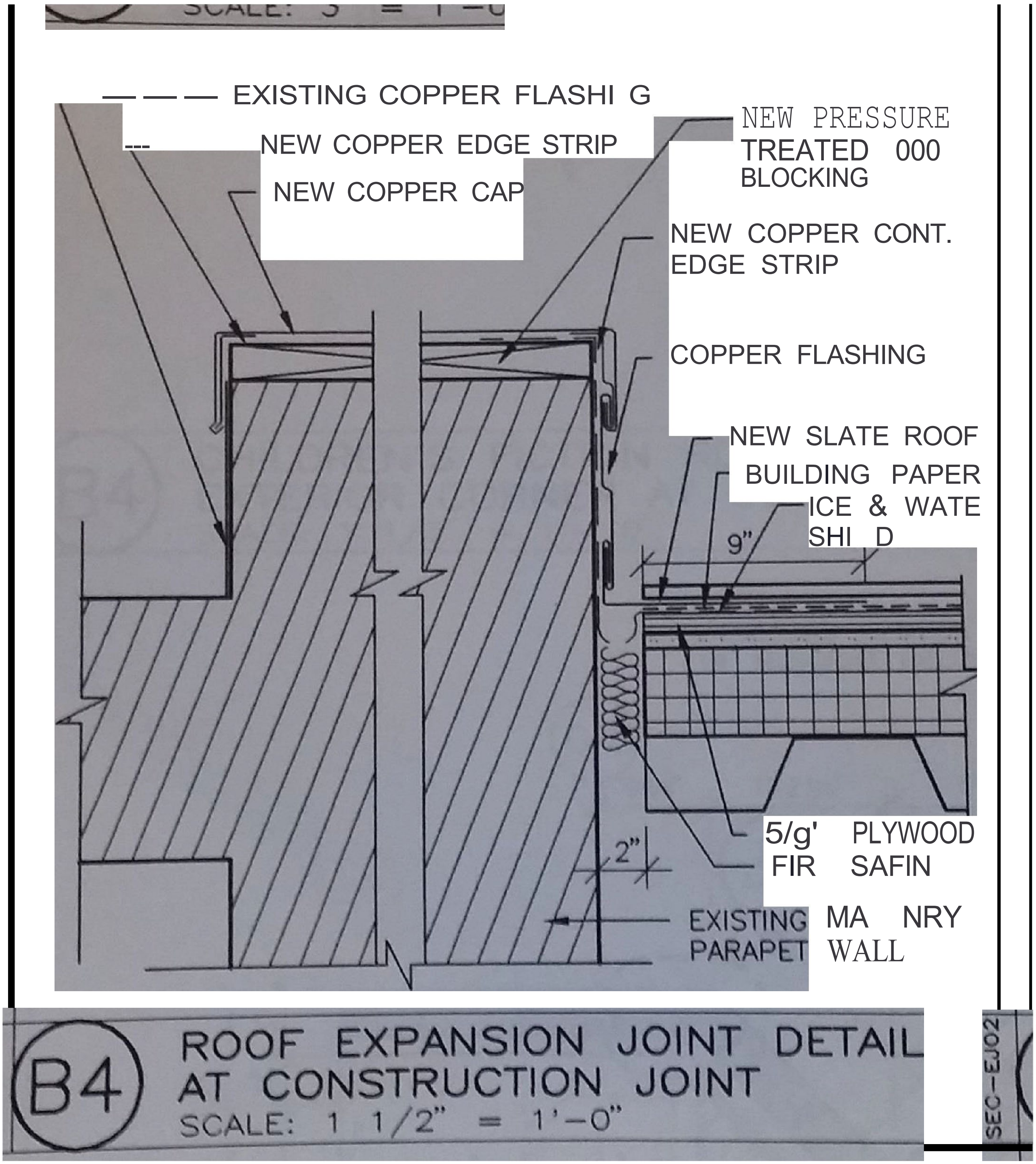
The product of the Merrill quarry is now used exclusively for roofing purposes; its magnetite, it is thought, prevents its use for electric appliances. However, a piece 6 by 4 by one-half inches makes no impression whatever on the magnetic needle, and the section photographed in Pl. XI-A came from that piece. The Brownville slate is highly crystalline.



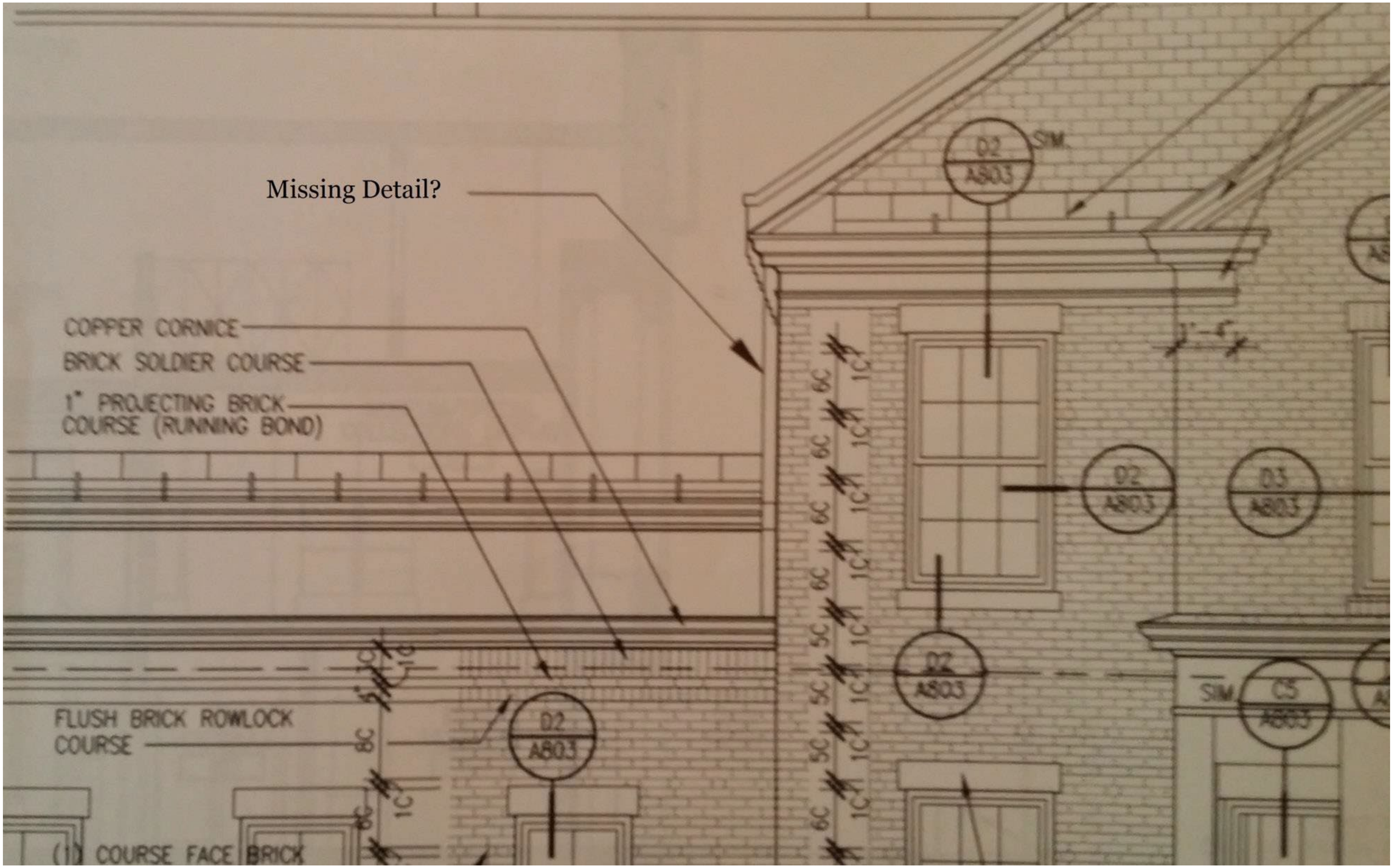
A. THIN SECTION OF BLACK ROOFING SLATE FROM THE MERRILL QUARRY AT BROWNVILLE, ME.

Showing a fine matrix of muscovite (sericite) with distorted octahedra of magnetite and (exceptionally for this quarry) a secondary plication resulting in slip cleavage ("false cleavage"). Ordinary light. Enlargement about 50 diameters. Bedding foliation and slaty cleavage here parallel. Lenses of chlorite and muscovite or quartz and muscovite or muscovite about some of the magnetite crystals.

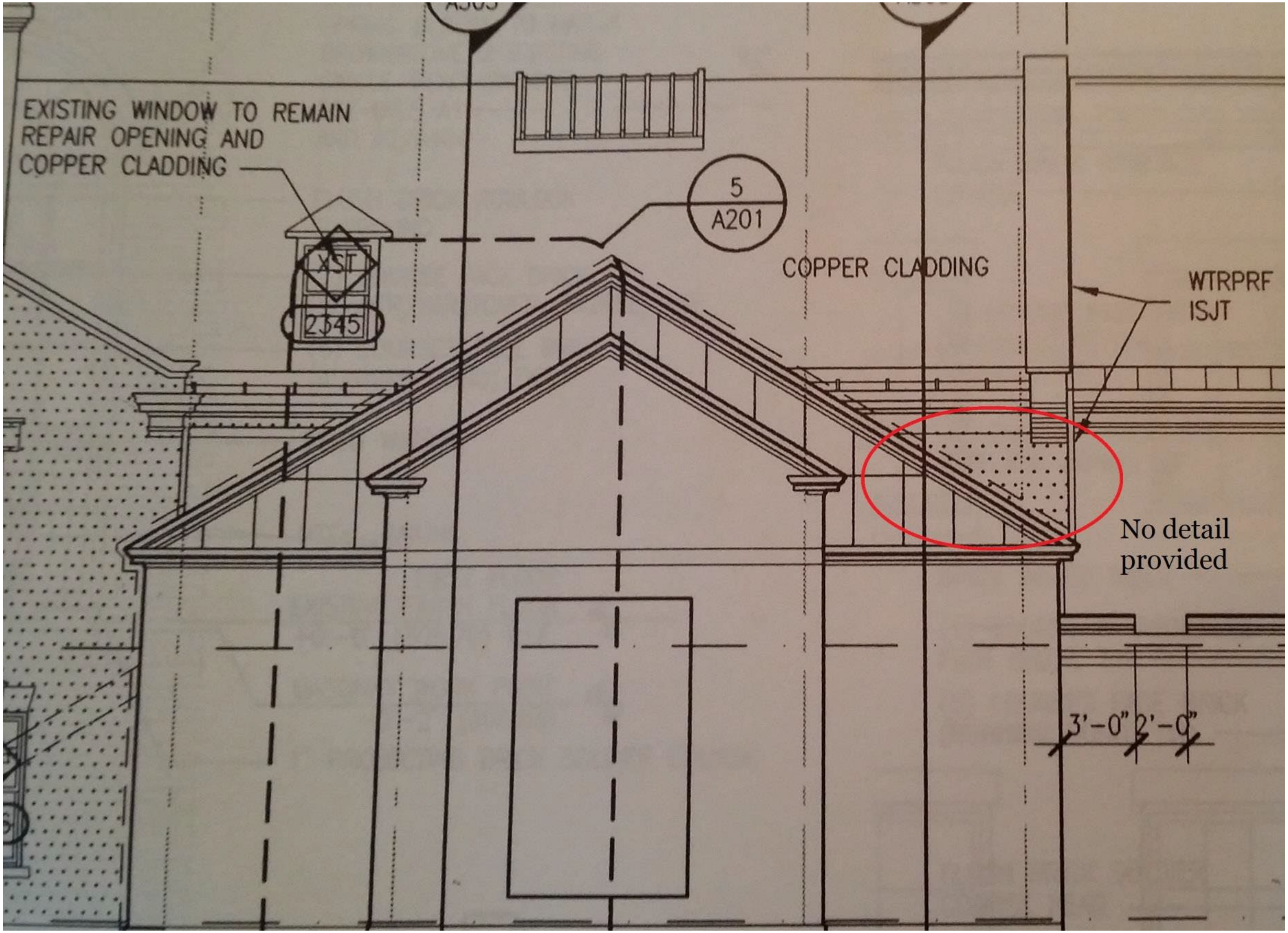
Addendum H – Sidewall flashing design issue



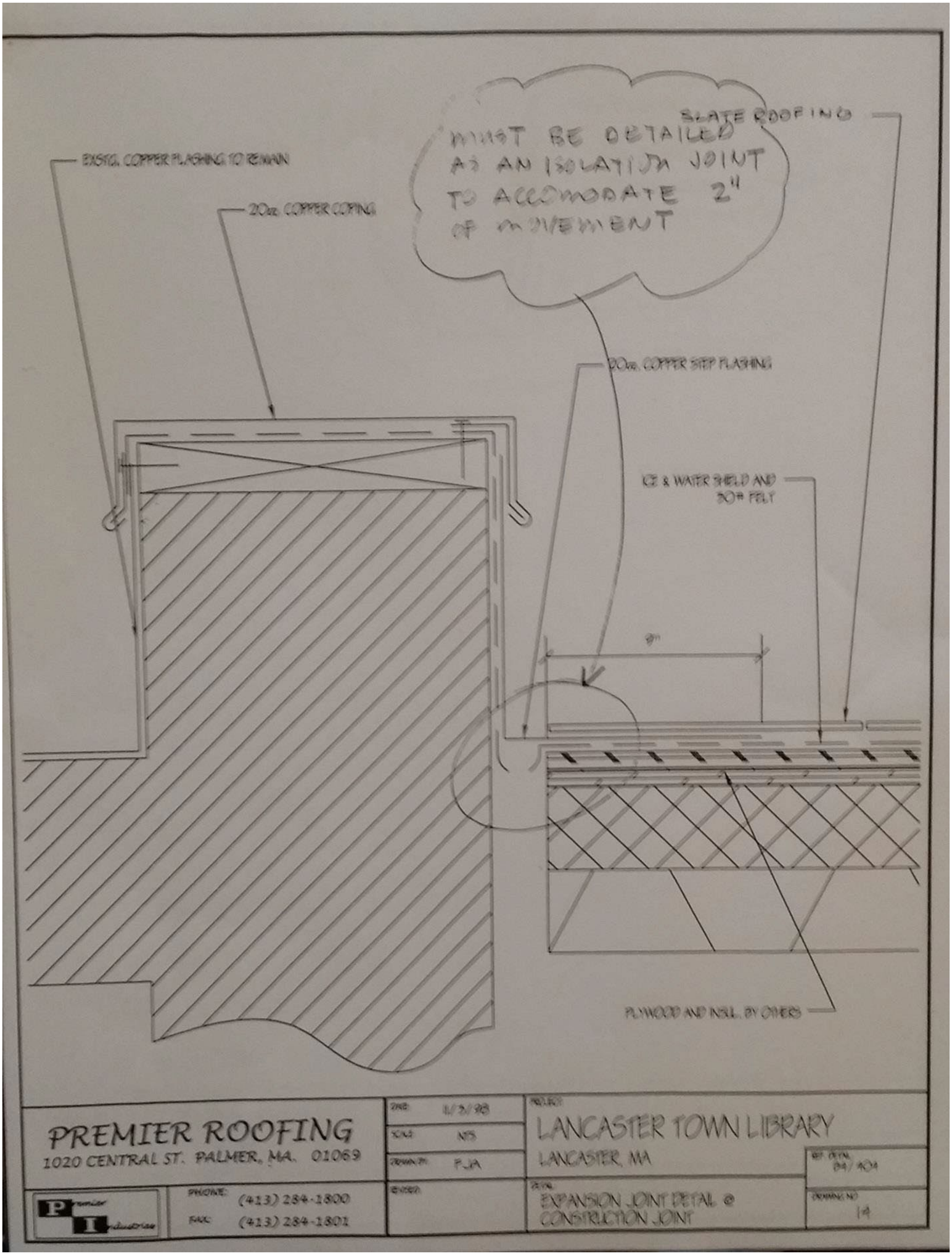
Bid documents - A404 detail B4 dated 21 Apr 1998 – Details sidewall flashing assembly



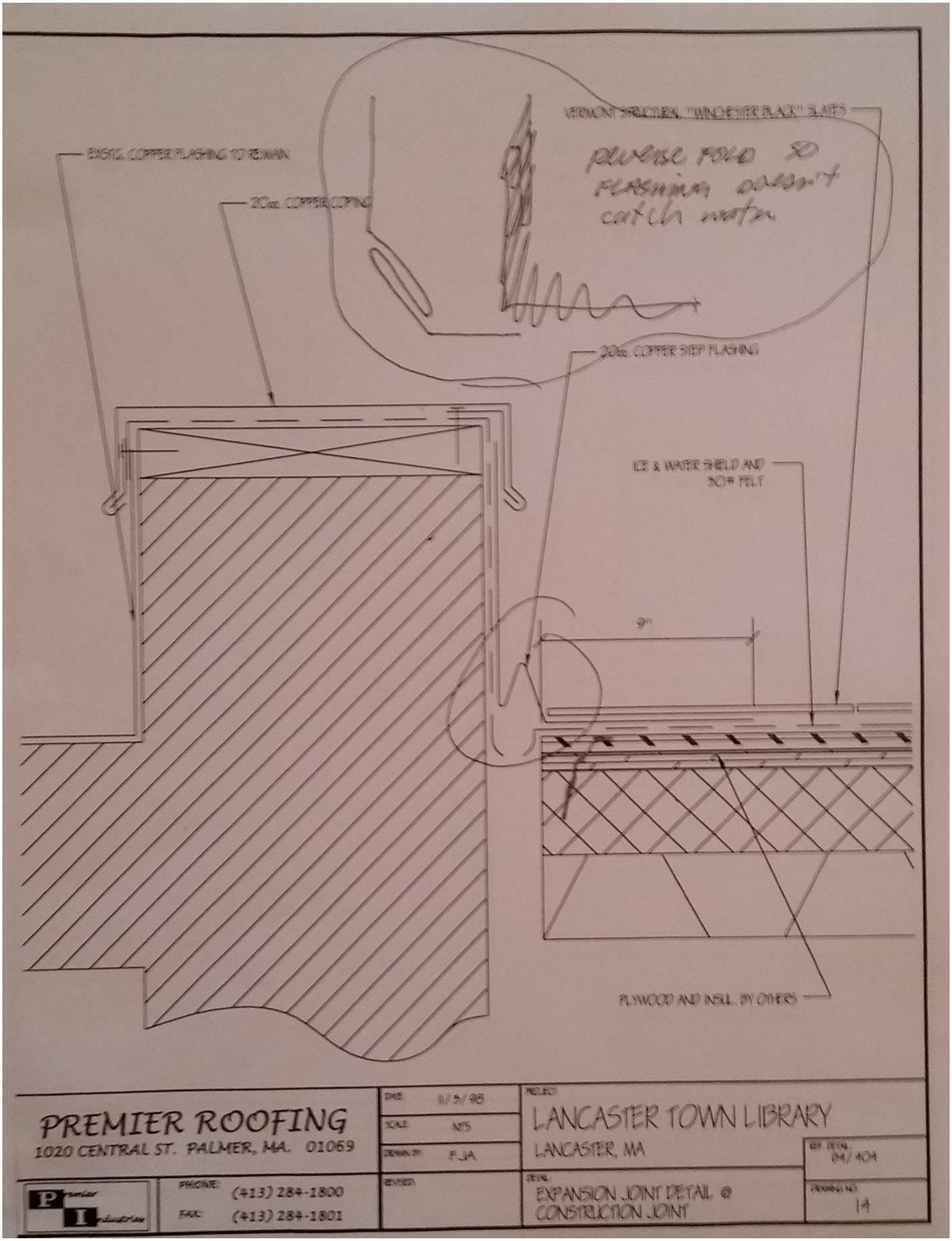
Bid documents - A202 detail 3 dated 21 Apr 1998 – An arrow points to the area in question, or a conductor pipe, but there's no note.



Bid documents - A202 detail 4 dated 21 Apr 1998 – No details or notes pertaining to the area circled in red.



Shop drawing submitted 3 Nov 1998 – Reflects detail shown in bid documents



Shop drawing also dated 3 Nov 1998 – Shows the detail as built. Handwritten note says "Reverse fold so flashing doesn't catch water."