11

Methods for Mitigating the Environmental Risks Associated With Wood Preservatives

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As noted in earlier chapters, the treatment of wood is both art and science. Wood is a variable material; treatment results tend to vary with the preservative and wood species and even within boards of the same species. This means that treated wood often contains a range of preservative retentions. Some pieces will have less than the desired retention, while others may have much more. In aggregate, however, the goal is for the retention in a combined sample of many pieces of wood treated at the same time to have the required chemical loading. The minimum retention is then set to ensure that even those pieces with less than the minimum aggregate retention have an adequate amount of chemical to provide protection. The goal of the wood treater is to produce a relatively narrow distribution of retentions so that no single board is either heavily overtreated or undertreated. One way to approach this problem is through the application of national standards.

11.1 Standards—The Starting Point

Each year across North America, about 760 million cubic feet (9.12 billion board feet) of lumber, timbers, posts, poles, and plywood are pressure treated with wood preservatives to provide protection against insect and fugal damage. This wood is generally treated according to national standards, such as those promulgated by the American Wood Protection Association (AWPA) or the Canadian Standards Association (CSA), although some building code bodies also have their own acceptance criteria (AWPA, 2010; CSA, 2008). The AWPA and CSA standards both specify minimum levels of chemical uptake (retention), define certain process limitations to ensure that treatment does not adversely affect wood properties, and provide guidance concerning methods for assessing whether wood meets the standards.

The AWPA and CSA standards are results- or performance-oriented standards and both include general guidance for product cleanliness and procedures to minimize drippage of preservative from the finished products. (AWPA, 2010; CSA, 2010). This means that, within certain process parameters, the treater can use any process needed to deliver the required amount of chemical to the specified depth in the wood. Both standards recognize the importance of surface cleanliness and identify methods for mitigation of preservative movement in several ways. Most of this information is provided within the portions of the standards that are primarily intended for use by the producer or treater. The AWPA standards use two approaches for minimizing preservative loss. For systems that do not chemically interact with the wood, the standards primarily depend upon process limitations to reduce surface deposits, over-treatment, and exudation (bleeding). Waterborne systems that interact or fix to the wood are primarily addressed through recommendations for post-treatment storage or heating to allow necessary fixation reactions to occur. None of these approaches is required under the standards; all are strictly advisory.

From 2001 to 2008, AWPA Standard M20, "Guidelines for Minimizing Oil-type Wood Preservative Migration," described treatment processes and practices that have been shown to help minimize bleeding from wood treated with creosote or oil-borne preservatives (AWPA, 2008). Cleanliness of treatment solutions was emphasized, as was the value of incorporating expansion baths, steaming, and long final vacuums into the treatment process. Standard M20 was dropped from AWPA Standards in 2009 because of lack of reaffirmation, but the use of expansion baths to minimize bleeding is also mentioned in several of the treatment standards. Both expansion baths and

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steaming heat the wood, thereby expanding air trapped within the wood cells. This helps to relieve residual pressure in the wood at the end of the treatment process and the application of a vacuum helps to accelerate this process. Although we tend to view wood as porous, the reality is that pressure can remain elevated in the interior of large members for long periods after treatment. This residual pressure can later force oil-borne preservatives to migrate from the wood, leading to unsightly surface deposits. These deposits pose a problem because they leave more preservative on the surface where it is available to migrate into the surrounding environment.

The AWPA standards do not include an equivalent to Standard M20 for waterborne preservatives. However, two of the treatment specifications in AWPA Standard T-1 Sections 8.4 and 8.5 (those for poles and those for wood used in marine environments) provide substantial detail on processes that can be used to achieve reduction of chromium in wood treated with chromated copper arsenate (CCA) (AWPA, 2010). Standard M2, Inspection of Wood Products Treated with Preservatives, also specifies how and when to use the chromotropic acid test to assess chromium reduction in CCA-treated wood (AWPA, 2010).

The commodity specification standards (AWPA Standard U-1) intended for the user or purchaser of treated wood products also include short statements addressing surface cleanliness (AWPA, 2010). The wording requires that wood treated with creosote and oil-borne preservatives shall be supplied "reasonably free of exudates and surface deposits" and that wood treated with waterborne preservatives be supplied "free of visible surface deposits." The user standard for poles (Commodity Specification D) also alerts the user that it is the responsibility of the purchaser to specify if fixation of waterborne preservatives is required (AWPA, 2010).

There are additional, less direct ways that AWPA standards recognize the importance of using processes that address mitigation of preservative movement. For example, Appendix A, Data Requirement Guidelines for Listing Wood Preservatives, recommends that a proponent of a new preservative system generate data on preservative fixation, and there is a standard method (E19) for conducting this assessment (AWPA, 2010). It is also noteworthy that most of the standards used to evaluate preservative efficacy specify that the specimens be conditioned in a manner that maximizes fixation (or stabilization) of the actives within the wood. In general, however, the AWPA standards focus most heavily on ensuring product durability. At this time, AWPA guidance on mitigating preservative movement is more limited and less cohesive than that developed by other organizations. It should be noted that the AWPA standards are under continual review and are updated on an annual basis, with an ongoing trend to include more provisions addressing environmental performance.

11.2 MOVING BEYOND AWPA

Materials treated in conformance with the AWPA standards (where the treater has complied with the EPA preservative label, and where the wood has been subjected to third-party inspection programs) results in products with a minimal environmental risk. Materials meeting these AWPA benchmarks are appropriate for use in the vast majority of all residential and structural applications. Where products are intended for use in sensitive applications, such as those adjacent to, over, or in aquatic environments, additional mitigation of potential preservative movement may be desirable. Procedures available for use in such cases are the subject of this discussion.

The need to apply additional preservative mitigation practices may be triggered by any of several factors:

1. Projects in potentially sensitive environments where a site evaluation and risk assessment demonstrates the need for mitigation

If a planned project involves a large volume of treated wood placed in an aquatic environment with low flows, or in an area known to be polluted with chemicals of concern, a risk assessment is warranted. A risk assessment requires basic information on project design, preservative preference; environmental factors such as water flows, pH, and temperatures; site sediment conditions; and applicable water and sediment quality standards. The resulting risk assessment will inform the user of potential risks in terms of preservative migration to the environment. This information can help determine the need for further mitigation or project modification.

Since conducting a risk assessment and requiring additional mitigation factors will add to the project expense, the user should understand when and where a full risk assessment is appropriate. The wood preservation industry has developed a guide for users: *Treated Wood in Aquatic Environments – A Specification and Environmental Guide to Selecting, Installing and Managing Wood Preservation Systems in Aquatic and Wetland Environments* (WWPI 2006a; see also Appendix 11.1). This document is available at

WWPInstitute.org with numerous one-click reference links. The site also contains a consolidated user-friendly computerized risk assessment tool.

2. Project requirements by federal and/or state agencies

As discussed in Chapter 6, a variety of government regulations and/or policies may control and impact the use of treated wood. The geographic location of the project and land ownership will dictate which agencies have regulatory authority over the project and what permits are needed. Marine projects generally require a permit from the U.S. Army Corps of Engineers (USACE). The National Marine Fisheries Service (NMFS) has additional oversight at sites classified as Threatened or Endangered Species habitats under the Endangered Species Act or Essential Fish Habitats under the Magnuson-Stevens Fishery Conservation and Management Act (MSA). Land and resource management agencies such as the Department of Agriculture, including the USDA Forest Service; and the Department of Interior, including the Bureau of Land Management (BLM) and U.S. Fish and Wildlife Service (FWS), may also have specific requirements for projects on lands under their jurisdiction. Defense, security, and transportation management agencies can also find their proposals for using treated wood the subject of review by other agencies. State environmental or resource agencies may also have additional authority over project design and materials. It is important to check with all agencies with potential oversight responsibilities prior to initiating a project.

Where the project is subject to one or more of the regulatory agencies, the authority may exercise its power through regulation, or, more than likely internal policy, over the use of treated wood. The user may encounter a range of requirements including, but not limited to the following:

a. No restrictions

b. Specific installation, demolition and disposal practices

c. Requirement that all material be treated in accordance with best management practices (BMP) or other specified guidance

d. Limitations on use of specific preservatives

e. Conducting a detailed risk assessment to justify the use of treated wood

f. Sealing or encasing the material to minimize the risk of preservative loss

3. Local authorities or personal preference

Even where scientific evaluation and/or regulatory authorities indicate additional mitigation is not needed, the views and perceptions of local agencies or the individual making decisions may require additional measures.

11.3 APPROACHES TO MITIGATING ENVIRONMENTAL RISKS ASSOCIATED WITH WOOD PRESERVATIVES

A variety of approaches are available to minimize the potential for adverse environmental impacts from treated wood. These may range from selecting the preservative system which, based on a Risk Assessment, indicates the lowest risk for the particular environment; adopting management practices for the production and use of the products designed to minimize the risk; utilizing coatings or sealants; and installing containments systems around the wood during installation.

11.3.1 The Best Management Practices

The wood preservation industry, like all heavy industry, was impacted and altered by the environmental awakening of the country in the 1960s. From the mid 1800s forward, the development of the country’s railroads, transportation, ports, and electrification and communications infrastructure depended heavily upon treated wood. Under the social, economic, and legal standards of the time, the hundreds of wood-preserving plants across the country operated with limited environmental control. This legacy became the focus of legislative activities in the 1970s and 1980s with the implementation of stricter pesticide registration requirements to protect public health and laws covering the treating processes to protect the environment. At one time, the wood-treating industry had the dubious distinction of having the most Superfund sites in the country, although most of these sites have since been or are being remediated. Wood treatment remains one of the most rigorously regulated industries in the U.S.

While the processes used to treat wood were under increasing scrutiny and regulation in the 1980s, there was little public concern over possible environmental impacts of the actual treated-wood products. A good example is the extensive 1992 National Geographic article, “Pillar of Life,” which detailed the wonders of life that lived on and was supported by preservative-treated marine piling, without any mention or indication of concern over the impact of the treatments (Grall 1992). It was not until the early 1990s that industry in the western U.S. began encountering customer and regulator concern over possible adverse impacts on the environment from the use of treated wood. Concerns expressed by regulators such as NMFS were often based upon individual perceptions or extrapolation of laboratory toxicity of the preservative. The issue came into focus in 1994 when the Port of Hood River, Oregon, made application to expand their dock system. The National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service reviewed the permit because of the presence of listed Threatened or Endangered Salmon species in the river system. The agency addressed the proposed use of treated wood by stating that, "Also, since chemicals from treated wood may be toxic to aquatic life, all piling should be constructed of non-treated wood, recycled plastic, steel, or concrete" (Wyland 1994). Failure by the applicant to follow the recommendation would mandate an ESA Consultation, a costly and time-consuming process. Concerns over the recommendation led to congressionally sponsored meetings between the industry, USACE, and NOAA officials (Hayward 1995). The agency acknowledged that it conducted no risk evaluation of the potential migration of the preservative or of the relative exposure dose within the environment relative to water quality or sediment standards, nor could they document what, if any threat would actually result from the use of treated wood or any of the recommended alternatives (Hayward 1995).

This case and a number of other similar situations made it clear that the various state and federal agencies had no specific policies or guidelines for dealing with the use of treated wood. The lack of guidelines left decision making at the discretion of the field representatives, creating the potential for arbitrary decisions and a lack of consistency in the permitting process. This clearly was not acceptable to either applicants or producers of the treated wood products.

The wood preservative producers and western treaters, under the auspices of the Western Wood Preservers Institute (WWPI), were among the first to address the issue. While a great deal was known about the chemistry of the preservative systems and the human risks, it was clear that little was known about the fate and impacts of these preservatives in the environment. The available assessments indicated the concern was minimal. For example, scientists examining the environmental effects of the major preservatives, including concerns over migration and bio-accumulation, concluded that, "Treated wood products can be safely used without any adverse effects on man, animals, or the environment" (Webb and Gjovik 1988, p. 258). A 1992 review by researchers at the University of Washington School of Fisheries, evaluating possible threats from creosote treated piling concluded, "there is no increased toxic risk to aquatic organisms as a result of using creosote piled treated by the "empty cell" process of impregnation" (Kocan 1992, p. 2).

While the limited literature suggested that the use of treated wood in aquatic environments had minimal effects in most applications, the WWPI conducted a global literature review for all research on the environmental impact of treated-wood products. The results were then used to develop a series of risk assessments for each preservative system. These data were then used to develop risk assessment models to predict the migration of a given preservative into the environment from treated wood placed in aquatic-based projects. The models were designed to be extremely conservative where data were lacking. This effort also identified data gaps and recommended needed research. The overall project was conducted by a third party, with an understanding that the industry could make technical comments on the both the review and the models, but could not alter the outcomes.

The preliminary outcomes of the review and the continued concerns by regulators led the WWPI, along with the Canadian Institute of Treated Wood (CITW), now known as Wood Preservation Canada (WPC), as well as the American Wood Preservers Institute (AWPI) to develop management practices that could be used to minimize the potential for the movement of preservative into the environment: the *Best Management Practice for the Use of Treated Wood in Aquatic Environments or BMPs* (WWPI 1994, 1995, 1996). Two goals formed the foundation of the BMP development effort:

Goal I. Establish a treating practices objective to place no more preservative into the product than necessary to meet the AWPA standards for penetration and retention for the specific species, preservative, and intended use.

While this sounds simple, wood is a highly variable material, even within a single species. Differences in growth rates, geographical source, density, and moisture content all make it difficult to treat to a precise level. The AWPA standards are minimum treating levels that must be achieved in order to assure biological performance and compliance with construction codes. Historically, exceeding the treating standard was the most practical approach to assure performance and market acceptance, while avoiding the costs associated with re-treatment or rejection of material that failed to meet the standard. While chemical minimization has an obvious economic incentive for the treater, the risk of under treated materials is also very real.

Goal II. Develop management practices to minimize the potential for movement of the chemical from the product into the environment after treatment, during installation, and through the life of the project. This was addressed by stabilization of the preservative on or in the wood using either process variations or post-treatment fixation (immobilization).

The overriding purpose of the BMPs was thus to develop guidance for "placing enough preservative into a product to provide the needed level of protection while also minimizing use of the preservative above the required minimum to reduce the amount potentially available for movement into the environment" (WWPI 2006b, p. 2). It was recognized that the natural variability of wood, along with the fact that all of the wood preservatives had some degree of water solubility, would make it difficult to completely eliminate preservative migration. The BMPs were, therefore designed to minimize migration.

A consortium of participants from universities, government agencies, independent inspection services, trade organizations, consulting firms, treating firms, and the wood preservative producers worked to develop consensus BMPs. The consensus effort developed several key principles for development of the BMPs:

1. Guidance would be provided for all aspects of the product life, including specification, production, use, and installation.
2. Specific achievable BMPs would be developed for each class and type of preservative.
3. AWPA standards were the starting point with BMPs to emphasize further improvements.
4. Quality provisions would include procedures for independent certification of BMP conformance.
5. BMPs would be technically and economically realistic and use the best information available, but allow for modification as better knowledge becomes available.
6. Initially BMPs would focus only on the western U.S. and Canadian species and not include the southern pines.

Treated Wood in the Aquatic Environment (1993) was the first output from this effort, covering all aspects of wood preservation, use of the products, a detailed literature review, and an assessment of potential environmental impacts. It also included the first conceptual presentation of the BMPs (Western Wood Preservers Institute 1992).

The first consensus edition of the BMPs was issued in August 1994. Ironically, one problem experienced among some users was concern over whether or not wood treated to BMPs and, therefore not over-treated or bleeding, would provide equivalent performance. Implementation of BMPs soon demonstrated the difficulty of achieving precise limits on retentions and this realization led to a modification of the BMPs in 1995. A separate document providing the production guidance, quality assurance procedures, and inspection standards needed to implement the BMPs was also issued. Finally, the WWPI implemented an oversight BMP program so that materials produced under BMPs could be easily identified in the marketplace. The BMPs have been used for over a decade since that time.

The BMPs were intensively reviewed in 2002, with a focus on updating the guidance to reflect the best current technology, expanding their applicability throughout North America for all treatments and species, and moving the quality-control guidance into the document. In addition, the title was modified from "aquatic applications" to "sensitive environments" to acknowledge that BMPs may be appropriate for applications over or adjacent to waters and wetlands.

The new BMPs were issued in 2006 (WWPI 2006b) under the sponsorship of the Southern Pressure Treaters Association (SPTA), The Timber Piling Council (TPC), The Western Wood Preservers Institute (WWPI), and Wood Preservation Canada (WPC) providing a uniform document for use throughout North America (see www.WWPInstitute.org to download a copy; or see the appendix at the end of this volume).

The BMP document is organized into five sections:

- Chapter One – The Importance of BMPs provides the user with an overview of the BMPs, where they can be used and the potential benefits of incorporating these into a specification.
- Chapter Two – Guide to Selection, Specification and Quality Assurance walks the user through the

steps to be used in evaluating a project, selecting an appropriate preservative system, specifying BMPs and ensuring BMP compliance.

- Chapter Three – BMPs for the Production of Treated Wood is directed to the producer of treated wood and not the user. It identifies the treating and post-treatment practices that are to be used for BMP materials treated with each preservative.
- Chapter Four –Installation and Maintenance Guidelines is directed to the user and installer of the project. The chapter provides guidance on design, transportation, inspection, rejection, field installation, demolition, and disposal of treated wood used in sensitive environments.
- Appendix A - Quality Assurance Inspection Procedures is for use by the producer and inspection agencies. This chapter specifies the requirement and procedures to be followed to ensure that materials meet BMP production requirements.

The BMPs take a holistic approach to the use of treated wood. The user must determine the most appropriate chemical to be used and then the treater must follow the steps required to produce well-treated, but clean product. The user must then take the necessary precautions during installation to minimize chemical losses. The most critical aspects of installation are the practices needed to keep sawdust and waste from entering the waterway. Drill shavings and sawdust expose a disproportionately high amount of treated surface area, unnecessarily increasing the risk of leaching.

Adhering to the BMPs sharply reduces the risk of chemical movement into the surrounding environment. If it is determined or mandated that BMPs be used, this needs to be recognized in the design and specification stage. Suggested language for specifying BMP materials, inspection certification, and use of installation guidance are provided in the BMP document.

11.4 BMP QUALITY ASSURANCE

BMPs entail a specific set of procedures to minimize the potential impact of using treated wood in aquatic applications. It is especially important that the consumer require certification to ensure that materials meet the BMP requirements. The industry has established two approaches to provide appropriate certification, either of which is considered acceptable, and the method is not specified by the consumer. The first is a batch approach requiring a *Certificate of Inspection* issued by an approved independent inspection agency and based on a physical inspection of the specific product at the plant. The second approach, designed for use by firms that produce significant volumes of BMP materials, is the *BMP Mark Program* (Figure 11.1). In order to place the BMP mark on materials, the firm must have a license agreement with WWPI and an ongoing BMP quality-control monitoring program by an approved independent inspection agency.

Figure 11.1 BMP quality assurance mark.

In either instance, it is important to establish a working relationship with the wood treater to ensure that materials are properly treated. This is particularly important when brokers are used to purchase materials because the desire for BMP-treated materials may be miscommunicated in the drive for lower costs. As mentioned earlier, the specifier, the producer, and the inspection agency all have key roles in producing treated wood products that minimize the risk of preservative migration.

11.4.1 Specifiers

Specifiers need to be aware of the BMP requirements, the producers offering these materials, and the inspection agencies who have oversight so that they are aware of any deviations, such as the substitution of a non-certified treater. In addition, the specifier plays a key role during installation by ensuring that proper construction processes are used to minimize release of drill shavings or sawdust into the surrounding environment. The specifier can further minimize this risk by requiring that cuts or holes be made prior to treatment. This reduces the need for the field fabrication that increases the risk of treated wood particles entering the environment, but also ensures that the treatment envelope remains intact, thereby producing improved product performance.

11.4.2 Producers

While the production BMPs have elements that are unique to each preservative type, a number of general BMPs apply to all materials: ensuring that preservatives and the treating solutions comply with the applicable AWPA standards; plant and solution cleanliness; uniformity of product charges; appropriate seasoning of the wood before treatment; chemical minimization efforts; use of recognized standardized treating protocols; final vacuum criteria; post conditioning guidance; record keeping criteria; and quality control requirements. Plants may take different approaches to achieve these requirements, but their compliance can be readily verified by inspection. Beyond plant housekeeping, the BMPs incorporate preservative-specific requirements, including stabilization for waterborne systems and surface cleanliness standards for oil-borne systems.

11.4.2.1 Stabilization of waterborne systems

Waterborne metallic preservative systems such as CCA, ACZA, ACQ, and copper azole are solubilized in water using either acids or bases to dissolve the metals. The treating solution enters the wood under pressure. Some components react quickly with the wood cell walls to become chemically fixed, while others are complexed with other metals, making them less water soluble. These processes, termed fixation but more properly stabilization, differ with the preservative involved, but all sharply reduce the ability of metals to migrate from the wood. Stabilization occurs naturally over time when the temperature is above freezing. A key goal of BMPs was thus to achieve a reasonable level of stabilization prior to material going into service.

Although it sounds simple, the actual processes are quite complex and varied between preservative systems. The basic process uses combinations of time and temperature. Longer times are required at lower temperatures, and vice versa. Artificial heating systems can reduce the time needed to stabilize chemicals in the wood; however, stabilization that occurs too rapidly can actually increase the leaching potential of the preservative. The BMPs have been designed to account for this variable time for stabilization through either longer holding periods in the plant after treatment or through accelerated fixation. One vexing issue with BMPs for the waterborne metal systems is determining when stabilization has reached a point where the wood is safe to install. Unfortunately, the only metal component for which there is a method for directly measuring stabilization is chromium, which is a component of chromated copper arsenate. Chromium is reduced from the hexavalent to trivalent state during fixation, and this process can be monitored by removing incremental cores from the wood and spraying chromotrophic acid on the surface, which turns pink in the presence of hexavalent chromium. The absence of color means that the reaction is 99.5% to 99.95 % complete and the material can be safely shipped.

While the metals in other water-based systems also undergo reactions with the wood, there are currently no indicators for assessing when these processes are complete. As a result, stabilization of these other water-based systems is time/temperature based. Although there is clearly no magic tool for ensuring stabilization, it is important to be careful about inserting seemingly helpful procedures into the BMPs. For example, there is evidence that requiring post-treatment water baths (as some permits have specified), which would presumably help to solubilize surface deposits of preservative, can actually increase subsequent chemical losses once the materials have been installed. While it is critical that the industry continue to search for improved techniques for immobilizing preservative components, it is equally important that any changes be based on sound technical data. For example, aqua ammonia baths are useful for ACZA, but they would be counter-productive for fixation of CCA.

The other important feature of BMPs is that they are results oriented. While there are some common processes, it is the responsibility of the treater to meet the required standard. This latitude recognizes that individual plants as well the wood they treat can vary. As a result, prescriptive requirements might unfairly hamper some facilities or be entirely inappropriate at others. The BMPs concentrate on achieving an end result.

11.4.2.2 Oil-type preservative systems

Oil-type preservative systems such as creosote, copper naphthenate, and pentachlorophenol differ from water-based systems in that there is little or no interaction between the wood cell wall and the preservative. The amount of residual chemical left in the wood can range from 20% to 67% of the wood weight. These materials remain in the wood because of their low viscosity and limited water solubility, coupled with the limited permeability of the pit membranes in the wood cells.

BMPs for oil-type preservative systems, therefore concentrate on preventing excess surface preservative deposits and limiting the risk of whole-oil migration (bleeding). Surface residues left on the wood following treatment or caused by subsequent bleeding represent the greatest opportunity for preservative movement into the environment. Early in the BMP development process, the creosote industry determined that a significant contributor to surface deposits was the use of creosote that was not "clean." In the treating process, preservative is flooded into the treating cylinder and then the surplus is drawn off after treatment and returned to the holding tank for future use. Creosote that is not clean enters the wood less efficiently and is more apt to accumulate on the surface. This problem can be mitigated through a combination of purchasing clean creosote and regularly filtering the treatment solution to remove particulates. The BMPs require that "The 'in use' Creosote inventory maintained by the treating firm at the plant for BMP-treated applications shall be purchased, managed and and/or processed such as to maintain a maximum xylene insoluble (XI) residue level of 0.5% and to maintain moisture content within specifications" (WWPI 2006b, p. 18). The AWPA Standard A1 Method 3a provides a simple in-plant method for monitoring this characteristic. The use of clean creosote combined with the other treating requirements produces dramatic changes in the surface appearance of BMP-treated creosote products (see Figure 11.2 for side-by-side comparison). In fact, the changes in surface appearance were so great that some long-time users of creosote were skeptical that the cleaner material would still perform. However, the resulting performance has demonstrated that BMP-treated materials will perform as well as non-BMP material.

Figure 11.2 Traditional (left) and BMP creosote piling.

As with many aspects of preservative treatment, wood species can have a marked effect on treatment results. It soon became apparent that the presence of higher resin levels in some species, such as ponderosa or southern pine, made it more difficult to meet the 0.5% xylene-insoluble standard. In these cases, the BMPs allow "a xylene insoluble (XI) level of 1.5%," but this exception is combined with other post-treating procedures to produce an acceptable BMP product for these species, which were included in the 2006 edition.

11.5 WHEN TO USE BMPs

Although BMPs can be used anywhere, they are specifically designed for use in sensitive aquatic environments. Furthermore, the BMP processes add cost to the treatment, so they should be used only where they add value to the process. Such areas include wood applications directly in contact with water or over waterways. Requiring BMPs for wood more than 10 ft (3 m) away from a body of water is of little value because there is compelling evidence that preservative migration in soil does not extend for more than 6 to 12 inches. As a result, any migration would be mitigated before the aquatic environment was affected. Although previous field monitoring and modeling work has shown that treated wood has little impact on most aquatic environments, except when large quantities of material are used in water bodies with little circulation or flow, BMPs appear to be on their way to being required for use of treated wood in or over all bodies of water.

11.5.1 Are BMP products really better?

It is logical to ask the question whether or not the requirement to follow the BMPs actually improves the performance of treated-wood products by reducing risks to the environment. Intuitively, minimizing the amount of preservative used, keeping free preservative off the surfaces, stabilizing the preservative in the wood, and preventing waste material from reaching the water all should result in lower environmental exposure to the chemicals of concern. Until recently, there has been little effort directly focused on quantifying the difference between BMP and non-BMP materials. The most critical element for the user, regulator, and industry has been to understand the performance of treated wood in the environment per se. Thus, research has concentrated on evaluating the leaching rates and environmental impacts associated with various preservatives, with BMP treatment generally given as a prerequisite for study materials. For example, the Wildwood

Study evaluated various BMP-treated materials in sensitive freshwater deck applications (Forest Products Laboratory 2000).

Empirical studies examining the environmental impacts of treated wood used in existing structures involving both BMP- and non-BMP-treated materials suggest that the general objective of the BMPs has been met. Research to quantify the specific improvements of the BMPs for oil-borne systems, for example, creosote, which generally has a single set of BMP treatment procedures, has not to date been undertaken. However, BMP analysis and verification on waterborne systems has been studied. It is difficult to model the environmental response to products whose performance varies significantly from one producer to another; BMPs are designed to improve predictability, giving consistent environmental performance. For preservatives such as CCA-C that chemically bind to the cellular structure of wood, BMPs require use of tests, like the chromotropic acid test to insure the reduction of chromium. The mechanisms of fixation are poorly understood in most other preservatives, however, and tests to ensure optimum preservative binding do not exist. In most cases, BMPs require that target retentions not be grossly exceeded and that the product does not have excessive preservative surface residues.

Specific BMP-verification studies have been undertaken in the last decade to evaluate the relationship between metal loss rates from CCA-C and ACZA pressure-treated wood to aquatic environments and their respective BMP procedures. Additional studies have evaluated the effectiveness of a variety of wraps designed to isolate treated wood from aquatic environments. Lastly, and most recently, three studies of newly developed micronized-copper products point out the importance of developing BMP procedures for all treated wood used in or over the water.

11.5.1.1 CCA-C BMP verification studies

The chromotropic acid test to insure fixation has provided the basis for CCA-C BMPs since they were first developed. Brooks (2002) evaluated additional BMPs used at Wood Preservers Inc. in Warsaw, Virginia. This producer uses steam to accelerate fixation of CCA-C treated piling. The process involves pulling a vacuum and then injecting live steam to create a uniformly high temperature, while maintaining high humidity. Unique to the Wood Preserver's system is an array of nozzles that spray clean, fresh water on the piling as they are pulled from the fixation cylinder (Figure 11.3). This wash is intended to remove any remaining surface residues. The wash-down water is recycled as make-up water for the next charge. The question asked in Brooks (2004) was, "what affect does this process have on metal loss rates from CCA-C treated piling." This question was answered by treating three southern yellow pine piling to a retention of 40 kg CCA-C/m^3. Each piling was nominally 3.4 m long by 20 cm dia. After treatment, 30 cm were cut from each end and the remainder of the piling was cut into three equal sections. One randomly chosen section from each piling was set under cover to fix at ambient conditions and the remainder processed by accelerated fixation. Following fixation, one randomly chosen section from each piling was removed from the charge and the final sections processed through the wash-down system. This provided three randomly chosen sections of piling that were fixed at ambient conditions, three that were fixed using the fixation cylinder, and three that were fixed in the cylinder and then washed with fresh water. The nine sections of piling were shipped to Aquatic Environmental

Figure 11.3 Fixation cylinder and wash down system used to satisfy BMP requirements for CCA-C treated piling at Wood Preserver's Inc.

Sciences following confirmation of fixation using the chromotropic acid Test [AWPA Standard A3-11 (1995)].

Copper, chromium, and arsenic loss rates were determined in the dynamic-leaching test apparatus described in Chapter 7. Copper losses from wood processed using the three techniques are summarized in Figure 11.4. The calculated values in the graph are based on Brooks (1996), which used CCA-C loss data available at that time. Copper losses in all of the treatments examined in this study were less than predicted using data collected prior to the advent of BMPs. However, copper losses from the piling processed using the accelerated fixation system were less than those observed from material fixed at ambient temperatures. Accelerated fixation, followed by a short wash down, appears to have nearly eliminated the first flush of copper. The lower copper loss continued for the first 14 d. Long-term loss rates after 14 d were similar for all of the BMP procedures.

One way to interpret the shape of the loss rates seen in Figure 11.4 is that the first flush was associated with surface deposits (residues) of preservative. This was followed by a period of rehydration in the dynamic leaching tanks, when water uptake by the wood reduced preservative loss. Following rehydration, preservative loss rates increased slightly as poorly bound metal complexes in the surficial layers of wood were released. Metal loss rates then declined as these poorly bound complexes were depleted. Arsenic and chromium loss rates are summarized in Figures 11.5 and 11.6. All of the chromium and arsenic loss rates were low.

Copper is the metal of greatest concern in aquatic environments (Brooks 1996). The accelerated fixation and wash down of southern yellow pine piling treated to 40 kg/m^3 in this study reduced copper losses from 2.6 µg/cm^2-d to 0.50 µg/cm^2-d—a reduction of 80%. The greatest benefit derived from this BMP process occurred during the first 14 d. Metal losses following that initial first flush were uniformly low for all of the metals, at about 0.20 µg/cm^2-d; and each of the BMPs was effective in reducing metal loss from the piling.

11.5.1.2 ACZA BMP verification studies

Copper, zinc, and arsenic loss rates from Douglas-fir piling treated to nominal retentions of 1.0 and 1.5 pounds per cubic foot with ACZA preservative, using four different post treatment BMPs, were evaluated by Brooks (2005). The studies were conducted for 30.5 d in 2002 and again in 2005 on commodity-size products in dynamic test cyl-

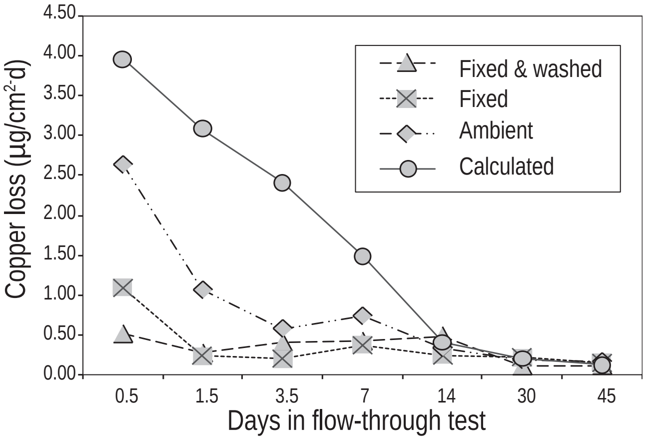

Figure 11.4 Copper loss from southern yellow pine piling treated to 40 kg/m^3 with CCA-C and fixed at ambient conditions or in a steam fixation cylinder with and without a final freshwater wash down. The predictive algorithm presented in Brooks (1996) is provided for comparison.

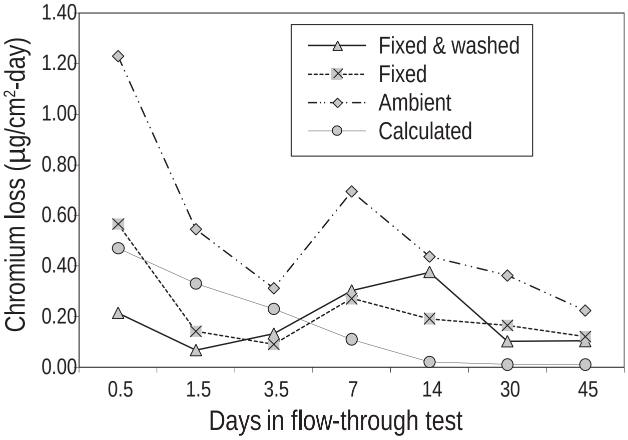

Figure 11.5 Total chromium loss rates from southern yellow pine piling treated to 40 kg/m^3 and fixed at ambient conditions or in a steam fixation cylinder with and without a final freshwater wash down. The predictive algorithm presented in Brooks (1996) is provided for comparison.

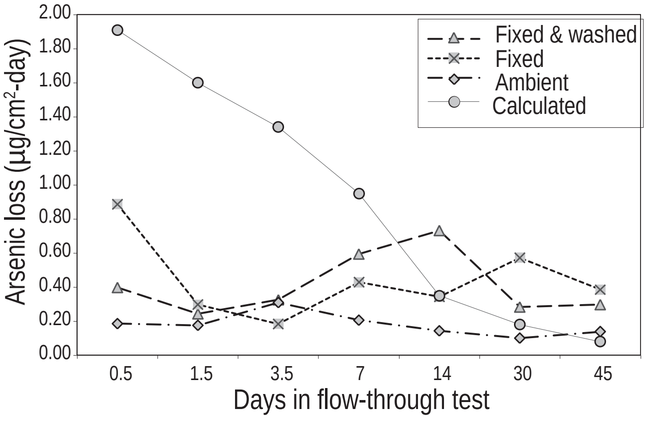

Figure 11.6 Total arsenic loss from southern yellow pine piling treated to 40 kg/m^3 and fixed at ambient conditions or in a steam fixation cylinder with and without a final freshwater wash down. Predictive algorithm presented in Brooks (1996) provided for comparison.

inders, using fresh water at pH = 7.0, saltwater at 28 PSU, and temperatures of 15 ± 2.0°C . In the 2002 study, copper, arsenic, and zinc loss rates declined exponentially with time, but had not reached steady state losses at the end of 30.5 d. The piling sections were then immersed for an additional 429 d in an experimental pond to confirm long-term preservative loss rates, which were evaluated using the same dynamic test system. The four BMPs evaluated in this study are described below.

- In-Retort Ammonia Removal Plus Plant Holding Time (Air)—After the final vacuum period with heat, the retort door was opened and ambient air drawn through the treated wood charge from the door to the rear of the retort, vented to a scrubber at a rate of 7.08 m^3/min minimum, for a period of 3 h. The material was then held in a storage area with free air circulation for a minimum of one week at an average temperature of about 18°C.
- Aqua-Ammonia Steaming Cycle (Ammonia)—Following the normal post-pressure period vacuum to draw excess preservative solution from the wood, the material was subjected to a post-treatment steam-conditioning process. The heating coils were covered with a minimum 2% solution of ammonia in water, which was heated for about 3 h. A minimum temperature of 88°C to 93°C was maintained for at least 1.5 h. The heating process was followed by a final vacuum for 2 h, then an hour of drawing fresh ambient air through the retort to remove excess ammonia vapors and cool the surface of the material. Material was held at the plant for a minimum of one week at ambient average temperatures above 18°C.
- ACZA Solution Bath/Rinse Procedure (ACZA bath)—After an appropriate time to allow surface deposits to establish and equalize in ambient conditions, the treated material was loaded into a retort and covered with ACZA treating solution (concentration of active chemical was not considered a significant factor) and circulated for a minimum of one hour. This ACZA rinse was followed by a one-hour vacuum, after which the material was removed to storage. This process contributes to the visual appearance by providing a more consistent color and removing surface residues. The process has not been verified as a means to achieve or improve chemical stabilization in treated wood.
- Kiln Drying (Kiln)—The piling were dried to a maximum moisture content of 30% in the specified treated zone by employing a kiln cycle of 50°C to 70°C dry-bulb temperature. ASTM Method D4442, using increment cores and oven drying, was used to determine the moisture content of the wood.

The results of these tests, summarized in Table 11.1, were variable by metal and BMP procedure. Kiln drying and high-volume air flow produced the lowest initial and long-term copper loss rates for this product immersed in fresh water. Loss rates from the Ammonia BMP resulted in much higher initial and somewhat higher long-term copper loss rates in fresh water. Marine copper loss rates were generally not a function of the BMP used.

Arsenic loss rates were generally low in both fresh and saltwater, as has historically been the case for ACZA. However, the Air BMP resulted in five to ten times higher short- and long-term arsenic loss rates in saltwater when compared with either the Ammonia or the Kiln BMPs. In contrast to copper, zinc loss was highest using the Air BMP and lowest using the kiln-dried BMP. The moderately high long-term copper and zinc losses in saltwater could, in some cases, result in significant accumulation in sediments. The temporal profiles of these losses, displayed in Figure 11.7, are consistent with other studies, in that the BMPs have the greatest effect during the first 2 wk of immersion. After that, differences associated with the BMPs were not significant.

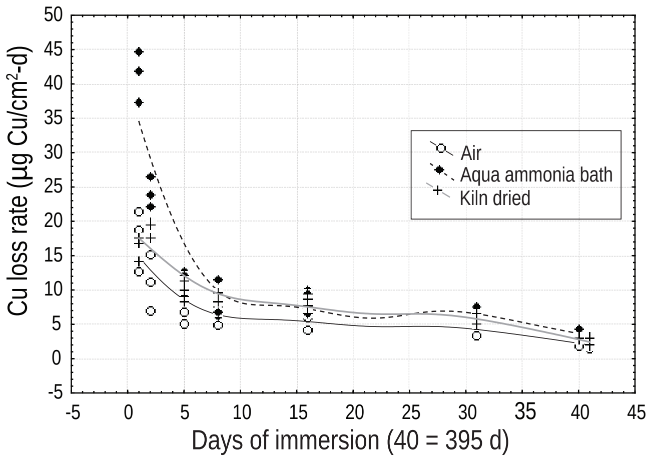

Figure 11.7 Copper loss rates (µg Cu/cm²-d) from Douglas-fir piling preserved with ACZA and immersed in flowing freshwater. Loss rates described at 40 and 41 d were actually collected at the end of 395 and 396 d of immersion. Cu Lossrate = Distance Weighted Least Squares.

Table 11.1 Copper, arsenic and zinc loss rates (µg/cm^2-day) and initial (Day <1.0) and long-term (Day ≥ 30.5) loss rates from ACZA treated piling as a function of end use (freshwater or saltwater immersion) and post treatment BMP (*Air*, *ACZA Bath*, *Ammonia*, or *Kiln*).

a) Copper loss rates

End-use	Treatment	Loss rate algorithm	Loss rates (µg/cm^2-d)	
			Day 0.5	Day ≥ 30.5
Freshwater	1.0 pcf; *Air* BMP;	$\mathrm{Log}_{10}\,\mathrm{Loss} = 1.099*\exp^{-0.423*\mathrm{Log(time(days))}}$; $R^2_a = 0.87$	17.7	2.32
Freshwater	1.0 pcf; *Ammonia* BMP	$\mathrm{Log}_{10}\,\mathrm{Loss} = 1.422*\exp^{(-0.388*\mathrm{Log(time\ in\ days)})}$ $R^2_a = 0.94$	39.6	3.30
Freshwater	1.0 pcf; *Kiln* BMP	$\mathrm{Loss} = 1.215 - 0.3038*\mathrm{Log}_{10}(\mathrm{Time\ (days)}$ $R^2 = 0.93$	13.7	2.60
Average of all BMPs in Freshwater		$\mathrm{Loss} = 1.246*\exp^{-(0.381*\mathrm{Log10(time\ (in\ days))}}$ $R^2_a = 0.82$	25.0	2.90
Saltwater	1.5 pcf; All BMPs	$\mathrm{Log}_{10}\,\mathrm{Loss} = 0.837 + 0.504*\exp^{-0.287*\mathrm{time(days)}}$; $R^2_a = 0.62$	18.78	6.87

b) Arsenic loss rates

End-use	Treatment	Loss rate algorithm	Loss rates (µg/cm^2-d)	
			Day 0.5	Day ≥ 30.5
Freshwater	1.0 pcf; *All* BMPs	$\mathrm{Loss} = 0.876 - 0.0017*\mathrm{time\ (days)}$; $R^2_a = 0.10$	0.88	0.20
Saltwater	1.5 pcf; *Air* BMP	$\mathrm{Loss} = 0.216 + 4.45*\exp^{-0.0174*\mathrm{time(days)}}$ $R^2_a = 0.68$	4.63	2.83
Saltwater	1.5 pcf; *Ammonia* and *Kiln* BMPs	Not a function of time	0.54	

c) Zinc loss rates

End-use	Treatment	Loss rate algorithm	Loss rates (µg/cm^2-d)	
			Day 0.5	Day ≥ 30.5
Freshwater	1.0 pcf; *Air* BMP	$\mathrm{Loss} = 0.92 + 28.8*\exp^{-0.271*\mathrm{time(days)}}$ $R^2_a = 0.79$	25.97	0.92
Freshwater	1.0 pcf; *Ammonia* BMP	$\mathrm{Loss} = 1.96 + 24.04*\exp^{-0.770*\mathrm{time(days)}}$ $R^2_a = 0.95$	18.32	1.96
Freshwater	1.0 pcf; *Kiln* BMP	$\mathrm{Loss} = 1.82 + 8.68*\exp^{-0.323*\mathrm{time(days)}}$ $R^2_a = 0.85$	9.21	1.82
Average of all BMPs in Freshwater		$\mathrm{Loss} = 2.67 + 20.59*\exp^{-0.609*\mathrm{time(days)}}$ $R^2_a = 0.61$	17.85	2.67
Saltwater	1.5 pcf; *Air* BMP	$\mathrm{Loss} = 4.12 + 26.83*\exp^{-0.364*\mathrm{time(days)}}$ $R^2a = 0.79$	18.49	4.12
Saltwater	1.5 pcf; *Ammonia* BMP	Not a function of time	6.56	
Saltwater	1.5 pcf; *Kiln* BMP	Not a function of time	5.76	

These results indicate significant short-term differences in metal loss rates from ACZA-preserved Douglas-fir piling as a function of the BMP used. Either Kiln or Air BMPs appear appropriate in fresh water. However, the Ammonia BMP resulted in copper loss rates that were about twice those associated with the other two BMPs, and this procedure is not recommended. The type of ACZA production BMP used in saltwater generally had little effect on metal loss rates. For purposes of modeling the environmental response to structures constructed using ACZA-treated wood, two models were developed, one for fresh water and one for saltwater. In either case, all of the data collected in these studies were used to predict metal loss rates.

11.5.1.3 Summary

All of the CCA-C BMPs appeared effective in reducing the loss of metal from pressure-treated wood to aquatic environments. Their effectiveness was most evident during the first 2 wk of immersion. Long-term preservative loss rates, important to predicting sediment accumulations of contaminants, appeared less influenced by BMPs. The results of testing the four proposed ACZA BMPs suggest that the development of good BMPs is not a trivial pursuit and that different results can be associated with small differences in treating procedures. Many of the BMPs focus on treating to the specified retention and on removing surface residues of preservative. Recent studies with non-BMP-produced micronized-copper preservatives reinforce this approach. The micronized copper product with obvious surface residues that contained a higher retention of copper lost statistically significantly more copper during the first 38 cm of rainfall than did the two products that showed no evidence of surface residues. The treated wood industry is expected to continue to refine BMPs for existing preservatives and develop new BMPs for new preservatives as they are developed. The information presented here, while not comprehensive for all preservatives in use today, suggests that these procedures can be effective in reducing environmental contamination.

11.5.2 The Use of the BMPs

The number of projects specifying BMP-treated materials has slowly increased over the decade since their first issuance. While BMPs have not resolved all the concerns over the use of treated wood, their availability and recognition in a wide range of guidance documents have given those advocating for the use of treated wood and the regulators seeking balance a tool to help resolve conflicts.

The BMPs emerged from a series of discussions with state and federal regulators over the issuance of permits for the use of treated wood in aquatic environments. In response to growing permit denials by Washington State regulators based on concerns over the use of treated wood in 1993 and 1994, the industry entered a year-long discussion with the State of Washington departments of Environmental Quality and Fish and Wildlife regarding treated wood policy. This resulted in a 1995 Memorandum of Agreement between the two agencies that allowed for the continued use of treated wood, provided that "Whenever treated wood products are approved for use in state waters the materials shall be produced in compliance with industry BMPs" (Patin and Baker 1995).

The first real test for the new policy, the BMPs, and the associated risk assessment tools came in 1997, with a dispute over Genoa's Restaurant in Olympia, Washington. When the use of steel or concrete piling (as proposed by the regulators) proved to be too costly, the owner sought a permit to install a number of treated wood piling and timber structures to allow the expansion at less than half the cost. A risk assessment conducted for the owner by WWPI recommended against the use of creosote materials, due to high levels of existing PAH contamination in the industrial area. However, the assessment indicated that the use of BMP-treated ACZA piling would not result in metal levels that exceeded the state's water or sediment standards for copper, zinc, or arsenic. Despite the existing MOA policy, the permit was denied through objection by the City of Olympia and the local habitat manager from the Washington Department of Fish and Wildlife. The permit denial was challenged through the public hearing process and the Hearing Examiner ultimately ruled that the project could proceed as proposed with ACZA, provided that pre- and post-operation monitoring was conducted. The results (see Table 11.2) validated the value of the risk assessment models and demonstrated that BMP-treated wood could be used with little or no measurable environmental impact and in compliance with state policy (Hayward 1998).

Another early application of BMPs occurred in the State of Idaho in 1995, where the Department of Health and Welfare, Division of Environmental Quality proposed a policy that would ban all treated wood in, over, or near the state's waters. The industry challenged the proposal, and a series of meetings were held with the agency staff that resulted in a revised interim policy, ultimately formalized (PM97-1), for *Water Quality & Wood Preservatives Policy Memorandum*. The policy replaced any prohibitions with a proactive requirement for using treated wood founded on mandating BMP materials and providing for risk assessments where appropriate (Wallace 1997).

There have been other adoptions of treated wood into regulatory policy, including the following:

- Federal agencies that have incorporated the BMPs into their national or regional construction specifications include the U.S. Navy, USACE, FWS, BLM, and the Forest Service.
- NOAA Fisheries, USACE, and the State of Oregon created the Standard Local Operating Procedures (Lohn 2004), a cooperative agreement covering activities on the Columbia River impacted by salmon listings.
- Other authorities have used the BMPs as the model for their own specific guidance. The Michigan Department of Transportation used the BMPs nearly verbatim (with permission) in their Treated Wood

Table 11.2 Sediment and water quality measurements at Genoa's project.

	Arsenic	Copper	Zinc
Washington Marine Water Standard (µg/L)	36.0	2.5	76.6
Measure values at site before and after (µg/L)	ND <0.005	ND < 0.004	ND < 0.008
Washington Marine Sediment Standard (mg/kg)	57.0	390.0	410.0
Pre-construction background levels (mg/kg)	5.7	40.7	68.6
During construction (3/13/98) (mg/kg)	4.8	21.2	42.8
Post-construction (7/16/98) (mg/kg)	ND <7.0	22.7	54.0

policy document (Pilon 2002). This successfully addressed public concerns and preserved the state's extensive treated-wood bridge program.

- In 2000, New York Department of Environmental Conservation did an extensive review of the use of treated wood in the state, including a review of habitat impacts and guidance for the use of treated wood (Sinnott 2000). The document recommends that "Only wood treated in accordance with WWPI Best Management Practices should be used for in-water constructions" (Sinnott 2000, p. 3), emphasizing the importance of BMP quality assurance, and it includes a complete reproduction of the BMPs as part of the document.

11.5.3 Other guidelines available and in use

The industry-developed BMPs are not the only guidance documents available for the specification of treated wood for use in aquatic environments. As discussed above, some authorities have developed guides based heavily on the BMPS, but other agencies have taken more independent approaches.

11.5.3.1 Canadian Guidelines

In 2000, Fisheries and Oceans Canada completed a review of treated wood and issued guidelines for use in western regions of Canada (Hutton and Samis 2000). The document reviewed the BMPs and recommended their use when treated wood was allowed, but also provided more restrictive recommendations reflective of internal agency policy, concluding, "In light of the lack of conclusive data on the long term impacts of treated wood on the aquatic environment, a precautionary approach is required" (Hutton and Samis 2000, p. 16).

11.5.3.2 Forest Products Laboratory Guidelines.

In 2001, the U.S. Forest Product Laboratory and National Wood in Transportation Information Center released a "Guide for Minimizing the Effect of Preservative-Treated Wood on Sensitive Environment" (Lebow and Tippie 2001). Intended for use by designers, specifiers, installers, and regulators, the document describes the types of preservative systems available, summarizes the science on environmental impacts, and discusses methods for minimizing environmental risks associated with treated wood. The report endorses the use of the industry-developed BMPs and further stresses beneficial practices, such as fabricating members before treatment and allowing sufficient time for the treating plants to conduct BMP processing. Additional topics include storage and handling of treated wood at the job site, techniques for collecting construction debris, and the relative merits of applying water repellant stains. The authors conclude:

> Although treated wood does contain chemicals that are potentially toxic, studies indicate that there are no measurable impacts on aquatic organisms if the wood is properly treated and installed. The potential environmental impact of treated wood can be minimized by specifying that the wood be treated using methods that ensure chemical fixation and prevent the formation of surface residues or bleeding of preservative (Lebow and Tippie 2001, p. 11).

11.5.3.3 Forest Service Technology and Development Program

In 2006, the Forest Service produced an updated and expanded report and guidelines (Groenier and Lebow 2006). This report has a broad scope, providing an overview of wood preservatives, treatment processes and alternative materials. It again stresses the importance of incorporating the industry-developed BMPs in situations where environmental impacts may be a concern.

11.5.3.4 NOAA Fisheries Guides

In 2004, the NOAA Fisheries Southwest Region launched a program to develop treated wood guidelines to assist agency biologists in understanding the issues relating to aquatic uses of treated wood and to make consistent effect determinations on the West Coast where they have authority or responsibility to provide input on proposed aquatic projects. This includes waters impacted by the Endangered Species Act and the Magnuson-Stevens Act. The project included a thorough scientific review by an independent consultant (Stratus Consulting Inc. 2006), followed by NOAA discussions with interested parties. The "Public Review Draft" of the guidance document was completed and put in the Federal Register in January of 2008 (NOAA 2008). The final guidelines titled "The Use of Treated Wood Products in Aquatic Environments: Guidelines to West Coast NOAA Fisheries Staff for Endangered Species Act and Essential Fish Habitat Consultations in the Alaska, Northwest a Southwest Regions" were approved October 12, 2009 and posted March 10, 2010 on the National Marine Fisheries Services South West Region website at http://swr.nmfs.noaa.gov.

The final guidelines acknowledge that "Overall, the use of pesticide treated wood products in aquatic environments with the examined formulations (ACZA, CCA and creosote) could be acceptable in many proposed projects" (NOAA 2009, p. 35) and provide suggested guidelines for screening level examinations and conditions for approving the use of treated wood. The guidelines strongly endorse BMPs wherever treated wood is used, as well as recognizing the value of using industry models to predict levels of environmental risk. Based on draft guideline public comments, there was a strong recommendation by users and producers for a more specific field worksheet decision tool. NOAA has had preliminary discussions with the Western Wood Preservers Institute (WWPI) regarding development of a "simplified" field decision tool (Joseph Dillon, personal communication, 2009).

11.6 ADDITIONAL MITIGATION PRACTICES

The BMPs are minimum methods for mitigating potential risks of using treated wood in aquatic environments. While more restrictive requirements may be implemented, it is important that they be technically sound and science-based to ensure that they have the desired effect. Among the possible additional steps are the use of alternative materials and requirements that the wood be protected from exposure through the use of coatings or physical barriers.

11.6.1 Alternative materials

Alternatives have been utilized or recommended where risk modeling indicates that treated wood cannot be safely used. Untreated wood piling and timbers have been required in freshwater applications where structural integrity and long service life are not key concerns. Wood that remains submerged at all times will not generally deteriorate in fresh water because there is little oxygen available to support decay organisms; however, oxygen is not limited for portions above the low water mark, and decay becomes a significant concern in a relatively short period compared to treated materials. Untreated wood of more durable species, such as redwood or western redcedar can also be used where longer service life is needed. Untreated wood is generally not an option in marine applications due to the threat from marine wood-boring organisms.

The most common approach employed by regulators or others with "concern" over treated wood has been to recommend alternatives such as steel, concrete, or plastic materials. There is little data on the potential environmental impacts of using alternative products. Steel products generally use either petroleum-based coatings or zinc-based galvanizing to limit the risk of corrosion, and these materials must be maintained to achieve reasonable service life. Unlike treated wood, which has been the focus of extensive study, the potential environmental impacts associated with migration of these protective coatings into the surrounding environment has not been documented or studied. Similarly, plastics can release chemical components into the environment, and particles eroded from the surfaces will remain in the environment for many decades, where they might pose an environmental risk. Concrete can also pose an environmental risk, especially when it is "green." These risks have encouraged the implementation of construction controls to mitigate the risk.

The point is that all materials release components into the environment; users of these products must know the risks and then take prudent steps to mitigate them. The lack of definitive data on the materials migrating from alternative materials would argue for much greater caution in specifying their use, as well as a call for more data to support the continued use of these products.

In discussing product selection, design criteria and economics cannot be ignored. In projects where treated wood is structurally appropriate, the alternatives often represent a significant cost increase, easily double that of treated wood (Smith 2003).

11.6.2 Coatings and wraps

Another approach to mitigating the impact of the treated wood is use of coatings or wraps to prevent or delay the potential migration of the preservative into the environment. Coatings, such as water repellants can slow preservative migration, but must be regularly reapplied. Physical barriers can also be used to slow preservative migration. Finishes applied to the surface of treated wood can temporarily reduce leaching from wood exposed to precipitation. However, the application of finishes to treated wood used in sensitive environments also introduces additional routes of environmental impact. If the finishes are applied to the completed structure, there is a risk of spillage of the finish into the environment. This risk can be avoided by applying the finish to components of the structure before installation, but it should be recognized that the finish will eventually fail. If film-forming coatings/sealers such as paints are applied, they will eventually become unsightly (i.e., peeling and flaking), prompting the need for removal or refinishing. Maintenance activities such as scraping, sanding, or power-washing will almost certainly result in increased release of treated wood and finish components into the environment. There may be some benefit to applying penetrating (non-film forming) water-repellent finishes to treated wood components before they are placed into the sensitive environment, but with the understanding that the benefit will be temporary and that reapplication to the finished structure may produce more risk than benefit.

Wraps or encasement techniques have also been proposed as mechanisms for reducing environmental releases. These technologies were originally developed to increase the durability of treated wood products by providing additional protection against wood-attacking organisms. Wraps applied in the ground-line area of poles and piles do appear to provide a durability benefit by depriving decay fungi of the ready supply of soil nutrients that they utilize in colonizing wood. However, the benefit of these wraps in minimizing environmental releases of preservatives has not been well quantified. If the wrap adheres tightly to the pole or pile, much of the precipitation draining down the wood surface is likely to be directed outside of the wrap and into the soil in the ground-line area. Water that is directed inside the wrap will eventually be discharged more deeply into the soil. The encasement of an entire piling in fiberglass, for example, can be technologically achieved, but at great cost. This approach has been used in an effort to extend the life of marine piles in areas with severe marine borer attack. Again, however the benefit of preventing environmental releases remains undocumented.

For wood above ground or above water, the encasement is likely to trap moisture and increase the risk of decay. The higher moisture content and trapped water may also result in a flush of preservative release if the encasement is eventually breached by a storm or physical event. Encasement of more complex structures with connections (i.e., dock or bridge superstructure) can only be accomplished after construction, introducing the risk of environmental contamination from chemicals in the encasement material. Such encasement would also hinder subsequent inspection of the structure for wood deterioration or fastener corrosion.

The Port of Los Angeles has performed extensive testing of polyurethane coatings, which appear to provide long-term performance under marine conditions. These systems, however, do add considerable cost, and their use must be weighed against the potential environmental benefits. There are a variety of possible coatings available, and work continues to identify suitable systems for aquatic applications that are durable and cost effective.

11.6.2.1 Wrapped piling studies

Metal loss rates from Strong-Seal™ Fiberglass Wrapped CCA-C Treated Wood (Brooks 2002)—In response to concerns for commercial shellfish production in waters where CCA-C treated wood projects were proposed, Wood Preservers Inc. developed a fiberglass wrap for CCA-C treated piling. Brooks (2004) reported the results of testing metal loss rates from the three treated and one untreated but wrapped piles described in Figure 11.8. Due to the expected low loss rates, the study was conducted in static test chambers with internal circulation of the diluents.

The loss rates are summarized in Table 11.3. Consistent with metal loss rates from CCA-C observed in other leaching studies, chromium losses were too low to be detected. Copper and arsenic losses were detected at very low rates from both treated and wrapped and untreated and wrapped piling samples. The initial copper and arsenic loss from both treatment and control samples was likely due to minor surface contamination during shipping or handling. No loss of copper or arsenic was observed from the control after the first sample day. Small amounts of copper (0.10 μg Cu/cm^2-d) and arsenic (0.006 μg As/cm^2-d) continued to be lost from the Strong Seal product through the remainder of the study. A Factorial ANOVA with time and treatment as independent variables, indicated that the copper, chromium, and arsenic losses were not sig-

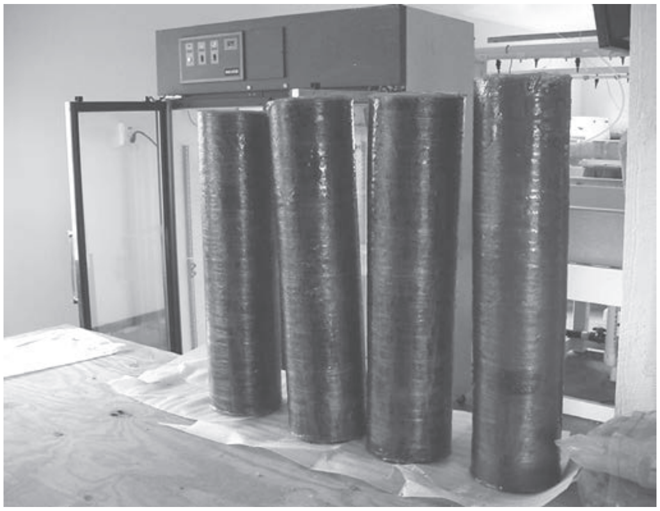

Figure 11.8 Three Strong-Seal fiberglass-wrapped CCA-treated wood piling and a similarly wrapped control.

nificantly ($\alpha = 0.05$) different as a function of either time or treatment. The fiberglass wrap appeared to have essentially stopped metal from migrating into the environment.

Port of Los Angeles Study—Brooks (2006) evaluated copper, arsenic, and zinc loss rates from wrapped and unwrapped piling in support of Port of Los Angeles efforts to continue use of wood piling in a marine environment already impacted by copper. A single, 21.3-m-long, Class- A Douglas-fir piling was treated to 38.3 kg ACZA/m^3 and cut into 75 cm. long samples. Triplicate samples were wrapped with one of four types of wraps. The ends were sealed with DAP® Silicone sealant. After curing for 18 h, the bottoms were covered with 6-mil plastic sheeting secured with ZipTies®. The space between the 6-mil end wrap and the piling wrap was then sealed with silicone. The samples were immersed for 30 d in 30 PSU seawater held in 115-L polypropylene tanks at 15°C. Water was recirculated within the tanks during this static test at a rate of 450 L/h using Aquatic Ecosystems epoxy-sealed magnetic drive pumps (MD-2). Static testing was used because metal loss rates were anticipated to be very low. Figure 11.9 shows two of the four types of wraps.

Copper loss rates over the 30-d test are described in Figure 11.10 for three of the four types of wrap. Rates for all of the tested wraps were very low. Treatments beginning with a T are for treated piling and those beginning with a U are for the untreated controls tested in parallel with each type of wrap. Arsenic and zinc loss rates were also low for all of the wrapped samples. The copper loss rate for the TIP-HDPE wrap peaked on the first day of immersion at 0.24 µg Cu/cm^2-d and was 0.00–0.01 on each of the other seven sample days. These TIP-HDPE wrapped piling had their cut ends sealed with HDPE. At the end of the study, a 5-cm-long section of seam between spirally wound sections of the wrap was observed with a 2-mm-wide turquoise stain, which is a typical color associated with ACZA. It is suspected that the small amount of metal lost through the TIP-HPDE wrap was associated with this poorly formed seam.

Following the initial 30-d test, a 100 cm^2 section of each wrap on each piling was removed to simulate a breach in

Table 11.3 Copper, chromium, and arsenic loss rates (µg/cm^2-day) from CCA-C preserved southern yellow pine encased in Strong-Seal fiberglass and resin.

Treatment code	Day of immersion	Copper loss rate means	Confidence +95.000%	Chromium loss rate means	Confidence +95.000%	Arsenic loss rate means	Confidence +95.000%	N
Treated	0.5	0.230	0.844	0.006	0.017	0.006	0.007	3
Treated	14.5	0.107	0.313	0.000	0.000	0.006	0.014	3
Treated	30.5	0.095	0.248	0.000	0.000	0.006	0.016	3
Control	0.5	0.249		-0.001		0.003		1
Control	14.5	-0.004		-0.000		0.000		1
Control	30.5	0.001		0.000		0.000		1

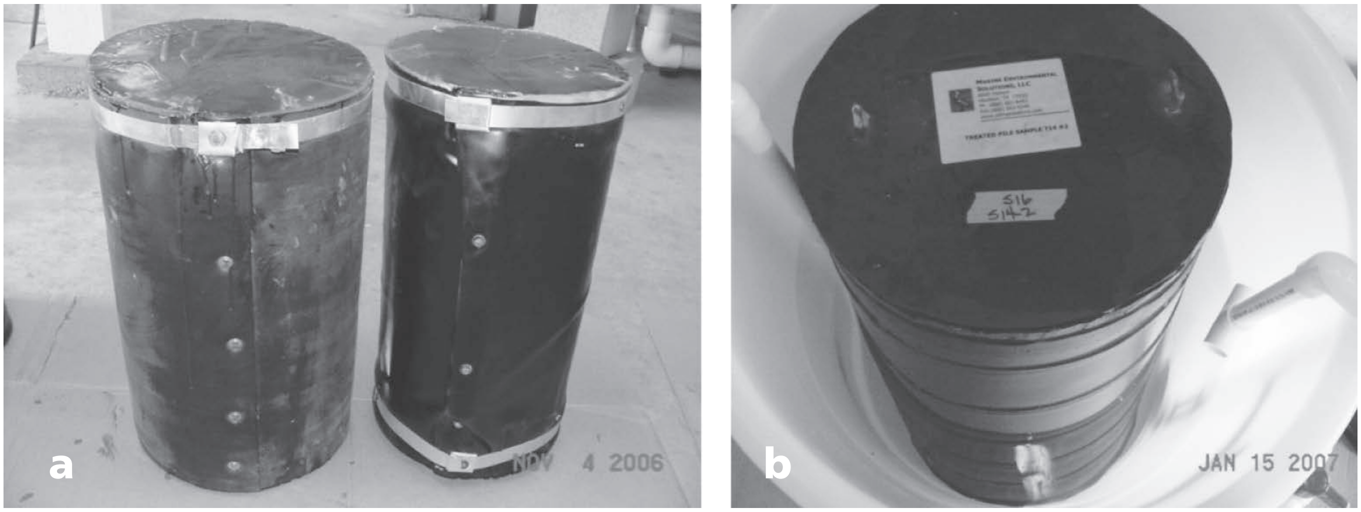

Figure 11.9 ACZA-treated piling wrapped with (a) Port of Los Angeles inner petrolatum saturated tape and 30 mil outer wrap of polyvinylchloride (PVC) or (b) TIP-HDPE.

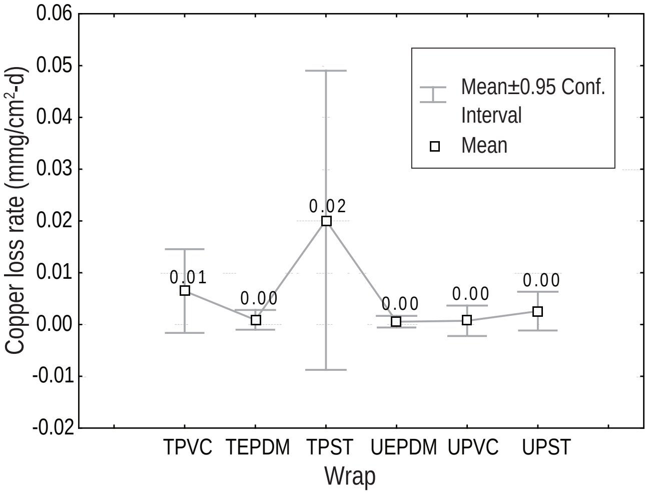

Figure 11.10 Copper loss rates from wrapped piling during 30-d static tests. N = 3 for the treated and wrapped samples (beginning with a "T") and N = 1 for the untreated samples ("U"). Samples were collected 6 times during the 30-d study, on days 0, 1, 3, 7, 14, and 30.

Table 11.4 Copper, zinc, and arsenic loss rates from ACZA-treated and untreated piling protected with a variety of wraps that were breached on d 30 by cutting out a 10-cm^2 section of wrap, exposing the underlying piling.

	Loss rate (µg/cm^2-d) means		
Wrap	Arsenic	Copper	Zinc
Treated with PVC wrap; N = 3	0.43	461.47	60.20
Treated with EPDM wrap; N = 3	2.08	390.16	22.17
Treated with PST wrap; N = 3	0.19	124.22	23.57
Untreated with EPDM wrap; N = 1	0.37	-3.02	-14.99
Untreated with PVC wrap; N = 1	0.39	-1.71	6.84
Untreated with PST wrap; N = 1	-0.29	-0.69	7.31

the wrap. Metal concentrations in the static diluent were then determined after 24 h of additional immersion (Table 11.4). Loss rates from the breached areas were one to two orders of magnitude higher than the loss rates from an equal area of unwrapped piling.

The TIP-HDPE breach was notable for two reasons. This material was so tough that it could not be cut with a knife. A grinder was needed to cut out all but the last mm depth of the breach. The remainder of the wrap was cut with a scalpel and the breach was removed with considerable prying, using an acid washed pry-bar that literally tore the breach away, taking surficial layers of the underlying ACZA-treated wood with it and creating a mirror image of the underlying wood surface (Figure 11.11a). Interestingly, the same was not true for the untreated sample where the breach came away cleanly (Figure 11.11b). In both cases, the underlying piling was dry, with no evidence of wetting during the test.

The copper loss rate during the TIP-HDPE wrap breach study was high (498.8 µg/cm^2-d) and similar to the results for other wraps. The wood under the TIP-HDPE wrap was dry and therefore it is unlikely that water trapped between the wrap and the treated wood was responsible for the large increase in copper. It could be hypothesized that residual ammonia in the wood at the time it was wrapped compromised the fixation of the preservative; however, that is also an unsubstantiated hypothesis.

Brooks (2006) did not include a cost analysis for these various wraps; however, each of the four wraps was effec-

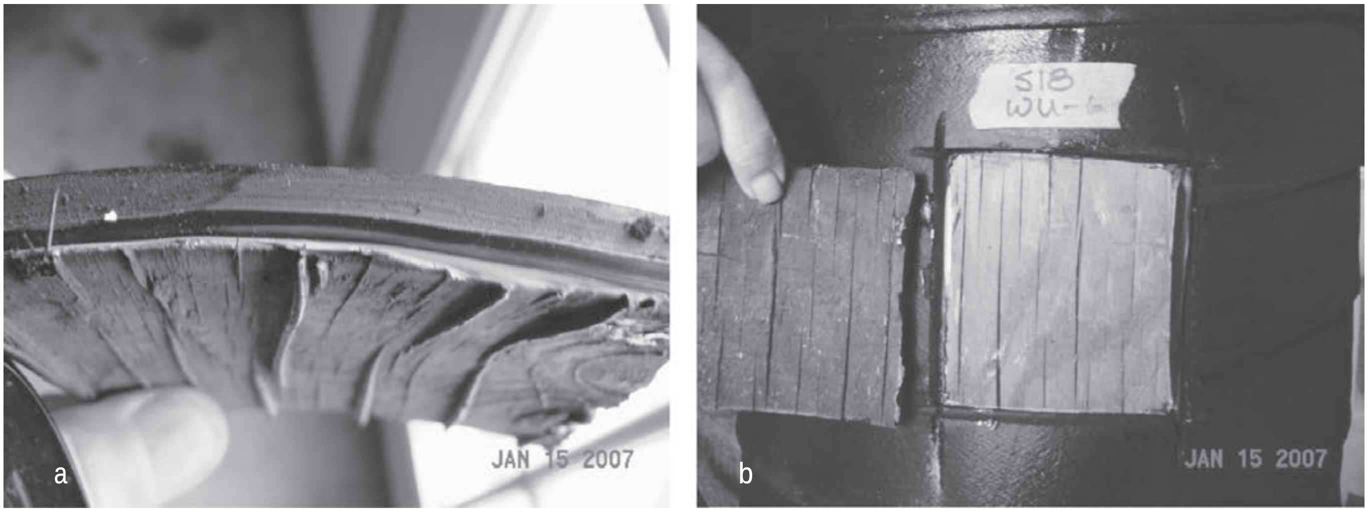

Figure 11.11 (a) Breach of the TIP HDPE piling wrap with adhered surficial layers of ACZA treated wood and (b) breach of the untreated piling with no adherence of the underlying wood fibers.

tive in nearly eliminating the movement of copper, arsenic, and zinc from ACZA-treated piling to the outside environment. The PVC, EPDM, and PST wraps appeared fragile for harsh marine environments and it is recommended that they be protected with HDPE wear strips to reduce the potential for breaching resulting in an episodic loss of metal. The TIP-HDPE wrap appeared very resistant to all but a catastrophic event. Following the study, that wrap could not be breached by repeated pounding with an 8-lb sledge hammer.

11.6.2.2 Summary

Wraps are expensive and generally not considered necessary—except where waters are already impacted by metals or PAH. However, in those cases where the added expense is considered warranted, the wraps appear effective in isolating the treated wood from sensitive environments. The results of wrap-breaching studies suggest that care must be taken to maintain the integrity of the barrier.

11.7 SUMMARY AND DISCUSSION

The wood treatment "standards," predominately those of AWPA and CSA, are "performance-oriented" standards intended to assure that the treated products are adequately protected from insect and fungal attack in order to achieve long service life in the use environment. The standards also provide guidance to mitigate preservative migration and minimize over treatment, but these provisions are "advisory" and secondary to the actual performance requirements.

Materials treated in conformance with the applicable standards (AWPA or equivalent) represent minimal risk to the environment. Where products are intended for use in sensitive applications, such as in or over waters, additional mitigation of preservative movement to the environment *may be* desirable. The decision to employ additional mitigation practices may be identified by site-specific analysis and modeling or be required by federal, state, or local authorities or by personal preference.

Developed over the last two decades, the most extensive and broadly adopted guidelines for improving the environmental performance of treated wood products are the "Best Management Practices for the use of Treated Wood in Sensitive Environments." Coordinated by the wood preservation industry, the development and updating of the BMPs involved a consortium of participants from universities, government agencies, independent inspection agencies, trade organizations, consulting firms, treating firms, and the wood preservative producers. The initial overriding purpose of the BMPs was to develop guidance for placing enough preservative into a product to provide the needed level of protection while also minimizing the preservative potentially available for movement to the environment. The BMPs ultimately evolved into a holistic life-cycle document providing guidance to minimize the potential for adverse environmental effects from utilizing treated wood. Chapters provide detailed guidance for: understanding the BMPs; evaluating projects and selecting and specifying the appropriate product; product production procedures; installation and maintenance; and quality control procedures.

A logical question is whether the BMPs are really better. Intuitively, minimizing preservative loss by proper controls of the amount used, removing surface deposits, and "fixing" the preservative in the wood all have a positive impact. The greatest risk of preservative loss occurs immediately after installation, and loss rates stabilize at low levels after a relatively short time. The BMPs focus on minimizing the early releases, and empirical studies suggest that the general objectives have been met. The key industrial waterborne preservatives (CCA and ACZA) have been studied in some detail to evaluate specific BMP procedures and comparative loss rates.

The BMPs have proven to be a useful tool in successfully balancing environmental regulatory concerns and the use of treated-wood products. Numerous federal and state agencies have adopted the BMPs, or very similar approaches, as requirements for the use of treated wood in aquatic applications.

Environmental assessments and guidelines for using treated wood products in aquatic or sensitive environments have been produced by other authorities, such as Fisheries and Oceans Canada and the U.S. Forest Products Laboratory. One of the most extensive efforts has been undertaken by the NOAA Fisheries agency in order to provide guidelines for treated wood use in habitats identified for protection under the Endangered Species Act and the Magnuson-Stevens Fisheries Act. The guidelines call for detailed risk assessment in the most critical situations, but generally support significant use of treated wood in compliance with the BMPs.

In addition to the BMPs, other mitigation practices are available. Avoiding treated wood by using alternative materials, such as steel, concrete, and plastic, are most often mentioned. These generally carry a significantly higher cost where the structural requirements are equal. Also, little is known about the potential environmental impacts of the alternatives, compared with the extensive database on treated wood. Thus, the advantage is more perceived than documented. Coating and wrapping of treated wood products are also options. Research indicates these can further lower the risk but at a great increase in cost, and thus are a justified alternatives only where the specific environment is already significantly impacted by PAH or metals contamination.

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APPENDIX 11.1 STEPS FOR APPROPRIATE USE OF TREATED WOOD IN AQUATIC ENVIRONMENTS*

STEP 2 – ENVIRONMENTAL CONSIDERATIONS AND EVALUATIONS*

Understanding Risk and Treated Wood

To protect wood from attack by insects and decay, materials must be treated with controlled amounts of preservatives. Like most chemicals (natural or man-made), they can be "toxic" to life forms at high enough concentrations. To manage the risk, society has turned to the Federal Environmental Protection Agency (US EPA) and other state or provincial agencies to conduct expansive scientific reviews of wood-treating preservatives to evaluate the risks to human health and the environment versus the benefits.

This process determines which treating preservatives will not be allowed, which will be allowed under strict application restrictions and which will be allowed for more general use. The results are expansive regulations governing the handling and application of preservatives in the treating process and guidelines for the use of the products. Ongoing US EPA and Canadian registration processes are the first level of Risk Management.

The purpose of this document is to provide guidance to a second level of Risk Management for treated wood that is to be used in the most sensitive environments – waterways and wetlands.

After identifying a preferred preservative, you need to review your project for its potential environmental impacts. In rare instances, this review will cause you to change the preservative you have selected.

Environmental Concerns with Treated Wood

Nearly all materials, man-made or natural, placed in an aquatic environment will introduce chemicals which, if present in large enough concentration, will either immediately or over time pose a potential threat to plant and animal life forms dependent upon that environment.

A certain quantity of the chemicals used to preserve wood will leach or migrate from treated wood structures built in aquatic and wetland areas into the water column and surrounding sediments. The question is how much and when will the preservatives move into the environment and under what circumstances might they represent a significant risk. Section B of this report concentrates on the science behind this question. The following summarizes the issues.

Chemicals of Potential Environmental Concern

For all practical purposes only three compounds used in common preservative systems could potentially cause concern in aquatic environments. Understanding these chemicals will help assure that the products you specify and handle will avoid risk to the aquatic and wetland environments.

Copper

Copper is a commonly used component in several wood preservatives. Many preservatives classified "general use" by the EPA rely on copper as the principal component for biocidal activity. For waterborne systems and for oil-based copper naphthenate, the chemical of concern is copper. Fish and other aquatic organisms are much less tolerant of copper than are people or other mammals. If the levels of copper from treated wood are appropriately managed for aquatic use, other chemicals used in waterborne preservative systems such as arsenic, zinc, chromium, tebuconazole and quaternary compounds simply are not present at levels of concern. Extensively reviewed and published information is available on the effects of copper in the environment and the biological importance of copper.

PAH

The toxic compounds in creosote are called polycyclic aromatic hydrocarbons or PAH. These naturally occurring substances are also generated by forest fires, volcanoes, coal deposits and oil seeps. They are formed whenever

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* Excerpted from *Treated Wood in Aquatic Environments: A Specification and Environmental Guide to Selecting, Installing and Managing Wood Preservation Systems in Aquatic and Wetland Environments* with permission from the Western Wood Preservers Institute, Vancouver, WA. Step 1 (not shown here) discusses how to select an appropriate preservative and end-use category.

there is combustion. Power generation, automobiles and asphalt paving are common sources of PAH associated with human activity. PAHs are not water soluble and are generally of little concern in the water column. However, they can accumulate in sediments to levels of 10 to 20 parts per million (ppm) and have been associated with cancer in fish.

PAHs are rarely found at concentrations that are acutely toxic to aquatic organisms except in association with historic industrial activities. Because they have been part of our environment long before mankind, they are metabolized by most organisms. In fact, bacteria efficiently break them down in healthy environments where there is sufficient oxygen, and they decompose more slowly in the absence of light or in anaerobic environments.

Pentachlorophenol

Pentachlorophenol (Penta) from treated wood may be dissolved in the water column and sorbed to matter in bottom sediments. Penta readily degrades in the environment by chemical, microbiological, and photochemical processes. Penta-treated materials used in aquatic applications are limited to above-water structures and freshwater pole or piling structures. If present in large enough quantities, penta may be toxic to fish and other aquatic life. Accumulation in fish and other animals is not a concern for penta.

Where Are Preservatives a Concern?

The safety of treated wood products is confirmed by their long history of use without a single documented instance in which treated wood products have jeopardized natural environments. However, wood preservatives do leach or migrate from pressure treated wood at very low rates. Previous research has accurately defined these loss rates allowing industry to produce guidelines and risk assessment models that insure the continued safe use of these products. For example, Appendix Figure 11.1A describes the loss of copper from CCA-C treated wood. Risk assessments are based on the first few days of immersion because that is when preservative loss rates are highest. These rates decline very quickly over time and are generally undetectable in the water after the first few weeks.

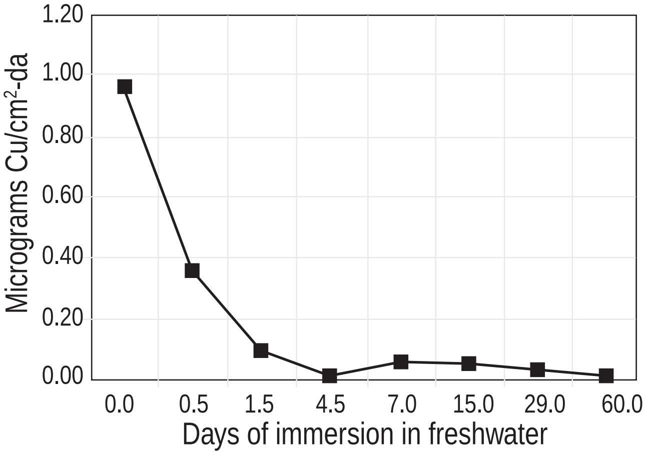
Because of the very low amounts of chemical that will move into the environment, the appropriate use of treated wood will not represent an adverse risk except in cases where the sites were previously contaminated from other sources, or in very sensitive environments with almost no water current where very large projects are planned.

Environmental Evaluation and Risk Assessment

Knowledge of preservative loss rates from properly treated wood, when coupled with site-specific environmental data (such as water current speeds and background levels of metals and organics), allow the industry to use relatively simple computer models to predict the environmental response to any project you might design. These models have been peer-reviewed, repeatedly field-tested and proven to protect the environment. They are used by the U.S. Forest Service, U.S. Park Service, Environment Canada and Canadian Department of Fisheries & Oceans as well as a host of local and state regulatory bodies.

Examples of Typical Models

Example 1: The models have also been used to define categories of projects that should require no risk assessment and those where additional assessment should be carried out during the preliminary design phase. As an example, Appendix Tables 11.1A and 11.1B describe the number of CCA-C, ACZA, ACQ-B, CA-B or Copper Naphthenate piling or timber that can be placed in a row paralleling freshwater currents without jeopardizing the environment. The tables were constructed assuming a receiving water pH of 6.5, hardness of 75 mg $CaCO_3$/L, and a background copper concentration of 1.5 g Cu/L. These values are typical of many rivers and lakes in the country.



Appendix Figure 11.1A Copper loss from CCA-C treated hemlock and fir.

Most large lakes have current speeds greater than 2.0 cm/sec and river speeds greater than 10 cm/sec. Most projects being permitted today involve fewer that four piling placed in a row parallel to the currents (i.e. along the shore) and all four of the preservatives listed in the table are acceptable in most applications.

Example 2: Creosote-treated projects are typically located in marine environments and their evaluation is somewhat more complex. The figure below describes projects where creosote-treated wood should not be used without a risk assessment (red); where it is not likely to have an effect but caution suggests an individual risk assessment should

Appendix Table 11.1A Guide for number of CCA-C, ACZA, or copper naphthenate piling (see UCS 4C) that can be placed in a row paralleling freshwater currents without jeopardizing the environment.

Preservative	Day 0.5 loss rate micrograms Cu/cm^2	Maximum Current Speed (cm/sec)							
		0.5	1.0	1.5	2.0	3.0	5.0	7.5	10.0
CCA-C	3.98	66	132	198	264	397	661	992	1322
ACZA	39.60	7	13	20	27	40	66	100	133
CuN	17.37	15	30	45	61	91	151	227	303

Appendix Table 11.1B Guide for number of ACQ-B or CA-B timbers (see UCS 4A) that can be placed in a row paralleling freshwater currents without jeopardizing the environment.

Preservative	Day 0.5 loss rate micrograms Cu/cm^2	Maximum Current Speed (cm/sec)							
		0.5	1.0	1.5	2.0	3.0	5.0	7.5	10.0
ACQ-B	44.10	6	12	18	24	36	60	90	119
CA-B	40.30	7	13	20	26	39	65	98	131

Appendix Table 11.1C Creosote Guide for determining need for Risk Assessment (RA). **Bold text with gray shading**: RA recommended; **Bold text**, no shading: RA advised; No bold, no shading: no RA needed

Maximum current speed (cm/s)	Depth of Reduction-Oxidation Potential Discontinuity (cm)						
	0.00	0.50	1.00	1.50	2.00	3.00	4.00
0.5	262.96	120.25	66.79	43.83	33.05	25.50	24.57
1	131.48	60.13	33.40	21.91	16.52	12.75	12.29
2	65.74	30.06	16.70	10.96	8.26	6.37	6.14
3	43.83	20.04	11.13	7.30	5.51	4.25	4.10
4	32.87	15.03	8.35	5.48	4.13	3.19	3.07
5	26.30	12.03	6.68	4.38	3.30	2.55	2.46
6	21.91	10.02	5.57	3.65	2.75	2.12	2.05
7	18.78	8.59	4.77	3.13	2.36	1.82	1.76
8	16.43	7.52	4.17	2.74	2.07	1.59	1.54
9	14.61	6.68	3.71	2.43	1.84	1.42	1.37
10	13.15	6.01	3.34	2.19	1.65	1.27	1.23
11	**11.95**	5.47	3.04	1.99	1.50	1.16	1.12
12	**10.96**	5.01	2.78	1.83	1.38	1.06	1.02
13	**10.11**	4.63	2.57	1.69	1.27	0.98	0.95
14	9.39	4.29	2.39	1.57	1.18	0.91	0.88
15	8.77	4.01	2.23	1.46	1.10	0.85	0.82

be completed (yellow); and where creosote-treated projects are not likely to affect the environment and require no additional assessment (blue or green). The values in each cell are the maximum predicted sediment concentrations of PAH.

Creosote is broken down by microbes in sediments and microbes need oxygen to start that process. Therefore, the suitability of creosote in an environment depends in part on the availability of oxygen–as measured by the depth of the reduction-oxidation potential discontinuity (RPD) in this chart. The RPD in healthy environments is generally greater than 3 cm and typical maximum current speeds present in most projects will be > 3 to 5 cm/sec. In sum: the typical small creosote-treated piling project is not likely to affect healthy marine environments.

When Is a Full Risk Assessment Needed?

A Starting Point

To be conservative, an individual Risk Assessment is recommended in the general cases that follow.

You can access on-line the actual guidelines that apply and the Microsoft EXCEL™ computer models that allow you to conduct your Risk Assessment. It should be emphasized that the criteria below are very conservative and it is likely that fewer than five percent of all typical projects will actually require a complete Risk Assessment.

Models

- Projects involving greater than 100 piling
- Substantial projects having large treated wood surface areas such as bulkheads

Risk Assessment Models

NOTE: For each preservative, select the model that fits your specific application.

- Projects in industrial areas where there may be high background levels of metals or polycyclic aromatic hydrocarbons
- Projects in close proximity (<50 feet) to other projects involving more than 20 piling that are treated with a similar preservative (creosote, copper based, etc.)

The industry is proud of the improvements in production processes and its history of environmentally appropriate product performance. The use of these guidelines and risk assessments is intended to insure that this history of safe use continues into the future.

Aquatic Use and Selection Guides for In-water Applications

In addition to running the models just described, the following preservative-specific criteria should be considered to determine if a full Risk Assessment is called for in water projects:

Creosote (freshwater or marine)

- The sediments are black and smell of hydrogen sulfide
- Maximum current speeds are less than three cm/sec
- Project involves more than four piling placed in a row parallel to the currents

Pentachlorophenol (freshwater only)

- Maximum current speeds less than 2.5 cm/sec
- Project involves more than four piling placed in a row parallel to the currents

Copper Naphthenate (freshwater)

- Maximum current speeds less than 1.0 cm/sec
- Project involves more than six piling paralleling the currents

Waterborne treatments (freshwater)

- Maximum current speeds less than 1.0 cm/sec or:

  CCA-C. Project involves more than 100 piling parallel to the currents ACZA.

  Project involves more than 25 piling parallel to the currents CA-B.

  Project involves more than two timbers parallel to the currents ACQ-B.

  Project involves more than two timbers parallel to the currents

  The pH of the receiving water is less than 5.5

Waterborne treatments (marine environments)

- Maximum current speeds less than 1.5 cm/sec or:

  CCA-C. Project involves more than four piling parallel to the currents

  ACZA. Project involves more than two piling parallel to the currents

Over-water Considerations

While the greatest potential environmental exposure is with in-water use of treated material where direct contact and higher retention levels exist, the large volume of wood used in above-water structures and decking also merits risk consideration and sound chemical management. Splash and rain runoff represent potential paths for treating chemicals to move from treated wood into the environment. Experience has shown that where environmental concerns have been raised, any adverse impacts found were caused by improper specification, treating or installation.

Conclusion

It should be emphasized that these recommendations are very conservative from an environmental point of view. Pressure treated wood has a long history of safe use in aquatic environments with no published report describing a significant loss of biological integrity associated with its proper use. Adverse impacts, where they have occurred, have been linked to significant concentrations of the preservative chemicals at old treating facilities and not with use of the treated product. The industry is proud of the improvements in production processes and its track record of environmentally appropriate product performance. The use of these guidelines and risk assessments is intended to insure that this history of safe use continues into the future.

STEP 3: Specifying the Best Management Practices

The treating industry believes the potential for any adverse environmental impact is reduced when certain conditions are met:

- Materials are specified with the minimum retention needed for their application
- Best Management Practices (BMPs) are mandated with certification of inspection
- Proper field guidelines are followed

Best Management Practices

Protecting the lakes, streams, bays, estuaries and wetlands of North America is a responsibility shared by every citizen. The pressure treated wood products industry is committed to ensuring that its products are manufactured and installed in a manner which minimizes any potential for adverse impacts to these waters. To achieve this objective, the industry developed and encourages the use of the Best Management Practices or BMPs. BMPs are in addition to the AWPA standards and contain guidelines specific to each preservative system related to the treating process. These include technical guidance on the handling and use of the treating preservative, wood preparation and treating procedures, post treatment processes and inspection. The BMPs are designed to:

Complete BMP Document

- Minimize the amount of preservative placed into the wood while assuring conformance with AWPA standards
- Maximize fixation or stabilization in waterborne systems
- Minimize surface residues and bleeding from oil-type, preservative-treated products.

The specification for treated wood products used in aquatic and wetland applications should contain language to the effect: These products are to be produced in accordance with the Best Management Practices for Treated Wood in Aquatic Environments issued by the Western Wood Preservers Institute, Wood Preservation Canada, and The Timber Piling Council. Using such a reference, you will not need to list the specific requirements of the BMPs.

STEP 4: Providing Quality Assurance and Certification

Treating Quality and BMP Assurance

Sound project management will provide for quality control to assure that the treatment and BMP specifications have been met. Third-party independent inspection procedures are in place to meet these needs.

Treating Quality

To assure products meet the specified AWPA standards, the presence of a quality mark or letter of certification from a third-party inspection agency should be required in the specification. Building codes require all treated wood used in structural applications must be inspected by an American Lumber Standard Committee (ALSC) accredited third-party agency. The presence of the CheckMark logo on structural materials notifies the user that the inspection agency and materials were under the ALSC Treated Wood Enforcement program to assure compliance with AWPA standards.

BMP Assurance

Specifications for material intended for use in aquatic or wetland applications should require that the material be produced in accordance with the BMPs. Conformance should be certified by third-party inspection documented by written certification or the presence of the BMP Certification Mark. Check on-line for details.

Work with the Treater

It is strongly recommended that, once a supplier has been selected, the specifying organization and/or contractor contact the wood treating company directly to review the project, specifications and material expectations. Direct contact with the treating firm should be made even if the material is being purchased through a third-party wholesale firm. Experience has shown that where treated materials have not met the purchaser's expectations it has been the result of a lack or breakdown in communications. In addition to going over the treating requirements, calling the treater affords you an opportunity to review lumber grades and framing requirements that may have been part of the specification.

STEP 5: Appropriate Handling, Installation and Maintenance

The most critical time in the life of a treated wood project – in terms of potential environmental impacts – is during and immediately following construction. Specification of BMP materials will provide assurance that materials at the job site meet fixation requirements (for waterborne preservatives) and are free of excessive surface preservative. This minimizes initial risks.

There are several additional actions that can be taken to ensure the project is completed in an environmentally safe manner:

- *Framing, sawing, cutting and drilling.* To the maximum degree possible, framing, sawing, cutting and drilling should be done before treatment. Most treaters are able to provide these services or the work can be done prior to the material going to the treating plant. This may require more engineering and product coordination, but it assures the best treated product, minimizes the need for field treating and yields the more efficient installation.
- *Field inspection*. The materials should be visually inspected when they arrive on site. Materials which display excessive bleeding (oil-type) or surface deposits should be rejected and the supplier contacted for replacement.
- *Re-treatment*. If the materials do not meet the retention or penetration specifications, caution should be taken before agreeing to re-treat. This is especially true with oil-type preservatives, since re-treatment can lead to excessive retentions and increased potential for environmental impact.
- *Fasteners*. Fasteners for preservative-treated wood shall be hot dipped galvanized in accordance with ASTM A-153, silicon bronze, copper or 304 or 316 stainless steel. Stainless steel fasteners should be used below grade in Permanent Wood Foundations and are recommended for use with treated wood in other corrosive exposures such as in or near salt water.
- *Field fabrication*. All sawing and drilling should be done away from the water when practical, taking steps to collect, contain and prevent dust and shavings from entering the water or soil. Dispose of all scraps and sawdust in an appropriate landfill.
- *Field treating.* All field cuts and drill holes should be field treated. Field treating (as well as applying sealers) should be done well away from the water if at all possible. If over-water treatment is necessary, steps should be taken (such as using tarps) to collect any surplus treatment for removal and disposal.
- *Absorbent booms.* When oil-type materials are first placed into the water, a sheen may appear on the water. While generally environmentally benign, a visual concern exists until the sheen evaporates or dissipates. You should consider installing absorbent materials to contain the sheen, and booms should remain in place until the sheen ceases.
- *Demolition.* Removal of old or abandoned treated wood structures from the water can disturb

sediments, creating a greater potential concern than if left alone. Alternative strategies such as cutting them off at the sediment line or leaving them as fish habitat should be considered.

- *Worker safety*. The treated wood material supplier will provide an EPA-approved Consumer Information Sheet (CIS) or Consumer Safety Information Sheet (CSIS) and a Material Safety Data Sheet (MSDS) for the treated material. Be sure employees are aware of the information in the CIS or CSIS and follow the guidelines.

For another perspective on using treated wood in sensitive environments, it is suggested you access: *Guide for Minimizing the Effect of Preservative-Treated Wood on Sensitive Environments,* published by the USDA Forest Products Laboratory.