

PRESERVATION

Tech Notes



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Cultural Resources

Preservation Assistance Division

EXTERIOR
WOODWORK

NUMBER 4

Protecting Woodwork
Against Decay Using Borate
Preservatives

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TOTEM POLES

Sitka National Historical Park
Sitka, Alaska

The totem pole collection at Sitka National Historical Park embodies the rich carving traditions — past and present — of Southeast Alaskan Natives. Started in the early 1900s, the collection was one of the significant factors for the park's designation as a National Monument in 1910. Deterioration of the poles' in-ground wood due to fungal decay necessitated making new base supports for seven poles. As part of the project, the carvings on the red cedar poles were treated with a borate wood preservative in order to protect them against

fungal decay and insect damage. This treatment has broad potential applicability for the preservation of exterior woodwork on structures, site features and objects.

Problem

Famous as the capital of Russian-America and the home of the Tlingit Indians, Sitka is located along the southeast coast of Alaska. It has a relatively mild, yet very moist, climate with more than 95 inches of rainfall annually. The famous outdoor totem pole collection at the national

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*Proper preservation treatments
and regular maintenance are essential
for effective protection of exterior
woodwork.*



Figure 1. Some of the Sitka totem collection shown on display at the 1904 Louisiana Purchase Exposition. Totem poles (totems) generally serve one of four purposes: crest poles give the ancestry of a particular family; history poles record the history of a clan; legend poles illustrate folklore or real life experiences; and memorial poles commemorate a particular individual. The first recorded sightings were by European explorers and traders in the late 18th century. Detached exterior poles reached their zenith in the late 19th century, standing along the village fronts of the Haida and Tlingit Indians of northern British Columbia and extreme southeast Alaska.

park has suffered from the effects of moisture throughout much of the twentieth century. The most serious fungal decay recently encountered occurred at the base of the poles, although fungal growth and structural problems, including splits and cracks, were prevalent on the above-ground carvings as well.

Replicating poles at Sitka for outdoor display is a treatment practiced at the park as early as the 1930s. However, re-carving inevitably results in the loss of the original craftsmanship as well as the original artistic expression. Today, the National Park Service strives to extend the life of the totems for outdoor display as long as possible. Older original totems that have survived have been relocated indoors for exhibit or storage because of their significance and condition. The older replicas and the more recently carved new totems are being maintained and conserved for outdoor display.

Past Treatments

Of the seven standing poles that were identified as in most serious need of preservation work, it is now believed that one (Yaadaas Crest Pole) dates to the 19th century and was part of the original collection assembled by the District of Alaska territorial governor John Brady and displayed at the 1904 Louisiana Purchase Exposition in St. Louis (see figure 1). This totem will be exhibited indoors. The other six poles are early replicas of ones in the park collection that were too deteriorated for outside display. Five of the replica poles had been carved during the 1930s by Alaskan Natives employed by the Civilian Conservation Corps. The remaining pole (Raven/Shark) is a 1978 reproduction of an original pole carved for the 1964 New York World's Fair, which was moved indoors in 1978 due

to deterioration. All 7 poles were hollowed out on the back side at varying lengths above ground. Four poles (Waasgo Legend, Lakich'inei, Yaadaas Crest and Raven/Shark) were mounted with steel bolts onto separate supporting posts that were set into the ground (see figure 2). The Mosquito Legend, Trader Legend and Frog Raven replicas, carved by the Civilian Conservation Corps, have concave backs (above ground only), with the full butt section of the carved poles extending into the ground — the original method for erecting totems.

A wide range of treatments was undertaken over the years to prolong the life of the poles. Some of the poles in the original collection may have had serious problems with base deterioration even in 1905 with "advanced decay" being reported by 1938. Rotted sections were cut out and re-carved pieces attached in some areas during the 1930s. Exposed surfaces were treated with creosote in 1938. Between 1938 and 1940, some poles were repaired and others re-carved completely. Yellow cedar logs, used as mounting posts, were treated with Avenarius Carbolineum® (highly refined penetrating creosote oil). Above-ground poles were treated with Permatox® (sodium pentachlorophenate) concentrate and coal tar, repainted and then treated with Perma Seal® varnish. By 1965, poles were being treated with pentachlorophenol. In 1972–73, the poles were taken down, most of the paint removed, then immersed in sodium fluoride and copper sulfate as a protective measure and the bases treated with "penta grease." Between 1976 and 1984, the poles were treated with a wax-mineral oil-varnish mixture (scheduled for reapplication every 3 years) and the poles were sprayed annually with 10% pentachlorophenol solution from 1976 to

1980. Since the wax-mineral oil-varnish mixture was not really effective, this treatment was discontinued by 1985.

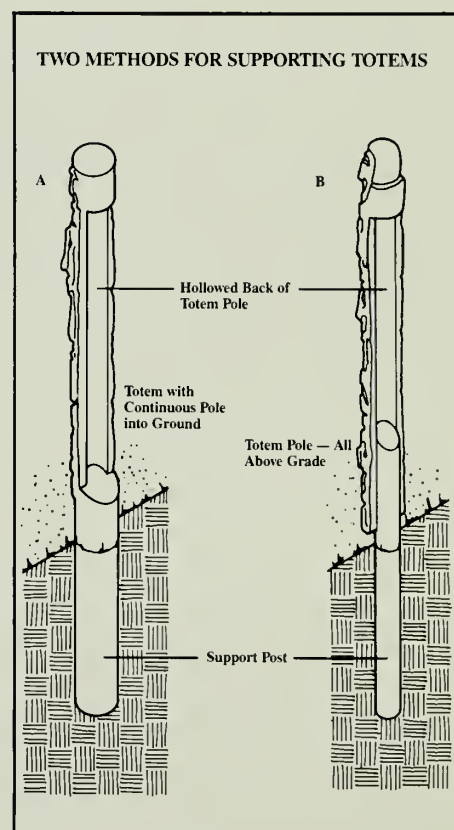


Figure 2. Two methods existed for securing the totems in place. Each of the 3 totems replicated by the Civilian Conservation Corps consisted of one continuous pole which extended into the ground (A). The other 4 totems did not extend into the ground but, rather, were attached to a separate supporting post (B). Due to the deteriorated wood below grade, all 7 totems are being re-erected using separate support posts (B). Drawing: Timothy Buehner.

Condition Survey

In 1991, a 3-day Totem Preservation Conference was held in Sitka to evaluate preservation approaches and a condition survey made of the collection. The survey included 30 carved poles and carved house poles at the park; some were on display and others were in storage (see figure 3).

The 7 poles determined to be in the most advanced state of decay shared several characteristics. They were all displayed outside and, in consequence, their bases were decayed. In several cases, the moisture content of the wood to 6" above ground was an high as 47% and fungal decay on the surface was clearly evident. Damage to the bases had occurred directly above ground and below grade to a depth of 18".

Although less serious than the damage to the bases, fungal decay also had occurred at other locations. At the top of the poles, the open end grain and cracks in the wood created perfect conditions for water retention (see figure 4). Some of the poles were flat at the top, permitting water ponding. Fungal decay also was evident on the horizontal surfaces of the carvings throughout the length of the poles, in crevices created by carvings, and in the cracks and splits in the wood where organic debris tended to accumulate and retain moisture. One pole had an 8 foot-long vertical split at the base. Finally, decay was evident in the concave backs of the poles that abutted supporting posts (see figure 5).

Solution

New support posts for the poles needed to be installed, including three that had been replaced in earlier work projects. Of greater concern, however, was choosing an appropriate method of treating the carvings along the pole to reduce water penetration and fungal decay. Three treatment goals were identified

- To provide effective protection for above-ground wood while minimizing hazards to both applicators and the environment.
- To utilize a treatment as "reversible" as possible in the event unforeseen problems or the availability in the future of improved preservation treatments.
- To minimize changes in the appearance of the wood.

After investigation of various possible techniques, the decision was made to apply a borate preservative followed by a water repellent coating.

Borates

The prime advantage of using borate preservatives rather than other preservatives

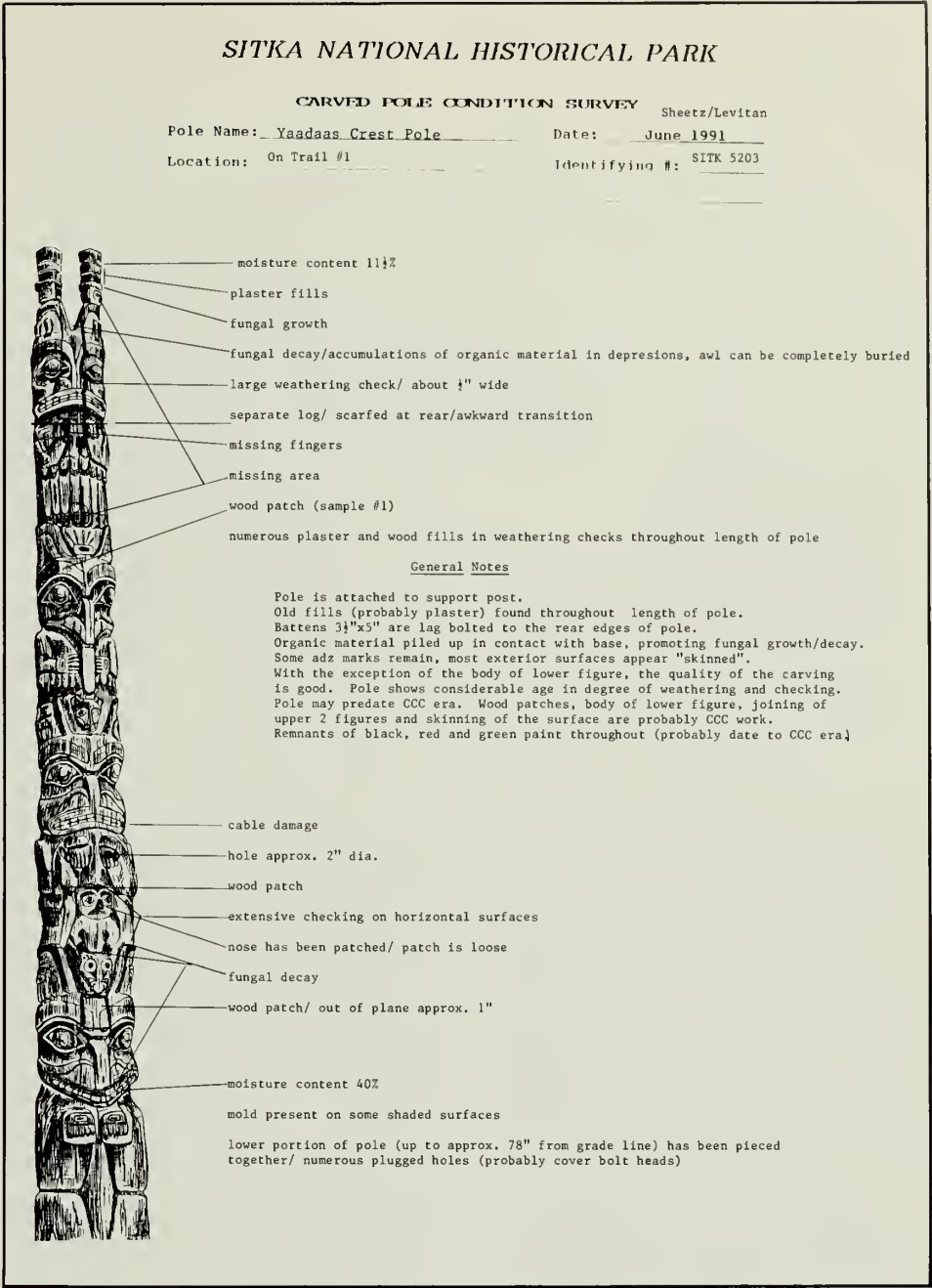


Figure 3. A condition survey of each of the 7 totem poles identified a variety of problems, including fungal decay, cracks and splits, and high moisture levels.

is that they are effective against brown rot and white rot fungi and most wood-destroying insects while being relatively safe for both users and the environment. Borate is a generic term for boron compounds containing the element oxygen. Boron is very toxic to most decay fungi and insects that commonly damage wood, including carpenter ants, most wood-destroying beetles and termites. While it penetrates wet wood better than dry wood and is used more commonly as a preservative for unseasoned wood, commercially available mixtures of borate and ethylene glycol provide protection even for seasoned wood. Aided by the ethylene glycol (a thick

liquid alcohol), the borate solution diffuses into the wood, with greater penetration of the outer areas and also into moist areas. The ethylene glycol used in commercial preparations will evaporate in a short time. Thus the mixture will wet and briefly darken freshly treated wood. However, this discoloration will usually diminish within a few days. After the glycol volatilizes, the treatment will not affect subsequent painting, staining or the gluing of wood (appropriate glues must be used). In addition, borate compounds are not corrosive to most metal fasteners, although aluminum and galvanized metal may be affected. Borate penetration of wood can be



Figure 4. Organic debris had collected in the splits and cracks, contributing to moisture retention and fungal growth.



Figure 5. Deterioration occurred between the support post and the hollowed back of the totem. Coal tar had been applied in the past to the hollowed back of this totem to deter fungal decay.

readily detected by use of an applied color test for boron, but it does require slicing off a section of the wood. The work with the totem poles involved removing an underground butt section, treating it with borate and water repellent, and placing it outdoors to serve as a test.

There are some disadvantages. Borate compounds are not effective in controlling mildew fungi or soft-rot fungi. Borates are water soluble and may leach out of the surface when exposed to frequent wetting. Borates also are not as effective for applications on wood that will be used below grade, unless formulated with a co-biocide and protected from leaching. For above-grade, unpainted wood, subject to frequent wetting, a stain, paint or water repellent coating is desirable after treatment with borate preservatives. (The fact that borates are water soluble does provide for "reversibility" if there are unforeseen problems in the future.) During applications, care must be taken to protect nearby vegetation since borates are non-selective herbicides and are toxic to plants. Finally, the borate solution does not penetrate when applied to painted surfaces.

Water Repellent

It was decided that a water repellent with a mildewcide additive should be applied, after treating the totems with a borate wood preservative. A commercially available oil based water repellent was selected. According to the manufacturer, the paraffin oil penetrates the wood to form a water

sealant while the soybean oil, reacts with oxygen and hardens to bond with surface fibers of the wood. The selected water repellent included in the mixture the mildewcide Busan 1009®, which is classified as a low-toxic chemical and has an odor that will dissipate in about a week's time. Application of a water repellent was considered necessary since frequent wetting of the poles would result in the borates leaching out of the unpainted wood. The mildewcide was used to reduce staining from mildew growth on the carvings. Like most water repellents, this one also caused some darkening of the wood. This was considered but some darkening was deemed acceptable, particularly since it will lighten over time. Since the effectiveness of most water repellents diminishes with age, reapplications to the totem poles will probably be needed approximately every 3 years. Samples to be taken from the test log in the future will help determine when reapplication of the borates may be needed.

Pole Preservation Procedures

The weather and work conditions necessitated that the project be done in two phases. Four poles were done in the first phase. Using a large crane and other equipment, the 1 to 2 ton totems were cut off at the decayed bases and removed to a covered area. The poles were then cleaned, using brushes to apply denatured alcohol in water in a 50/50 mixture. This was done to remove lichen, moss, and mold that was widespread at the top and at the

base. Support posts were detached by removing the 1/2" all-thread steel rods that had connected the posts to the carved poles (see figure 6). The totem poles then were cleaned with water using natural bristle brushes and a garden hose with a spray attachment. Since the red cedar poles had



Figure 6. Three of the 7 totems had support posts. The steel bolts connecting the support posts to the totem had rusted and often needed to be chiseled out of the support post. Note the hollowed back of the totem which extended nearly the entire length while the support post extended only about half way.

been exposed to rain, the use of water to clean them didn't present any problems.

Small pockets of decayed wood were removed from the totems. These usually occurred near the base and where the totem poles abutted the support posts at the back. Most of these pockets were small enough that patching with new wood was not warranted. All the totems had checks and splits, some as wide as one inch. Over the years, many had been filled with a variety of materials, including Plaster of Paris, wood shims, and wood filler compounds. Others were untreated but had collected organic matter. These filler materials had not moved with the old wood as it expanded and contracted. Thus, much of the filler material had separated from the wood, allowing retention of moisture that seeped in behind it. Each filled crack or split was first documented and, in most cases, the filler was removed, using compressed air, brushes, spatulas, and other small implements.

Small cracks and splits were similarly cleaned. Borates and water repellents would be used to retard water penetration and provide protection from insects and fungal decay. Large splits and cracks were handled differently because of a possible loss of structural integrity. They were filled with a flexible epoxy, fumed silica and micro-balloon mix, and then covered with an oil stain to blend with the adjacent old wood. The water repellent coating was then applied over the oil stain. In some instances where wood had been inlaid and recarved during earlier repairs, reattachment of these patches was done using an epoxy adhesive. (Future repairs with adhesives would require removal of the

water repellent coating using a solvent since most adhesives do not bind to wood coated with a water repellent. Most exterior adhesives, however, will bind to wood treated with borates).

Following repairs, the poles were first treated with a commercially available borate preservative. It was purchased as a concentrate and diluted with warm water in a 1:1 mixture in accordance with label instructions. With the pole on its back, supported by cribbing and padding, the ends were treated with a brush application of the preservative as well as with any end grain exposed by carvings. The preservative was then sprayed onto the rest of the pole using a 2-gallon garden sprayer (see figure 7). This was followed by a second coat, spraying slowly to ensure all cracks and crevices received ample coverage. The poles were sprayed until thoroughly wet and rotated with a chain hoist as needed. Near the surface, where wood was over-saturated with the preservatives, boron salts fluoresced on the surface after the glycol and water evaporated. The fluorescence was removed by wiping with a wet brush. After waiting several days for the surface to dry from the application of the wood preservative, the water repellent and mildewcide mix then was sprayed onto the pole, again using a garden sprayer to apply the mix and a brush to spread it.

Support Posts

Each of the totems needed to be fitted with a new support post. The support system selected consisted of a yellow cedar log, each engineered to size, that extended above and below grade. The yellow cedar log was shaped to fit against the concave back

of the totem and bolted to it with fiberglass all-thread rods, thereby providing lateral support. Yellow cedar was chosen for the replacement bases. Yellow cedar was readily available in the required sizes and has a decay resistance similar to red cedar. Pressure-treated logs meeting project requirements were not commercially available in the Sitka area. Since the greatest deterioration would be at and below grade, a preservative treatment that could be applied in the field was necessary to facilitate future reapplications. Since major deterioration had occurred in the red cedar bases from the ground to 18" below grade, some additional protection was needed in the corresponding area of the new yellow cedar support posts.

After careful study, the decision was made to apply to the bases of the support posts a preservative in paste form that consisted of copper naphthenate and borax. This method had been developed to treat the groundline of utility poles. Copper naphthenate protects the outer layers of wood and is not readily leachable. The borate is not fixed and will move with the moisture in the wood, throughout the cross-section. A prepared bandage, consisting of the paste, applied to a polyethylene-backed wrap (bandage), was stapled to the support post so that it covered the post from 3" above ground to 18" below the ground. It was anticipated that the copper naphthenate might migrate up the base about 6" above the bandage, giving a greenish color visible on the support base. This discoloration was not considered objectionable in the case of the support poles, since most of them at Sitka are already greenish in color at the base from



Figure 7. Borates were applied to the totem using a garden sprayer and brushes. This was followed by an application of a water repellent with mildewcide. Photo A is during application and photo B shows totems while drying.



Figure 8. Due to the heavy weight of the totems, they were usually attached to their fitted support post and re-erected at the site.

mold and mildew. The utilization of a wrap or bandage was considered the most effective application method and, in addition, it would retard the borate from leaching out of the wood. It is anticipated that the wraps will be inspected in 10 years to assess their condition and possible replacement. (This would only require removal of the dirt around the bases to a depth of approximately 20" so that a new wrap could be applied, if needed.)

Upon securing the support post to the totem, the entire unit was re-erected (*see figure 8*). The prepared bandage was fastened to the support post before the last 20" of fill dirt was added (*see figure 9*).

Environmental and Health Considerations

The National Park Service favors an integrated pest management program (IPM) approach to pest management. This program maximizes the use of natural controls, when possible, while minimizing chemical treatments. Where chemicals are deemed necessary, it requires that chemicals may be used: (a) only after sufficient monitoring has shown that an injurious level of damage can be expected, if chemicals are not applied and, (b) when the least toxic chemicals are used. (Prior approval for use of chemical preservatives and pesticides may be necessary in organizations that have designated integrated pest management coordinators).

With the decision to keep the poles uncovered and displayed outdoors, experience had shown that effective chemical preservatives were needed in order to provide more long-term protection of the carvings.



Figure 9. After securing the support post in the ground, a wood preservative in a "bandage" form was attached to the support post before dirt was filled to grade level.

Since exposed end-grains in the carvings and cracks and splits in the wood were commonplace, the unpainted poles could not be adequately protected by using water repellents alone. Clear repellents would need to be applied on a regular basis and the thoroughness of coverage would be difficult to establish over a long term, thus the need in the case of the totems of both a wood preservative and a water repellent.

Historically, the poles were painted only in selected areas and not in their entirety. No historic paint documentation existed and application of paint as a protective coating over the entire pole was not considered.

The borate application was selected as the most effective wood preservative for the totem pole, minimizing changes in appearance, as well as carrying the least safety risks.

In addition to the health precautions provided by manufacturer, nearby vegetation needs to be protected from contact during field re-application because borates are nonselective herbicides. This is accomplished by spreading a trap around the base of the totem to collect the run-off from both the borates and the water repellents with mildewcide.

Evaluation To Date

Research has indicated that borate preservatives can be effective in controlling most fungal decay and insect damage to above-ground wood. The type of wood involved, depth of penetration of the preservative, and site conditions may influence its effectiveness. It can be applied to seasoned unpainted wood in the field or under shop conditions using brushes, garden sprayers, or a dip trough.

Selected for use on various totem poles at Sitka because of its purported effectiveness and relative safety, borate treatment has potentially broad applications to wooden structures and outdoor artifacts. Log buildings, window sills, and above-ground outdoor wooden objects subject to decay or insect damage are just some of the potential applications. There are commercially available borate preservatives designed for topical applications to seasoned or partially seasoned wood such as that which was applied to the poles at Sitka. Careful monitoring of the carvings on the poles along with the test log will help document the long-term value of borate preservatives when applied to unpainted wood in this moist environment. Successful results will depend in part on regular maintenance of the poles, particularly in removing collected organic debris and in periodically reapplying a water repellent coating (see figure 10).



Figure 10. Application of a water repellent to the totems will probably be needed approximately every 3 years. This can easily be done in place. The support post's "bandage" wrap located just below grade, will need to be inspected in about 10 years.

FOR FEATURE READING:

For an extensive technical and historical review of borates for wood protection, consult the proceedings of the First International Conference on Wood Protection with Diffusible Preservatives. (Available from the Forest Products Society (Telephone 608-231-1361).

Barnes, H.M.; Amburgey, T.L.; Williams, L. H.; Morrell, J.J. 1989. "Borates as Wood Preserving Compounds: The Status of Research in the United States." In: *Proceedings of the International Research Group on Wood Preservation — Working Group III: Preservatives and Methods of Treatment*; 1989 March 31; Stockholm, Sweden: IRG Secretariat; Document No: IRG/WP/3542.

Curtis, A. B., Jr.; Williams, Lonnie H. 1990. "Borates Offer Effective Protection with Less Hazard to the Environment." *Technology Update*, Southern Region, U.S. Department of Agriculture, Forest Service. Utilization Report R8-UR 6.

Quarles, William, "Borates Provide Least Toxic Wood Protection," *The IPM Practitioner*.

Williams, Lonnie H. 1990. "Diffusion Treatment of Domestic and Tropical Hardwood Lumber for Long-Term Protection from Decay Fungi and Insects." In: *Proceedings 47355. First International Conference on Wood Protection with Diffusible Preservatives*. 1990 November 27-30; Nashville, TN.

PROJECT DATA

Waasgo Legend Pole
Mosquito Legend Pole
Lekich' Inei Pole
Trader Legend Pole

Totem Poles (Phase II)-in progress:

Yaadaas Crest Pole
Frog Raven Pole
Raven/Shark Pole

Owner:

National Park Service
Sitka National Historical Park
Sitka, Alaska

Project Dates:

Summers of 1992 and 1993

Preservation Team:

Harpers Ferry Center
National Park Service
Harper Ferry, West Virginia

Williamsport Training Center
National Park Service
Williamsport, Maryland

Alaska Regional Office
National Park Service
Anchorage, Alaska

Sitka National Historical Park
National Park Service
Sitka, Alaska

Supplies:

Borate Preservative:
Bora-Care
Nisus Corporation
Knoxville, Tennessee

Water Repellent:
X-100 Natural Seal Clear
American Building Restoration
Chemicals, Inc.
Franklin, Wisconsin

Base Bandage:
CuRap-20
CuRap with bandage maker
ISK Biotech Corporation
Memphis, Tennessee

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Preservation Tech Notes are designed to provide practical information on practices and innovative techniques for successfully maintaining

and preserving cultural resources. All techniques and practices described herein conform to established National Park Service policies, procedures and standards. This Tech Note was prepared pursuant to the National Historic Preservation Act as amended, which directs the Secretary of the Interior to develop and make available to government agencies and individuals information concerning professional methods and techniques for the preservation of historic properties.

Comments on the usefulness of the information are welcomed and should be addressed to PRESERVATION TECH NOTES, Preservation Assistance Division-424, National Park Service, P.O. Box 37127, Washington, DC 20013-7127.