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The Preservation and Repair of Historic Log Buildings

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The intent of this Brief is to present a concise history and description of the diversity of American log buildings and to provide basic guidance regarding their preservation and maintenance. A log building is defined as a building whose structural walls are composed of horizontally laid or vertically positioned logs. While this Brief will focus upon horizontally-laid, corner-notched log construction, and, in particular, houses as a building type, the basic approach to preservation presented here, as well as many of the physical treatments, can be applied to virtually any kind of log structure.

Log buildings, because of their distinct material, physical structure, and sometimes their architectural design, can develop their own unique deterioration problems. The information presented here is intended to convey the range of appropriate preservation techniques available. It does not, however, detail how to perform these treatments; this work should be left to professionals experienced in the preservation of historic log buildings.

Despite the publication since the 1930s of a number of books and articles on the history of log construction in America, some misconceptions persist about log buildings. Log cabins were not the first type of shelter built by all American colonists. The term "log cabin" today is often loosely applied to any type of log house, regardless of its form and the historic context of its set-

Fig. 1. Log construction was practical in the rough frontier and climate of Alaska, where it was used for a variety of structures such as the Sourdough Lodge (c. 1903) near Gakona. Built to serve the trail leading to the Klondike gold discoveries, this 1-story, L-shaped roadhouse is primarily of horizontal log construction with vertical logs in the front gable. Photo: National Park Service Files.

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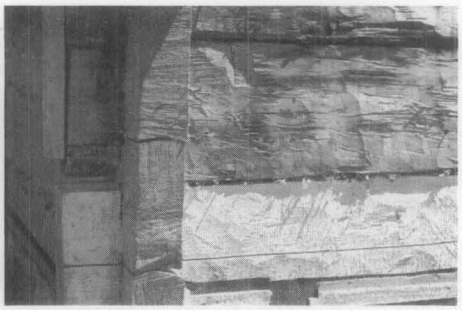

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Fig. 2. Logs, both round and hewn, continued to be a basic construction material throughout much of the 19th century, here illustrated by (a) these c. 1831 industrial workers' houses for forgemen at the Mt. Etna Iron Furnace in Pennsylvania, and (b) the Larsson-Ostlund House built by Swedish immigrants in New Sweden, Maine, during the 1870s. (c) Corner detail of the Larsson-Ostlund House with the original clapboarding removed during restoration shows close-fitting log joints in the Scandinavian style that did not require chinking. Photos: (a) Jet Lowe, HAER Collection, (b-c) Maine Historic Preservation Commission.

ting. "Log cabin" or "log house" often conjures up associations with colonial American history and rough frontier life (Fig. 1). While unaltered colonial era buildings in general are rare, historic log buildings as a group are neither as old nor as rare as generally believed. One and two-story log houses were built in towns and settlements across the country until about the middle of the 19th century, and in many areas, particularly in the West, as well as the Midwest and southern mountain regions, log continued to be a basic building material despite the introduction of wooden balloon frame construction (Fig. 2). By the early 20th century, the popularity of "rustic" architecture had revived log construction throughout the country, and in many areas where it had not been used for decades.

A distinction should be drawn between the traditional meanings of "log cabin" and "log house." "Log cabin" generally denotes a simple one, or one-and-one-half story structure, somewhat impermanent, and less finished or less architecturally sophisticated. A "log cabin" was usually constructed with *round* rather than hewn, or hand-worked, logs, and it was the first generation homestead erected quickly for frontier shelter. "Log house" historically denotes a more permanent, *hewn*-log dwelling, either one or two stories, of more complex design, often built as a second generation replacement. Many of the earliest 18th and early 19th century log houses were traditionally clad, sooner or later, with wood siding or stucco.

Historical Background

No other architectural form has so captured the imagination of the American people than the log cabin. Political supporters of 1840 presidential candidate William Henry Harrison appropriated the log cabin as a campaign symbol. The log cabin was birthplace and home for young Abe Lincoln, as well as other national figures, and assumed by many 19th century historians to be the very first type of house constructed by English colonists. In 1893 Frederick Jackson Turner in his influential paper, *The Significance of the Frontier in American History* suggested that European colonists had adopted this means of shelter from the Indians.

More recent 20th century scholarship has demonstrated that horizontal log buildings were not the first form of shelter erected by all colonists in America. Nor was log construction technology invented here, but brought by Northern and Central European colonists. Finnish and Swedish settlers are credited with first introducing horizontal log building in the colony of New Sweden (now Pennsylvania) on the upper shores of Delaware Bay in 1638, who later passed on their tradition of log construction to the Welsh settlers in Pennsylvania.

During the 17th and 18th centuries, new waves of Eastern and Central Europeans, including Swiss and Germans, came to America bringing their knowledge of log construction. Even the Scotch-Irish, who did not possess a log building tradition of their own, adapted the form of the stone houses of their native country to log construction, and contributed to spreading it across the frontier. In the Mississippi Valley, Colonial French fur traders and settlers had introduced vertical log construction in the 17th century.

Through the late 18th and early 19th centuries, frontier settlers erected log cabins as they cleared land, winding their way south in and along the Appalachian valleys through the back country areas of Maryland, Virginia, the Carolinas and Georgia. They moved westward across the Appalachian Mountain barrier into the Ohio and Mississippi River valleys transporting their indispensable logcraft with them, into Kentucky and Tennessee, and as far to the southwest as eastern Texas. Log buildings are known to have been con-

Fig. 3. This mid-19th century double-pen corncrib on the Jamison Farm in Rowan County, North Carolina, is an example of a type of log building that did not require chinking. Photo: Denise Whitley.

structed as temporary shelters by soldiers during the Revolutionary War, and across the country, Americans used logs not only to build houses, but also commercial structures, schools, churches, gristmills, barns, corncribs and a variety of outbuildings (Fig. 3).

Around the mid-19th century, successive generations of fur traders, metal prospectors, and settlers that included farmers and ranchers began to construct log buildings in the Rocky Mountains, the Northwest, California, and Alaska (Fig. 4). In California and Alaska, Americans encountered log buildings that had been erected by Russian traders and colonists in the late 18th and early 19th centuries. Scandinavian and Finnish immigrants who settled in the Upper Midwest later in the 19th century also brought their own log building techniques with them. And, many log structures in the Southwest, particularly in New Mexico, show Hispanic influences of its early settlers.

While many parts of the country never stopped building with logs, wooden balloon frame construction had made it obsolete in some of the more populous parts of the country by about the mid-19th century. However, later in the century, log construction was employed in new ways. In the 1870s, wealthy Americans initiated the Great Camp Movement for rustic vacation retreats in the Adirondack Mountains of upstate New York. Developers such as William Durant, who used natural materials, including wood shingles, stone, and log—often with its bark retained to emphasize the Rustic style—designed comfortable summer houses and lodges that blended with the natural setting (Fig. 5). Durant and other creators of the Rustic style drew upon Swiss chalets, traditional Japanese design, and other sources for simple compositions harmonious with nature.

The Adirondack or Rustic style was balanced in the West with construction of the Old Faithful Inn at Yellowstone National Park in Wyoming, designed by Robert C. Reamer, and begun in 1903 (Fig. 6). This popular resort was tremendously influential in its use of locally-available natural materials, especially log, and gave impetus to Rustic as a true national style. From the turn of the century through the 1920s, Gustav

Fig. 4. Beginning around the mid-19th century, entire western boomtowns were hastily constructed of frame and log, such as the buildings in Bannack, Montana, the site of the State's first gold discovery. Photo: National Park Service Files.

Fig. 5. The main lodge of Echo Camp on Raquette Lake in New York State was built in 1883 by the governor of Connecticut. It typifies the Adirondack style in the use of exposed round logs with crowns, and porches and balconies constructed with bowed logs and round log columns. Photo: Courtesy The Adirondack Museum.

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Fig. 6. (a) Old Faithful Inn, Yellowstone National Park, Wyoming, shown here in 1912, brought the Rustic style to the West in 1903 in an original design, and a scale befitting its setting. (b) Although only the first story is of horizontal log construction, the use of logs is striking in the trestle work and cribbed piers around the entrance. Photo: (a) Courtesy National Park Service, (b) Laura Soulliere Harrison.

Fig. 7. The Civilian Conservation Corps built many recreational log structures across the country in the 1930s and 40s, including this rustic log gateway to Camp Morton, Lycoming County, Pennsylvania. Photo: Courtesy Lycoming County Historical Society and Museum.

Stickley and other leaders of the Craftsman Movement promoted exposed log construction. During the 1930s and 40s, the Civilian Conservation Corps (CCC) used log construction extensively in many of the country's Federal and State parks to build cabins, lean-tos, visitor centers, and maintenance and support buildings that are still in service (Fig. 7).

Traditional Log Construction

Plan and Form

When settlers took the craft of log construction with them onto the frontier, they successfully adapted it to regional materials, climates and terrains. One of the most notable characteristics of the earliest 18th and 19th century log houses is the plan and form. The plan can sometimes provide clues to the ethnic origin or route of migration of the original inhabitant or builder. *But in the absence of corroborating documentary evidence, it is important not to infer too much about the ethnic craft traditions of a particular log house.*

Historians have identified a number of traditional house plans and forms as prototypes (Fig. 8). They were often repeated with simple variations. The basic unit of each of these types is the one room enclosure formed by four log walls joined at their corners, called a single "pen" or "crib." The single pen was improved upon by installing interior partitions or by adding another log pen. Some variations of historic log house plans include: the typically mid-Atlantic "continental" plan, consisting of a single-pen of three rooms organized around a central hearth; the "saddlebag" or double-pen plan, composed of two contiguous log pens; and the "dogtrot" plan, formed by two pens separated by an open passage space (sometimes enclosed later), all covered by a continuous roof. The continental plan originated in central and eastern Europe and is attributed to 18th century German immigrants to Pennsylvania. Non-log interior partition walls form the multi-room plan within the exterior log walls. The saddlebag plan consists of two adjoining log pens that share a central chimney. A saddlebag is often the evolution of a single pen with an end chimney, expanded by adding a second pen onto the chimney endwall. The saddlebag was built in a number of different regions across the country. The dogtrot plan may be seen with variation in many parts of the country, although it is sometimes, perhaps erroneously, considered the most typically southern, because its covered passageway provided both air circulation and shelter from the heat. All these plan types were typically built in the form of one or one-and-one-half story settlement cabins.

A somewhat different form evolved in the West around the middle of the 19th century which became especially distinctive of the Rocky Mountain cabin. While the entrance doorway to most earlier log houses was generally placed beneath the eaves, as a means of adapting to the greater snowfall in the Rockies, here the entrance was placed in the gable end, and sometimes protected from roof slides by a porch supported by two corner posts created by an extension of the roof beyond the gable wall (Fig. 9).

From the late 18th through the mid-19th centuries, Americans also built many substantial two-story log

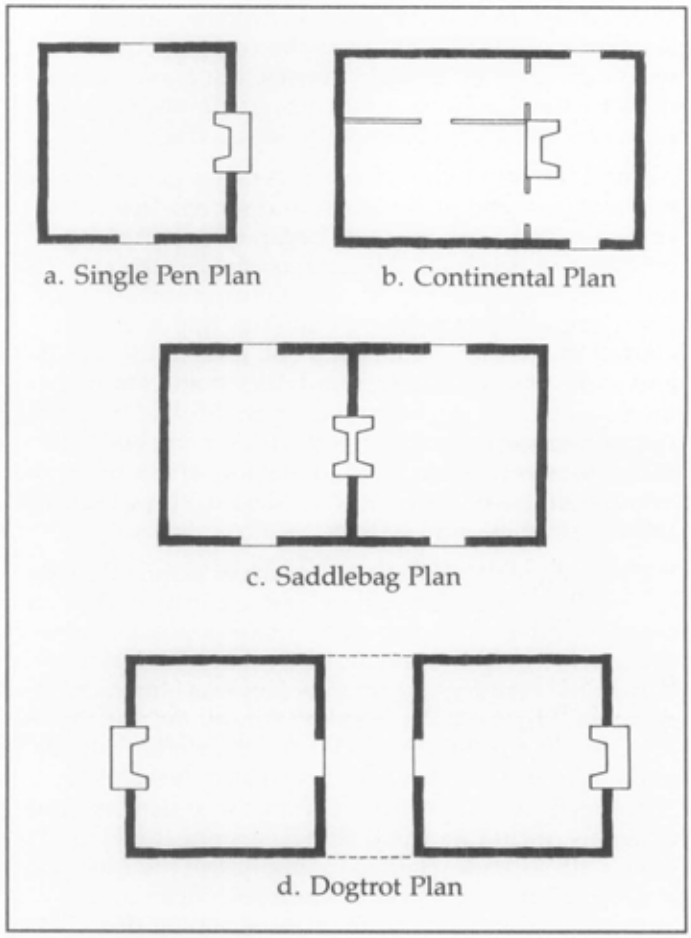

Fig. 8. These log house plans represent some of the basic housing forms constructed during the 18th and 19th centuries, and include: (a) single pen, (b) continental, (c) saddlebag, and (d) dogtrot. Drawing: James Caufield.

Fig. 9. This historic log building on the Walker Ranch in Boulder, Colorado is an example of the Rocky Mountain cabin form which is typified by the entrance door being located in the gable end. Photo: Bernard Weisgerber.

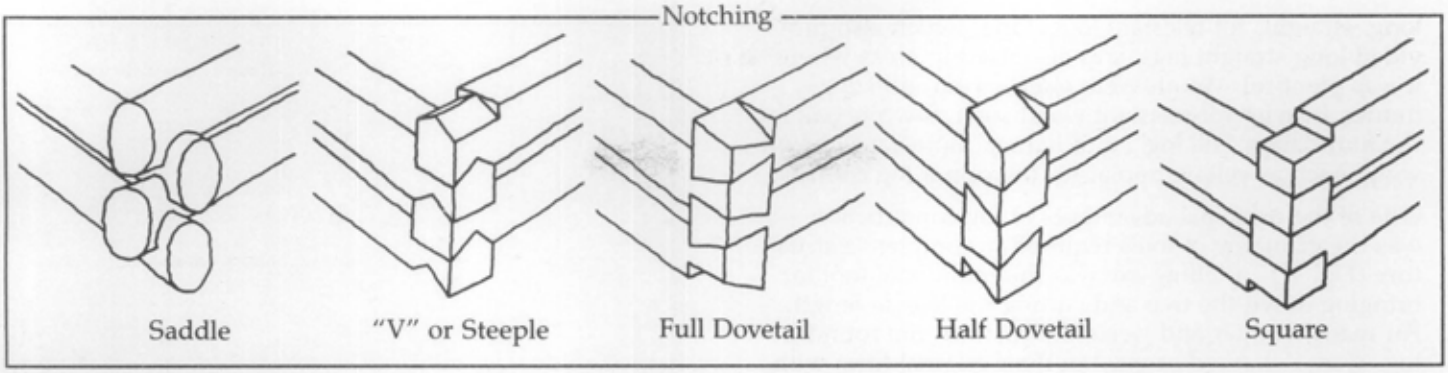

Fig. 10. Five examples of the more common historical methods of corner notching. Drawing: James Caufield.

houses in towns throughout the eastern half of the country. In rural areas two-story log houses were sometimes built to replace earlier, first-generation settlement cabins, but just as often the early hewn-log house was retained and enlarged. A second story was added by removing the roof and gables, constructing a second floor, laying additional courses of logs, and building a new roof, or reassembling the old one. Each generation of owners might expand an early log core building by adding on new log pens, or masonry or wood frame extensions. The addition of a rear ell, or infill construction to link a formerly free-standing outbuilding, such as a kitchen to the log main house was particularly common. Such a layering of alterations is part of the evolution of many log buildings.

Corner Notching and Other Fastening Techniques

Corner notching is another of the characteristic features of log construction. Most notching methods provide structural integrity, by locking the log ends in place, and give the pen rigidity and stability. Like the floor plan, the type of corner notching can sometimes be a clue to the ethnic craft origin of a log building, but it is important not to draw conclusions based only on notching details. Numerous corner notching techniques have been identified throughout the country (Fig. 10). They range from the simple "saddle" notching, which demands minimal time and hewing skill, to the very common "V" notching or "steeple" notching, to "full dovetail" notching, one of the tightest but most time-consuming to accomplish, "half-dovetail" notching which is probably one of the most common, and "square" notching secured with pegs or spikes.

The notching method on some of the earliest eastern cabins and most 19th century western cabins, particularly saddle notching, left an extended log end or "crown." Crowns are especially pronounced or exaggerated in Rustic style structures, and sometimes they are cut shorter as the wall rises, creating a buttress effect at the corners of the building.

Another method of securing log ends consists of fastening logs that are laid without notching ("false notching") with tenons into vertical corner posts, or using spikes or pegs to attach them to vertical corner planks. Vertically positioned logs were secured at their top and bottom ends, usually into roof and sill plate timbers.

Selecting Logs and Assembling the Building

Although wood selection was most likely to be determined by availability, chestnut, white oak, cedar, and fir were preferred because these trees could provide

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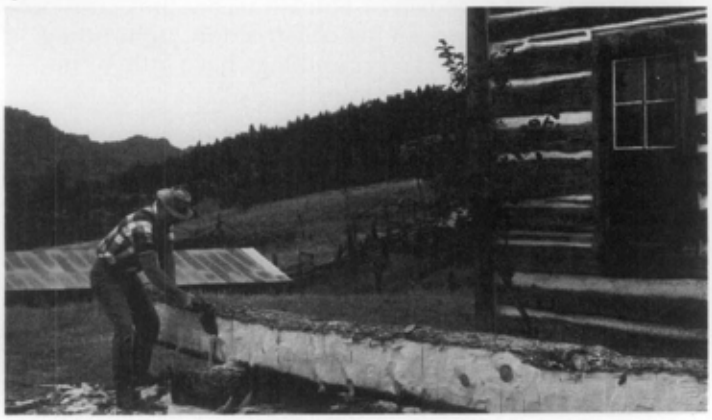

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Fig. 11. Log-hewing tools and techniques: (a) scoring the log with a single-bladed felling axe, or "pole axe" in preparation for removing a uniform thickness of wood; (b) removal to depth of scoring; (c) finish hewing with a broad axe. Photos: Courtesy Bernard Weisgerber.

long, straight, rot-resistant logs. Pine, which also provided long straight logs, was also used in areas where it was plentiful. Woods were often mixed, utilizing harder, heavier rot-resistant wood such as white oak for the foundation "sill log", and lighter, more-easily hewn wood such as yellow poplar for the upper log courses.

One of the principal advantages of log construction was the economy of tools required to complete a structure (Fig. 11). A felling axe was the traditional tool for bringing down the tree and cutting the logs to length. For many frontier and western structures the round logs were debarked or used in their original form with the bark left on, or one or more sides of the logs were hewn flat with a broadaxe, or more finely finished with an adze as smooth thick planks. Notching was done with an axe, hatchet or saw; openings for doors and windows were usually cut after the logs were set into place, and door and window frames, particularly jambs, were put in place during construction to help hold the logs in place. Roof framing members and floor joists were either hewn from logs or of milled lumber. A log cabin could be raised and largely completed with as few as two to four different tools, including a felling axe, a broad axe, and a hand saw or crosscut saw.

The upper gable walls were completed with logs if the roof was constructed with purlins, which is more typical of Scandinavian or Finnish construction, and western and 20th century Rustic styles. However, vertical or horizontal weatherboard sheathing was commonly used throughout the country to cover wood-framed gables.

Chinking and Daubing

The horizontal spaces or joints between logs are usually filled with a combination of materials that together is known as "chinking" and "daubing." Chinking and daubing completed the exterior walls of the log pen by sealing them against driving wind and snow, helping them to shed rain, and blocking the entry of vermin. In addition, chinking and daubing could compensate for a minimal amount of hewing and save time if immediate shelter was needed. Not all types of log buildings were chinked. Corncribs, and sometimes portions of barns where ventilation was needed were not chinked. While more typical of Swedish or Finnish techniques, and not as common in American log construction, tight-fitting plank-hewn or scribed-fit round logs have little or no need for chinking and daubing.

A variety of materials were used for chinking and daubing, including whatever was most conveniently at hand. Generally though, it is a three-part system applied in several steps. The chinking consists of two parts: first, a dry, bulky, rigid blocking, such as wood slabs or stones is inserted into the joint, followed by a soft packing filler such as oakum, moss, clay, or dried animal dung (Fig. 12). Daubing, which completes the system, is the outer wet-troweled finish layer of varying composition, but often consisting of a mixture of clay and lime or other locally available materials. Instead of daubing, carefully fitted quarter poles or narrow wood strips were sometimes nailed lengthwise across the log joints.

Chinking, especially the daubing, is the least durable part of a log building. It is susceptible to cracking as a result of freeze-thaw action, structural settlement, drying of the logs, and a thermal expansion-contraction rate that differs from that of the logs. Seasonal deterioration of chinking necessitates continual inspection and regular patching or replacement.

Fig. 12. The log joints have been cleaned out in preparation for new daubing exposing carefully laid stone chinking in this building in Virginia. Photo: Bernard Weisgerber.

Exterior Wall Treatments

Although the exterior logs of cabins in the West, and 20th century Rustic buildings are generally not covered, many 18th and 19th century log houses east of the Mississippi, with the exception of some of the simpler cabins and houses in remote or poorer areas, were covered with exterior cladding. The exterior of the log walls was covered for both aesthetic and practical reasons either as soon as the building was completed or sometime later.

In some instances, the exterior (and interior) of the logs was whitewashed. This served to discourage insects, and sealed hairline cracks in the daubing and fissures between the daubing and logs. Although the solubility of whitewash allows it to heal some of its own hairline cracks with the wash of rain, like daubing it has to be periodically reapplied. Usually, a more permanent covering such as wood siding or stucco was applied to the walls, which provided better insulation and protection, and reduced the maintenance of the log walls.

Sometimes log houses were sided or stuccoed later in an attempt to express a newly-achieved financial or social status. Many log houses were immediately sided and trimmed upon completion to disguise their simple construction beneath Georgian, Federal and later architectural styles. Frequently a log house was covered, or recovered, when a new addition was erected in order to harmonize the whole, especially if the original core and its addition were constructed of different materials such as log and wood frame (Fig. 13).

Vertical wood furring strips were generally nailed to the logs prior to applying weatherboarding or stucco (Fig. 14). This ensured that the walls would be plumb, and provided a base on which to attach the clapboards, or on which to nail the wood lath for stucco.

Fig. 13. Historic wood clapboard siding originally applied to conceal the fact that this house was built in two sections of different materials has been inappropriately removed from the 1793 log portion. Photo: National Park Service Files.

Fig. 14. Removal of the historic wood siding from the 1804 Zachariah Price DeWitt House in Butler County, Ohio, reveals that the clapboards were attached to vertical wood furring strips nailed to the logs. Photo: National Park Service Files.

Foundations

Log building foundations varied considerably in quality, material, and configuration. In many cases, the foundation consisted of a continuous course of flat stones (with or without mortar), several piers consisting of rubblestone, single stones, brick, short vertical log pilings, or horizontal log "sleepers" set on grade. The two "sill logs," were laid directly upon one of these types of foundations.

Climate and intended permanence of the structure were the primary factors affecting foundation construction. The earliest log cabins, and temporary log dwellings in general, were the most likely to be constructed on log pilings or log sleepers set directly on grade. Where a more permanent log dwelling was intended, or where a warm, humid climate accelerated wood decay, such as in the South, it was sometimes more common to use stone piers which allowed air to circulate beneath the sill logs. Full cellars were not generally included in the original construction of most of the earliest log houses, but root cellars were often dug later.

Roofs

Log buildings were roofed with a variety of different framing systems and covering materials. Like log house plans and corner notching styles, the types of roof framing systems used were often variations on particular ethnic and regional carpentry traditions. In most cases wood shingles were the first roof covering used on the earliest 18th and 19th century log houses. As wood shingle roofs deteriorated, many were replaced with standing seam metal roofs, many of which continue to provide good service today. Later pioneer log buildings west of the Mississippi were likely to be roofed with metal or roll roofing, or even with sod. Other log buildings have been re-roofed in the 20th century with asphalt shingles. For some rustic log buildings in the West and Great Camps in the Adirondacks, asphalt shingles are the original historic roofing material.

Chimneys

Ethnic tradition and regional adaptation also influenced chimney construction and placement. Chimneys in log houses were usually built of stone or brick, a combination of the two, or even clay-lined, notched logs or smaller sticks (Fig. 15). Later log buildings were frequently constructed with only metal stacks to accommodate wood stoves. The chimneys of log buildings erected in cold climates tended to be located entirely inside the house to maximize heat retention. In the South, where winters were less severe the chimney stack was more typically constructed outside the log walls. With the advent of more efficient heating systems, interior chimneys were frequently demolished or relocated and rebuilt to maximize interior space.

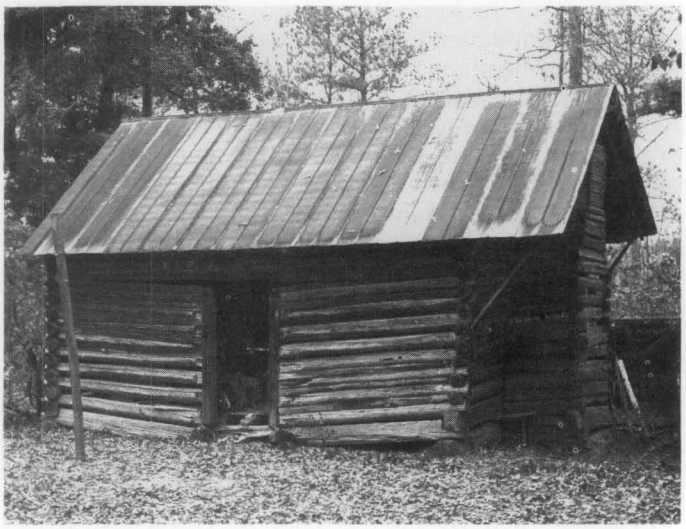


Fig. 15. The mid-19th century O'Quinn House, Moore County, North Carolina, provides a rare surviving example of a clay-lined log chimney. Although the logs of the house are saddle-notched, the chimney logs are "V" notched. The roof was extended out over the chimney to protect the daubing from the weather, and the chimney stack would have originally projected through a hole in the roof. Photo: Michael Southern.

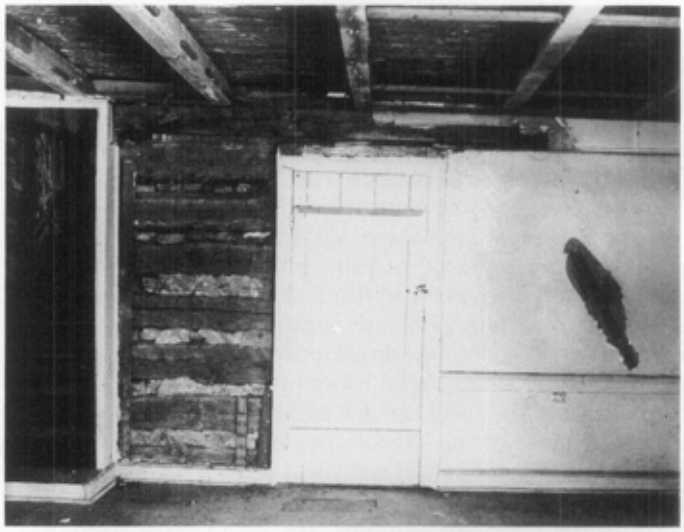


Fig. 16. This photograph of the interior of a 1793 log house in Maryland reveals much about historic log building construction and interior finish treatments. To the left of the plank door plaster has been removed exposing the stone chinking and daubing; remnants of vertical furring strips attached to the logs show evidence of traditional horizontal lath, while the hole broken through the plaster wall on the right shows the use of diagonal lath. The open door reveals a very steep, enclosed stairway typical of many early log houses. Although plaster has been removed from the ceiling, the wall to the right of the door shows the original plaster finish and fine woodwork including beaded chair rail, floor and door molding. Photo: National Park Service Files.

Interior Finishes

Logs on the interiors of many of the simpler cabins and Rustic style structures were often given a flattened surface or left exposed. But, in the more finished log houses of the 18th and 19th century, they were more commonly covered for most of the same reasons that the exterior of the logs was covered—improved insulation, ease of maintenance, aesthetics, and keeping out vermin. Covering the interior log walls with planks, lath and plaster, boards pasted with newspaper, fabric such as muslin, or wallpaper increased their resistance to air infiltration and their insulation value. Finished walls could be cleaned and painted more easily, and plastered walls and ceilings obscured the rough log construction and prepared interior surfaces for decorative wood trim in the current styles (Fig. 16).

Historical Evaluation and Damage Assessment

Before undertaking preservation work on a historic log building, its history and design should be investigated, and physical condition evaluated. It is always advisable to hire a historical architect or qualified professional experienced in preservation work to supervise the project. In addition, State Historic Preservation Offices, regional offices of the National Park Service, and local historical commissions may also provide technical and procedural advice.

The historical investigation should be carried out in conjunction with a visual inspection of the log building. Physical assessment needs to be systematic and thorough. It should include taking notes, photographs or video recording, and making drawings of existing conditions, including overall and detail views. This will serve as a record of the appearance and condition which can be referred to once work is under way. A physical assessment should also identify causes of deterioration, not just symptoms or manifestations and, in some instances, may need to include a structural investigation.

Foundation Inspection

The foundation of a log building should always be inspected before beginning work because, as in any building, foundation-related problems can transfer structural defects to other components of the building. Settling of the foundation is a typical condition of log buildings. If settlement is not severe and is no longer active, it is not necessarily a problem. If, however, settlement is active or uneven, if it is shifting structural weight to unintended bearing points away from the intended main bearing points of the corner notches and sill log, serious wall deflections may have resulted. Causes of settlement may include foundation or chimney stones or sill logs that have sunk into the ground, decay of log pilings, log sleepers, or of the sill logs themselves.

Log Inspection

Foundation problems usually result in damage to the sill logs and spandrels, which are often the most susceptible to deterioration. Sill logs, along with the corner notching, tend to bear most of the weight of the building, and are closest to vegetation and the ground, which harbors wood-destroying moisture and insects. If the sill log has come into contact with the ground, deterioration is probably underway or likely to begin (Fig. 17). It is also important to check the drainage around the building. The building assessment should note the condition of each log and attempt to identify the sources of problems that appear to exist.

Sill log inspection should not necessitate destruction of historic exterior cladding if it exists. Inspection can usually be made in areas where cladding is missing,

Fig. 17. Contact of this building's sill log with the ground has led to its decay, infestation by wood-destroying insects, and resulting building settlement. Photo: Anne Grimmer.

loose, or deteriorated. Sill log, as well as upper log, deterioration may also be revealed by loose or peeling areas of the cladding. If pieces of cladding must be removed for log inspection, they should be labeled and saved for reinstallation, or as samples for replacement work. Historic cladding generally need not be disturbed unless there are obvious signs of settling or other indications of deterioration.

Other areas of the log walls which are particularly susceptible to deterioration include window and door sills, corner notches, and crowns, and any other areas regularly saturated by rain run-off or backsplash. The characteristic design feature of Adirondack or Rustic style log buildings of leaving log ends or crowns to extend beyond the notched corners of the building positions the crowns beyond the drip-line of the roof edge. This makes them vulnerable to saturation from roof run-off, and a likely spot for deterioration. Saddle notching in which the cut was made out of the top surface of the log and which cups upward, and flat notching, may also be especially susceptible to collecting run-off moisture.

Detection of decay requires thorough inspection. Probing for rot should be done carefully since repair techniques can sometimes save even badly deteriorated logs. Soft areas should be probed with a small knife blade or icepick to determine the depth of decay. Logs should be gently tapped at regular intervals up and down their lengths with the tool handle to detect hollow-sounding areas of possible interior decay. Long cracks which run with the wood grain, called "checks," are not signs of rot, but are characteristic features of the seasoning of the logs. However, a check can admit moisture and fungal decay into a log, especially if it is located on the log's upper surface. Checks should also be probed with a tool blade to determine whether decay is underway inside the log.

Sill log ground contact and relative moisture content also provide ideal conditions for certain types of insect infestation. Wood building members, such as sill logs or weatherboarding, less than eight inches from the ground, should be noted as a potential problem for monitoring or correction. Sighting of insects, or their damage, or telltale signs of their activity, such as mud tunnels, exit holes, or "frass," a sawdust-like powder, should be recorded. Insect infestation is best treated by a professionally licensed exterminator, as the chemicals used to kill wood-destroying insects and deter re-infestation are generally toxic.

Roof Inspection

Along with the foundation, the roof is the other most vital component of any building. The roof system consists of, from top to bottom, the covering, usually some form of shingles or metal sheeting and flashing; board sheathing or roof lath strips; the framing structure, such as rafters or purlins; the top log, sometimes referred to as the "roof plate" or "rafter plate;" and, sometimes, but not always, gutters and downspouts.

The roof and gutters should be inspected and checked for leaks both from the exterior, as well as inside if possible. Inspection may reveal evidence of an earlier roof type, or covering, and sometimes remnants of more than one historic covering material. The roof may be the result of a later alteration, or raised when a second story was added, or repaired as the result of storm or fire damage. Often, roof framing may be composed of reused material recycled from earlier buildings. Inspection of the roof framing should note its configuration and condition. Typical problems to look for are framing members that have been dislodged from their sockets in the roof plate, or that are cracked, ridge damage, sagging rafters, broken ties and braces, and decay of exterior exposed rafter or purlin ends, especially common on Rustic style buildings (Fig. 18).

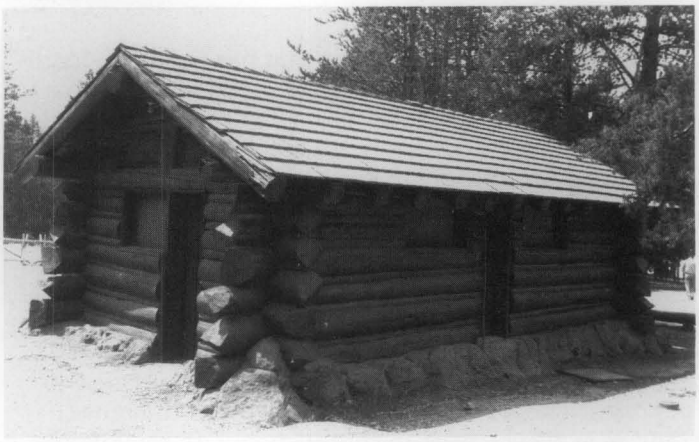


Fig. 18. Exposed roofing members of Rustic style buildings such as this structure at Yellowstone National Park are highly susceptible to deterioration. Photo: Laura Soulliere Harrison.

Other Features

The rest of the building should also be inspected as part of the overall assessment, including siding, window sash and frames, door frames and leafs, chimneys, porches, and interior walls, trim, and finishes. Any of these features may exhibit deterioration problems, inherent to the material or to a construction detail, or may show the effects of problems transmitted from elsewhere, such as a deformed or mis-shapen window frame resulting from a failed sill log. The inspection should note alterations and repairs made over time, and identify those modifications which have acquired significance and should be preserved. Nothing should be removed or altered before it has been examined and its historical significance noted.

Preservation Treatments

Since excessive moisture promotes and hastens both fungal and insect attack, it should be dealt with immediately. Not only must the roof and gutters be repaired —if none exist, gutters should probably be added—but the foundation grade should be sloped to ensure drainage away from the building. If the distance from the ground to the sill log or exterior sheathing is less than eight inches, the ground should be graded to achieve this minimum distance. Excess vegetation and debris such as firewood, dead leaves, or rubbish should be cleared from the foundation perimeter, and climbing vines whose leaves retain moisture and tendrils erode daubing, should be killed and removed. Moisture problems due to faulty interior plumbing should also be remedied. Solving or reducing moisture problems may in itself end or halt the progress of rot and wood-destroying insects.

Log Repair

Stabilizing and repairing a log that has been only partially damaged by decay or insects is always preferable to replacing it. Retaining the log, rather than substituting a new one, preserves more of the building's integrity, including historic tool marks and the wood species which may no longer be obtainable in original dimensions. Log repair can generally be done with the log in place at less cost, in less time, and with less damage to building fabric, than by removing, and installing a new hewn and notched replacement log. Log repair is accomplished by two basic methods: traditional methods of splicing-in new or old wood, or through the use of epoxies. These treatments are sometimes combined, and may also be used in conjunction with reinforcing members. *Historic log repair, whether it involves patching techniques or the use of epoxies, should always be performed only by an experienced craftsperson or architectural conservator.*

Wood Splicing

Wood splicing can involve several types of techniques. Also referred to as "piecing-in" or "Dutchman" repair, it involves treating a localized area of deterioration by cutting out the decayed area of the log, and carefully carving and installing a matching, seasoned wood replacement plug or splice. The wood species, if available, and the direction and pattern of the grain should match that of adjacent original wood. The location and depth of decay should determine the splicing technique to be used. In a case where decay runs deep within a log, a full-depth segment containing the affected area can be cut out, severing the log completely, and a new segment of log spliced in, using angled "scarf" joints or square-cut "half-lap" joints (Fig. 19). The splice is secured to the severed log by angling lag screws or bolts through the upper and lower surfaces that will be concealed by daubing.

Splicing can also be performed using epoxy as an adhesive. A log with shallow decay on its outer face can be cut back to sound depth, and a half-log face spliced on, adhered with epoxy, screws or bolts. A technique for the repair of badly deterioriated log crowns involves cutting them back to sound wood, and into the notching joint if necessary, and installing new crowns cut to match. Fiberglass or aluminum reinforcement rods are inserted into holes drilled into the new crowns, and into corresponding holes drilled in the ends of the original cut-off logs. Epoxy is used as an adhesive to attach and hold the new crowns in place. Long lag screws can be angled up through the underside of the crown into the log above to provide additional support for the repair.

Epoxy Consolidation and Repair

In some instances, epoxies may be used by themselves to consolidate and fill the voids left by deteriorated wood. Epoxies are versatile in performance, relatively easy to use by experts, and, after curing, may be shaped with wood-working tools. Their use requires that sufficient sound wood survives for the epoxy to adhere. But they can be used to stabilize rotted wood, return full or greater than original strength to decayed structure-bearing members, and to reconstitute the shape of decayed log ends. Epoxies resist decay and

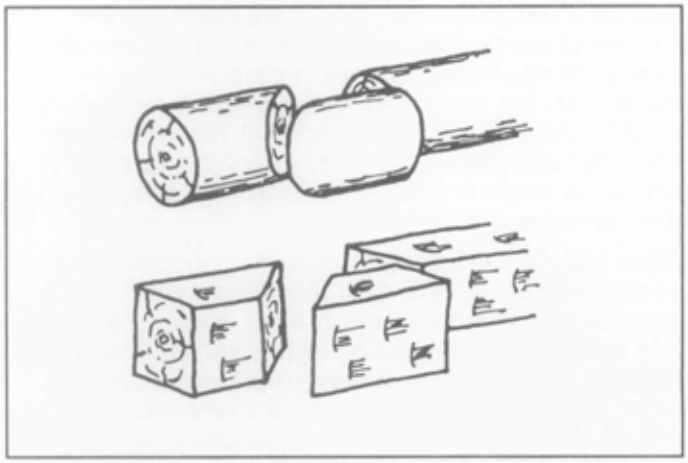
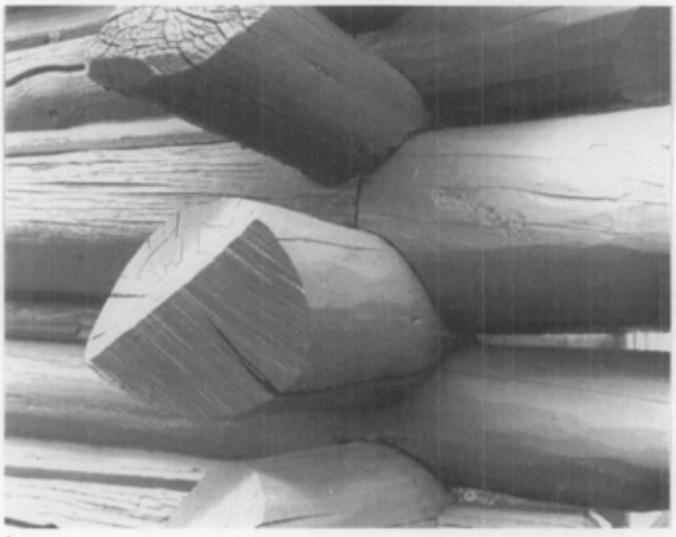


Fig. 19. Log splicing with scarf joints. Drawing: Harrison Goodall.

a



b

Fig. 20. (a) These deteriorated log crowns were (b) repaired with new crowns which were attached to the historic logs with reinforcing bars and epoxy. Epoxy repair of log crowns is most successful when the repaired crowns are protected from excess moisture by a roof overhang. Photos: Harrison Goodall.

insects, and while epoxy itself is resistant to moisture, epoxy tends to cause adjacent wood to retain moisture rather than dry out, and if not used in the right location, can actually further a continuing cycle of wood decay. Hence, epoxy repairs are most successful in areas where they are protected from moisture. Epoxies, of which there are a variety of commercially-available products on the market, are prepared in essentially two forms: a liquid consolidant and a flexible putty filler. Each consists of a resin and a hardener which must be mixed prior to use.

The technique of treating, for an example, a decayed log crown with epoxies is begun by removing loose decayed wood, and drying the area if necessary (Fig. 20). The rot-affected cavity and surface of the log end is then saturated with liquid epoxy by repeated brushing, or by soaking it in a plastic bag filled with epoxy that is attached to the log. The porous condition of the rot-damaged wood will draw up the epoxy like a lamp wick. Once the liquid epoxy has saturated the log end and cured, the log end has been consolidated, and is ready for the application of an epoxy putty filler. The filler resin and hardener must also be mixed; pigments must be mixed with the filler epoxy to color the patch, and more importantly to protect it from ultraviolet sunlight. The filler can be applied with a putty knife, pressing it into the irregularities of the cavity. The cured patch can be worked like wood and painted with an opaque stain or a dull finish paint to help it blend with surrounding wood, although epoxy repairs can be difficult to disguise on natural, unpainted wood.

Epoxies can be used to consolidate and repair other areas of a log, including rotted internal areas which have not yet progressed to damage the log's outer surface. Saturation of small internal areas can be accomplished by drilling several random holes into the log through an area that will be concealed by daubing, and then pouring in liquid epoxy. If a pure resin is used, it should be a casting resin to minimize shrinkage, and it is best to fill voids with a resin that contains aggregates such as sand, or micro-balloons. Epoxy is frequently used by architectural conservators to strengthen deteriorated structural members. The damaged log can be strengthened by removing the deteriorated wood, and filling the void by imbedding a reinforcing bar in epoxy filler, making sure the void is properly sealed to contain the epoxy before using it (Fig. 21). Sometimes larger decayed internal areas of a log can be more easily accessed and repaired from the interior of a structure. This may be a useful technique if it can be accomplished without causing undue damage to the interior finishes in the log building. However, despite its many advantages, epoxy may not be an appropriate treatment for all log repairs, and it should not be used in an attempt to conceal checking, or extensive log surface patching that is exposed to view, or logs that are substantially decayed or collapsed.

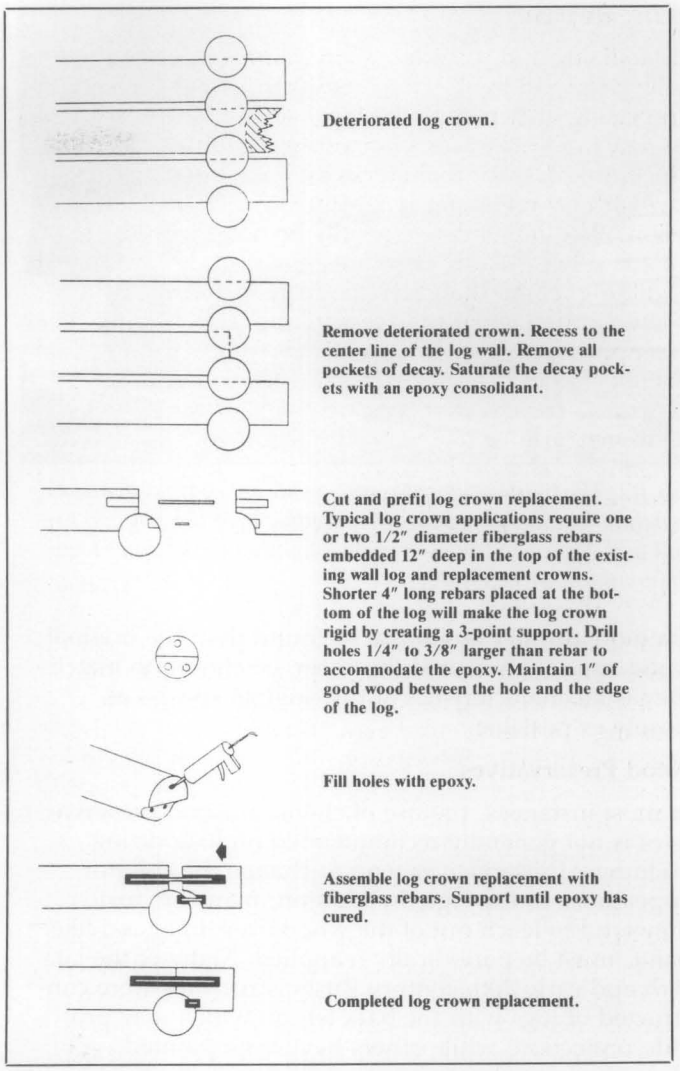


Fig. 21. Epoxy repair. Drawing: Harrison Goodall.

Log Replacement

Repairing or replacing only a segment of a log is not always possible. Replacement of an entire log may be the only solution if it has been substantially lost to decay and collapsed under the weight of logs above it. Log replacement, which should be carried out only by experienced craftspersons, is begun by temporarily supporting the logs above, and then jacking them up just enough to insert the new log. Potential danger to the structure may include creating inadequate temporary bearing points, and crushing chinking and interior finishes which may have settled slowly into non-original positions that cannot withstand jacking.

To begin the process of log replacement, the entire length of the log must be inspected from the exterior and the interior of the structure to determine whether it supports any structural members or features, and how their load can be taken up by bracing during jacking and removal. On the exterior, sheathing such as weatherboard, and adjacent chinking, must be removed along the length of the log to perform this inspection. Likewise, on the interior, abutting partition walls and plaster may also need to be removed around the log to determine what, if any, features are supported by or tied into the log to be removed.

A replacement log should be obtained to match the wood species of the original being removed. If it is a hewn log, then the replacement must be hewn to replicate the dimensions and tool marks of the original (Fig. 22). If the same wood species cannot be obtained in the original dimensions, a substitute species may have to be used, and may even be preferable in some instances

Fig. 22. The lighter-colored replacement log in this barn matches the dimensions and hewing marks of the original logs, and will darken in time to blend visually with the other logs. Photo: Bernard Weisgerber.

if a more durable wood can be found than the original wood species. It should, however, be chosen to match the visual characteristics of the original species as closely as possible.

Wood Preservatives

In most instances, the use of chemical wood preservatives is not generally recommended on historic log buildings. Preservatives tend to change the color or appearance of the logs. In addition, many are toxic, they tend to leach out of the wood over time, and like paint, must be periodically reapplied. Many of the late 19th and early 20th century Rustic structures were constructed of logs with the bark left on which may provide protection, while others have been painted. However, some log buildings, and especially log houses that have been inappropriately stripped of historic cladding in an earlier restoration, and now show signs of weathering, such as deep checking, may be exceptions to this guidance. A preservative treatment may be worth considering in these cases. Boiled linseed oil may sometimes be appropriate to use on selected exposures of a building that are particularly vulnerable to weathering, although linseed oil does tend to darken over time. Borate solutions, which do not alter the color or appearance of wood, may be another of the few effective, non-hazardous preservatives available. However, borate solutions do not penetrate dry wood well, and thus the wood must be green or wet. Because borate solutions are water-soluble, after treating, the wood must be coated with a water-repellent coating. In some instances, it may be appropriate to reapply varnish where it was used as the original finish treatment. Pressure-treating, while effective for new wood, is not applicable to in-place log treatment, and is generally not effective for large timbers and logs because it does not penetrate deeply enough.

Foundation Repair

The foundation should have good drainage, be stable, adequately support the building as well as any future floorloads, and keep the sill log sufficiently clear of the ground and moisture to deter decay and insect infestation. Log buildings with cellars are less likely to suffer problems than those built upon the ground or with crawl spaces, as long as the cellar is kept dry and ventilated. Because the foundations of many log buildings were neither dug nor laid below the frostline, they generally tend to be susceptible to freeze-thaw ground heaving and settlement. Also, as previously noted, some foundations consisted of wooden sleepers or pilings in direct contact with the ground. If a foundation problem is minor, such as the need for repointing or resetting a few stones, work should address only those areas. Loose stones should be reset in their original locations if possible. A clearly inadequate foundation that has virtually disappeared into the ground, or where large areas of masonry have buckled or sunk, resulting in excessively uneven or active settlement, will need to be rebuilt using modern construction methods but to match the historic appearance.

Chinking Repair

Repair of chinking, whether it is finished on the exterior with wooden strips or with daubing, should not be done until all log repair or replacement, structural jacking and shoring is completed, and all replacement logs have seasoned. Historically, patching and replacing daubing on a routine basis was a seasonal chore. This was because environmental factors—building settlement, seasonal expansion and contraction of logs, and moisture infiltration followed by freeze-thaw action—cracks and loosens daubing. If the exterior log walls are exposed, and the chinking or daubing requires repair, as much of the remaining inner blocking filler and daubing should be retained as possible. A daubing formula and tooled finish that matches the historic daubing, if known, should be used, or based on one of the mixes listed here. For the most part, modern commercially-available chinking products are not suitable for use on historic log buildings, although an exception might be on the interior of a log building where it will be covered by plaster or wood, and will not be visible. These products tend to have a sandy appearance that may be compatible with some historic daubing, but the color, and other visual and physical characteristics are generally incompatible with historic log surfaces.

Sections of wood chinking which are gone or cannot be made weathertight should be replaced with same-sized species saplings or quarter poles cut to fit. Generally, unless bark was used originally, it should be removed before nailing the new wood chinking replacements tightly into place.

Analysis of daubing can be done in much the same way as mortar analysis. If that is not feasible, by crushing a loose piece of daubing its constituent parts can be exposed, which may typically include lime, sand, clay, and, as binders, straw or animal hair. The color imparted by the sand or pigmented constituents should be noted, and any areas of original daubing should be recorded with color film for later reference. Daubing that is loose or is not adhered to the logs must first be cleaned out by hand. Blocking filler should be left intact, refitting only loose pieces. (Sometimes it may be difficult to obtain a good bond in which case it may be necessary to clean out the joint entirely.) If needed, soft filler should be added, such as jute or bits of fiberglass batt, pressed firmly into voids with a stick or blunt

tool. Concealed reinforcement may sometimes be used, depending upon the authenticity of the restoration. This can include galvanized nails partially inserted only on the upper side of the log to allow for the daubing to move with the upper log and keep the top joint sealed, or galvanized wire mesh secured with galvanized nails (Fig. 23). Like repointing masonry, daubing should not be done in full sun, excessive heat or when freezing temperatures are expected. The daubing materials should be dry-mixed, the chinking rechecked as being tight and secure, and the mix wetted and stirred to a stiff, paste-like consistency. The mix dries quickly, so no more daubing should be prepared at a time than can be applied in about 30 minutes. A test patch of new daubing, either on the building, or in a mock-up elsewhere, will help test the suitability of the formula's color and texture match.

Before applying the daubing, the chinking area, including filler and log surfaces to be covered, should be sprayed with water to prevent the dry filler from too rapidly drawing off the daubing moisture which will result in hairline cracking. A trowel, ground to the width of the daubing, is used to press the daubing into the chinking space, and to smooth the filled areas. Wide or deep chinking spaces or joints may have to be daubed in layers, to prevent sagging and separation from the logs, by applying one or two scratch coats before finishing the surface.

Daubing Mixes

	parts (volume)	material
Mix A.	1/4	cement
	1	lime
	4	sand
	1/8	dry color
		hog bristles or excelsior

(Donald A. Hutslar, "Log Cabin Restoration: Guidelines for the Historical Society," American Association for State and local History, Technical Leaflet No. 74, "History News," Vol. 29, No. 5 (May 1974.)

Mix B.	6	sand
	4	lime
	1	cement
Mix C.	1	portland cement
	4–8	lime
	7–10	sand

Mix B and C are reprinted from "Log Structures: Preservation and Problem-Solving," by Harrison Goodall and Renee Friedman, Nashville, TN: American Association for State and Local History, 1980.

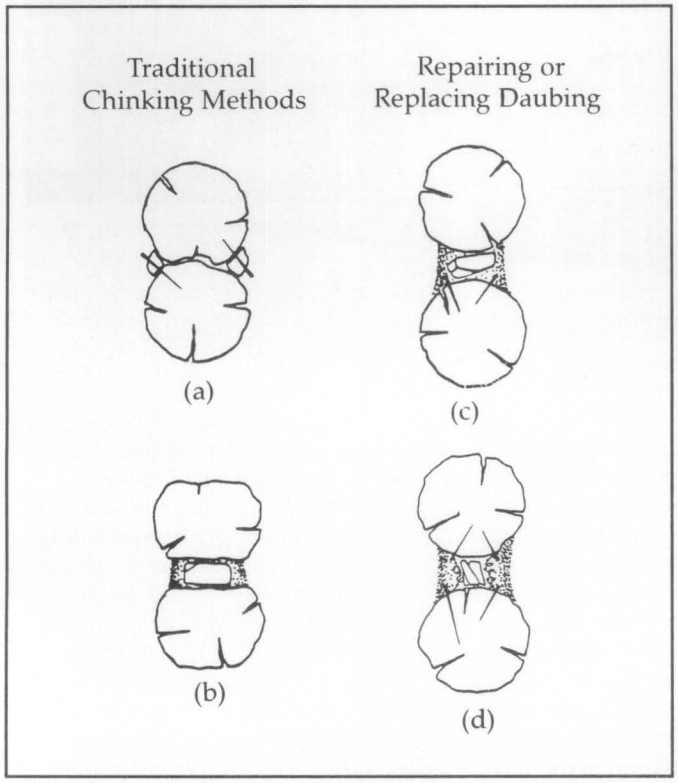


Fig. 23. Illustrated are various methods of chinking and daubing: (a) wood strips, or thin saplings nailed in place; and (b) 3-part system consisting of an inner blocking filler of stones or wood slabs, together with soft filler, such as clay, stuffed around the blocking, composes the chinking, and wet-applied daubing. Concealed aids that may improve the adherence of new daubing include (c) galvanized nails, or (d) galvanized mesh lath. Drawing: James Caufield.

Portland cement was a part of the original daubing used in many late 19th and early 20th century log buildings, and is therefore appropriate to include in repairing buildings of this period. Although a small amount of portland cement may be added to a lime, clay and sand mix for workability, there should not be more than 1 part portland cement to 2 parts of lime in daubing mixes intended for most historic log buildings. Portland cement tends to shrink and develop hairline cracks, and retain moisture, all of which can be potentially damaging to the logs.

Interior Treatments

There is no single appropriate way to finish or restore the interior of a historic log house. Each building and its history is unique. The temptation should be resisted to impart an unfinished frontier character by removing plaster to expose interior log walls or joists in the ceiling. Instead, interior treatments should be based on existing evidence, and guided by old photographs, written documentation, and interviews with previous owners. Interior features and finishes that might exist in some 18th and 19th century log houses include wood paneled walls, wood moldings, stairs, and fireplace mantels; where they have survived, these features should be retained. Many of the more rustic log buildings built later in the 19th or early 20th century intentionally featured exposed interior log walls, sometimes with the logs peeled and varnished. If interior plaster is severely damaged or has previously been removed, and evidence such as lath ghosting on the logs exists, walls should be replastered or recovered with gypsum board or dry wall to match the historic appearance.

a

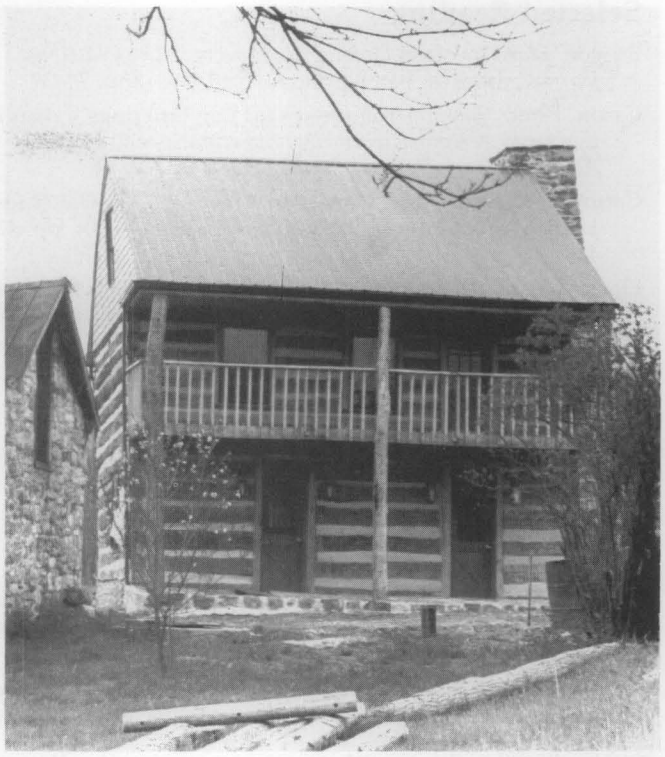
Preserving Log Buildings in Their Historic Settings

Log buildings are too often viewed as portable resources. Like other historic buildings, moved or relocated log structures can suffer a loss of integrity of materials and of setting (Fig. 24). Historic buildings listed in the National Register of Historic Places may be subject to loss of that status if moved. Despite the popularity of dismantling and relocating log buildings, they should be moved only as a last resort, if that is the only way to save them from demolition. If they must be moved, it is preferable that they be moved intact—that is, in one piece rather than disassembled. Disassembling and moving a log building can result in considerable loss of the historic building materials. While the logs and roof framing members can be numbered for reassembly, dismantling a log building can result in loss of such features as foundation and chimney, chinking and daubing, exterior cladding, and interior finishes. Furthermore, log buildings can rarely be put back together as easily as they were taken apart.

b

Fig. 24. Some towns still retain a high number of early log houses. (a) Middleway, West Virginia, is a small village dominated by 18th and 19th century log houses, and, with the exception of outbuildings, all are clad in original wood siding or stucco. Removal of one of the houses from this streetscape would not only result in a loss of integrity to the building, but also to the historic district. (b) The original wood clapboard of two of these c. 1830 log houses in Stouchsburg, Pennsylvania, has been covered with asphalt siding, and later porches added. Rehabilitation plans might appropriately include retention of the porches as having acquired significance over time, and removal of the asphalt siding. Uneven spacing between the two upper left windows of the house on the left, and the center chimney are indications that the house was built in two stages. Photos: (a) Anne Grimmer, (b) Pennsylvania Historical and Museum Commission.

a



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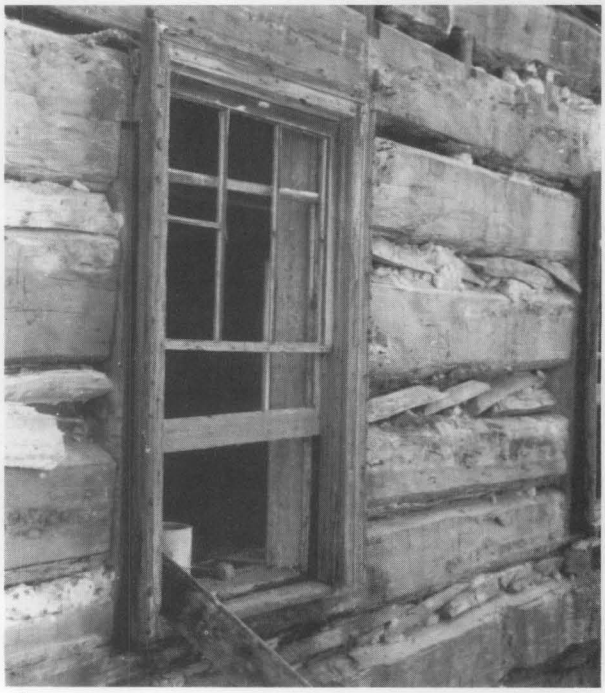

c

Fig. 25. (a) Prior to rehabilitation, the exterior of this late 18th century log house was sided with wood clapboard, which had been covered over by a later artificial siding, while the upper gallery of the second floor porch was stuccoed. (b) During the rehabilitation both the historic wood siding and stucco were removed to expose the logs, the gables were sided with wood shingles, and what would have originally been milled wood columns supporting the porch were replaced with rough, unmilled log posts. Collectively, these treatments diminished the building's architectural integrity, and gave it an appearance it never had. (c) The depth that the window frames extend out beyond the log surface allowing space for siding is an indication that cladding was part of the building's original construction. Photos: National Park Service Files.

Summary

Historic log buildings regardless of whether they are of horizontal or vertical construction, or whether they are 18th century log houses or early 20th century Rustic style cabins, are unique. Their conservation essentially centers on the preservation and repair of the logs, and appropriate repairs to chinking and daubing, which like repointing of masonry, is necessary to ensure that most log buildings are weathertight. Log building preservation may be accomplished with a variety of techniques including splicing and piecing-in, the use of epoxy, or a combination of patching and epoxy, and often, selected replacement. But, like any historic building, a log structure is a system that functions through the maintenance of the totality of its parts.

The exterior of many of the earliest late 18th and 19th century log buildings, and particularly those east of the Mississippi, were commonly covered at the time of construction or later with some type of cladding, either horizontal or vertical wood siding, stucco, or sometimes a combination. If extant, this historic cladding, which may be hidden under a later, non-historic artificial siding such as aluminum, vinyl, or asbestos, should be preserved and repaired, or replaced if evidence indicates that it existed, as a significant character-defining feature of the building (Fig. 25).

Selected Reading

Briscoe, Frank. "Wood-Destroying Insects." *The Old-House Journal.* Vol. XIX, No. 2 (March/April 1991), pp. 34–39.

Caron, Peter. "Jacking Techniques for Log Buildings." *Association for Preservation Technology Bulletin.* Special Issue: *Alberta Culture.* Vol. XX, No. 4 (1988), pp. 42–54.

Cotton, J. Randall. "Log Houses in America." *The Old-House Journal.* Vol. XVIII, No. 1 (January/February 1990), pp. 37–44.

Elbert, Duane E., and Keith A. Sculle. *Log Buildings in Illinois: Their Interpretation and Preservation.* Illinois Preservation Series: Number 3. Springfield, IL: Illinois Department of Conservation, Division of Historic Sites, 1982.

Goodall, Harrison. "Log Crown Repair and Selective Replacement Using Epoxy and Fiberglass Reinforcing Rebars: Lamar Barn, Yellowstone National Park, Wyoming." *Preservation Tech Notes,* Exterior Woodwork Number 3. Washington, D.C.: Preservation Assistance Division, National Park Service, U.S. Department of the Interior, 1989.

_____, and Renee Friedman. *Log Structures: Preservation and Problem-Solving.* Nashville, TN: American Association for State and Local History, 1980.

Hutslar, Donald A. *The Architecture of Migration: Log Construction in the Ohio Country, 1750–1850.* Athens, OH: Ohio University Press, 1986.

_____. *Log Cabin Restoration: Guidelines for the Historical Society.* American Association for State and Local History Technical Leaflet 74. *History News.* Vol. 29, No. 5, May 1974.

Jordan, Terry G. *American Log Buildings: An Old World Heritage.* Chapel Hill, NC: The University of North Carolina Press, 1985.

Kaiser, Harvey H. *Great Camps of the Adirondacks.* Boston: David R. Godine Publisher, Inc., 1986.

Merrill, William. "Wood Deterioration: Causes, Detection and Prevention." American Association for State and Local History Technical Leaflet 77. *History News.* Vol. 29, No. 8, August, 1974.

Rowell, R.M., J.M. Black, L.R. Gjovik, and W.C. Feist. *Protecting Log Cabins from Decay.* U.S.D.A. Forest Service Products Laboratory, General Technical Report, FPL–11. Madison, WI: Forest Products Laboratory, Forest Service, U.S. Department of Agriculture, 1977.

St. George, R.A. *Protecting Log Cabins, Rustic Work and Unseasoned Wood from Injurious Insects in the Eastern United States.* Farmer's Bulletin No. 2104, United States Department of Agriculture. Washington, D.C.: Government Printing Office, 1962 (Rev. 1970).

Tweed, William C., Laura E. Soulliere, and Henry G. Law. *National Park Service Rustic Architecture: 1916–1942.* San Francisco, CA: Division of Cultural Resource Management, Western Regional Office, National Park Service, February 1977.

Wilson, Mary. *Log Cabin Studies.* Cultural Resources Report No. 9. Ogden, UT: United States Department of Agriculture, Forest Service, 1984.

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Cover Photograph (logo): The log cabin was used on this 1840 campaign medal to symbolize frontier life and democratic egalitarianism, a platform that successfully elected William Henry Harrison to the presidency. Photo: The State Museum of Pennsylvania, Pennsylvania Historical and Museum Commission.

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