

# **Environmental Performance of Treated Wood Cooperative**

Fifth Annual Report

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## Executive Summary

The Environmental Performance of Treated Wood Cooperative was established to improve knowledge related to the use and disposal of treated wood. The Coop has been active in a number of areas; progress on each will be reviewed below.

The BMP field tests have been completed, but we are setting up additional tests for more controlled BMP evaluations. We will use our controlled overhead leaching device and prepare materials in a much more controlled fashion. Wood will be frozen until it can be exposed to reduce any potential for immobilization due to air-drying prior to rainfall exposure. We have prepared southern pine and some of the spruce-pine fir and will begin evaluations in the new year. The results, along with previous tests on Douglas-fir, will be used to determine which BMP processes are most appropriate for each of the treatment/species combinations.. One question that has arisen in this effort is the effect of wood-temperature at time of treatment on BMP effectiveness. We will explore this issue in a follow-up test since most of the material for the first test is already treated and frozen while awaiting testing.

We are also continuing to monitor a number of field trials to assess preservative migration in BMP treated material. The House Rock Bridge contains both pentachlorophenol and copper naphthenate treated wood. We have been periodically monitoring levels of both preservatives in rainwater runoff from the bridge for the past 2 years. Both preservatives are always present in the runoff, which is to be expected. We have used stream gauge data to estimate the actual concentrations of preservative that would be in the receiving stream during both low and high water flow. The results indicate that both systems would be present in parts per trillion levels, which would be well below any level of concern in the Brooks model. They would also be below our limit of detection. We will continue to monitor the bridge as rainfall events allow.

We have also re-evaluated a 20 year old BMP treated decking project near Corvallis, Oregon. This deck was constructed using ACZA treated Douglas-fir that had been subjected to BMP processes. We found elevated levels of copper, zinc and arsenic beneath the decks, but the levels declined with soil depth. These findings are not surprising and we are following up with additional soil sampling away from the deck itself. These results will be reported later in 2016.

We have examined metal losses from an ACZA treated parallam and solid wood decking bridge located in the McDonald Dunn Research Forest near the OSU campus. Metal levels were slightly elevated directly underneath the bridge, but not 600 mm away from the structure. The results indicate that metal migration is very limited in this setting.

We are also examining the effects of polyurea coatings on metal losses from marine piling. Douglas-fir piling treated with ACZA to the marine retention were either left alone or coated with polyurea. These materials were then installed in salt water. Metal levels in the water have been monitored over the past 2 months. Copper, zinc and arsenic remain below the detection limit in water from coated piles, while the levels of these metals in the non-coated piling continue to increase. The results illustrate the potential benefits of using coatings in sensitive aquatic applications. We will continue to monitor these piles.

Finally, we have co-sponsored one aquatic workshop this past year with the Washington Department of Ecology and plan to host at least 2 more this coming year. These workshops help treated wood users employ the prediction model but they also help us identify the gaps that regulators see in the Brooks model so that we can design tests to address those questions.

## **INTRODUCTION**

Treated wood is widely used in a variety of environments and has a well-known ability to markedly extend the service life of products, thereby reducing the need to harvest additional trees. At the same time, however, the chemicals used to protect wood from degradation are toxic at some levels and all are known to migrate, to some extent, from the products treated with these chemicals and into the surrounding environment. The concerns about this migration are highest in aquatic environments where the potential toxic effects are greatest. Previous studies have shown that the levels of migration are generally low and predictable, and models have been developed to predict the rates of migration from various treated wood commodities under a range of conditions. The treating industry also uses modified production procedures for some site-specific applications to improve the quality of these products, to reduce the presence of surface deposits, limit over-treatment, and, as far as practical, produce products with a reduced environmental footprint. While these actions have proven useful, there are little data demonstrating the benefits of these procedures and a continuing need to better understand the environmental behavior of treated wood products. The Environmental Performance of Treated Wood Cooperative (EPTWC) was established to help develop data on the performance of treated wood, beginning with aquatic applications. The program is an extension of studies begun by Dr. Kenneth Brooks of Aquatic Environmental Sciences (Port Townsend, WA).

## **OBJECTIVES**

The overall goal of the EPTWC is to develop knowledge that improves the ability to use and dispose of treated wood in a safe and environmentally sensitive manner. This goal is being addressed through the following objectives:

- 1. Develop fundamental data on preservative migration from wood*
- 2. Develop standardized accelerated methodologies for assessing treated wood risks*
- 3. Work cooperatively to develop and improve models to predict the risk of using treated wood in various applications*
- 4. Identify improved methods for reducing the potential for migration*
- 5. Evaluate the environmental impacts and identify methods for reuse, recycling and/ or disposal of preserved that wood removed from service*
- 6. Deliver educational outreach programs on the proper use of treated wood in relation to the Best Management Practices*

## ACCOMPLISHMENTS

Over the past year, we have initiated a number of efforts under some of these objectives, with involvement of the advisory committee. The results will be summarized by Objective.

### 1. Develop fundamental data on preservative migration from wood

#### A. Evaluate the BMPS to determine if they alter preservative emigration patterns

In previous reports, we have described efforts to develop data on the effects of the BMP's on preservative migration. The results have been mixed, in some cases suggesting a benefit for using these practices, but mostly suggesting that BMP's had little effect. We believe these results occurred because most of the material that was exposed was already air-dried prior to exposure; in essence, receiving one of the BMP's (air-seasoning). The BMP's were originally developed in response to situations where freshly treated wood was taken out of the cylinder, transported to a site and then installed in projects where it was subjected to nearly immediate rainfall or soaking (WWPI, 2011). To work around this problem and examine the real effect of BMP's on migration, we moved to a smaller scale test where we could control all aspects of the process to produce more reproducible results.

We plan to perform these tests using our controlled overhead rainfall apparatus. We described results from this system using ACZA, ACQ and CA treated Douglas-fir decking (Ye and Morrell, 2015a,b). We have expanded this test to examine the behavior of the BMP's on southern pine and SPF treated with these materials along with pentachlorophenol and creosote.

Samples were treated with the given preservative using only vacuum and pressure with no post-treatment BMP processes. The samples were placed into plastic bags and frozen (-5 °C) until needed. The preparations are still underway. Once they are completed, we will perform the following tests.

*Post-treatment with BMP's:* The frozen samples will be defrosted before being subjected to one of nine treatments listed in the Western Wood Preservers Institute Best Management Practices requirements. The methods will be applied to sub-samples of each board treated with a given chemical even though we recognize that not all of these processes are currently listed as BMP's for all chemicals.

-Air-drying: Samples will be placed on stickers at ambient temperature (20-25°C), to encourage air-flow, and conditioned to a target moisture content below 19% over a four-week conditioning period.

-Kiln drying: The samples will be placed in a steam fired kiln on stickers to enhance air flow. Samples will either be dried over a three-day cycle at a dry-bulb temperature of 71.1°C with a wet-bulb depression of 16.7°C or a one-week kiln schedule at a dry-bulb temperature of 48.9°C and wet-bulb depression of 5.6°C. The latter cycle limits drying,

but the heat should encourage ammonia or amine loss. Both of the schedules result in wood moisture contents below 19%.

-Steaming: Samples will be subjected to 1, 3 or 6 hours of steaming at 104.4°C with stickers in between samples.

-Hot water bath: Samples will be soaked in water at 100°C for 1 or 3 hours.

-Ammonia bath: Samples will be soaked in aqueous 1% ammonia at 100°C for 1 to 3 hours.

The samples will be frozen after being subjected to a given BMP until needed. Each treatment has been replicated on one section cut from each board treated with a given preservative to help reduce the potential for variability between boards since a portion of each is subjected to a given BMP.

*Leaching test:* The samples will be warmed overnight before the potential for preservative migration is evaluated in a specially constructed overhead leaching apparatus that applies a controlled amount of simulated rainfall at a desired temperature (Figure 1). Previous studies (Simonsen et al, 2008) have shown that migration is independent of both temperature and rainfall rate so the device will be operated at room temperature (20~28°C) and a rainfall rate ranging from 0.1cm/h to 0.3 cm/h.



Figure 1 - Overhead leaching apparatus used to evaluate the effects of BMP procedures on migration of metals from ACZA, CA or ACQ treated wood.

The apparatus (1.5 m wide \* 0.6 m long \* 0.9 m) is constructed with stainless steel and a plastic panel and has eight 152 mm wide x 457 mm long x 51 mm high sample holders. Holders are placed on a shelf with a 4.5° incline from the horizontal to allow water to flow down the wood. Simulated rainfall is produced by four spray nozzles connected to a deionized water supply. The rate of water spray is controlled by a small pump and an electronic controller.

Post-treated samples will be placed into each holder and subjected to simulated overhead rainfall for periods up to 9 hours. Runoff water is collected in tared 50mL beakers that are weighed after rainfall exposure to determine the total volume of water applied per board for each time period. The weight of water is recorded and 10 mL of each water sample is placed into a vial. Water is collected at 15-minute intervals for the first hour then at 30-minute intervals for two hours and then after 240, 300, 420 or 540 minutes.

*Chemical analysis:* Samples from waterborne preservatives are acidified by adding 0.25 ml of 1 M nitric acid into 4.75 mL of runoff water. The samples are stored at 3°C until they can be analyzed for residual metal, mainly copper, using a Perkin Elmer Optima 3000DV inductively-coupled plasma optical emission spectrometer with a diode array detector (ICP). Since most of the chemical migration occurs at the beginning of water exposure, water samples collected over the first two hours of simulated rainfall will be tested for copper, chromium or arsenic (depending on the treatment) while the remaining samples will be retained in case metal levels were elevated after 2 hours. Copper concentrations are used as a measure of BMP effectiveness.

All of the waterborne treatment processes will consist of a vacuum followed by a pressure process, but no BMP processes will be applied. The boards will be immediately cut into 12 inch long sections, placed in plastic bags and frozen until needed. The freezing should slow drying as well as any immobilization processes. Penta and creosote treatments will be performed in commercial cylinders without any post-treatment BMP procedures. These materials will then be frozen until needed

These materials will then be removed as needed, defrosted, and either tested without further treatment or subjected to a BMP process that is appropriate for that preservative system. Our intent will be to use the current BMP's as a baseline for the testing.

Table 1. Treatments to be applied to evaluate BMP processes on southern pine, Douglas-fir and spruce-pine-fir lumber.							
Species	Material	Treatment Type					
		Penta	Creosote	ACZA	CCA	ACQ	CA
Douglas-fir	Lumber	Conc.	P1/P13	Done	-	Done	Done
Southern pine	Lumber	Conc	P1/P13	-	Type B	Type D	Type B
SPF	Lumber	-	P1/P13		Type C	Type B	Type B

These materials will then be exposed to rainfall from a controlled device that allows us to deliver a specific amount of rain to a sample and then collect any subsequent runoff for analysis. As noted, we have previously used this device to assess metal losses from Douglas-fir lumber treated with the waterborne systems and found that it did show differences between BMP and non-BMP treated wood. These results will allow us to more directly compare the effects of BMP processes on preservative migration on materials that are exposed shortly after treatment. This is similar to the worst case

scenario where freshly treated materials were immediately installed and subjected to moisture.

### *B. Effects of coatings on migration of metals from treated wood*

While all of the current models indicate that properly pressure treated wood can be used with little or no risk in most environments, that often means little to those regulating the products. One requirement that appears to be increasingly specified is that all wood be coated with an “impermeable” barrier. This is both extremely difficult to do and unlikely to last long on a surface exposed to ultraviolet light. Studies at the Connecticut Agricultural Experiment Station showed that coatings can affect metal losses from CCA treated southern pine decking (Stilwell et al., 2006), but there have been no follow-up studies on the effects of coatings on other preservatives. Last year, we explored the effects of various coatings on migration of metals from ACZA treated Douglas-fir lumber. Decks, similar to those used to assess the BMP processes were constructed using these materials, then two coats of a given coating were applied (Figure 1). The decks were then exposed to natural rainfall for 333 days. Water collected after each measurable rainfall was weighed and a small sample was acidified and analyzed for copper, zinc and arsenic by ICP. The test was run over most of one winter, an entire summer and then the beginning of the fall wet season. The goal was to determine the initial effect of the coating on metal losses and then allow the decks to be exposed to a long summer of UV exposure with little rainfall.

The coatings evaluated in this study were a polyvinyl acetate, a polyurethane, an SBR, a vinyl acryl ethylene, and a halogenated resin. Each coating contained approximately 20% solids and was applied to 3 decks using a paint brush. The decks were exposed in Corvallis, Oregon. We have not done any additional work on these materials, which are continuing to be exposed to UV and rainfall and will be monitored in the coming year.

### *C. Effects of BMP processes on preservative losses from round timbers immersed in water.*

A second component of the BMP verification process was to assess the potential migration of preservatives from round-timbers with and without BMP treatments. As noted previously, we had some difficulty locating a body of water that was suitable for this test and then had some difficulty establishing uniform sediment collection methods. We finally found a freshwater pond approximately 20 km from Corvallis that was suitable for the test. We initially had difficulties with sediment sampling because the pond had a very organic layer that made it difficult to obtain uniform sediment samples over time. Instead we developed a system whereby sediment packets were created. These packets could be placed into the native sediment at selected distances from our piling and could be easily removed without disturbing the surrounding sediment. We performed a number of preliminary trials with these packets, or sachets, to ensure that we could recover compounds from the sediment and the sachet material. This approach provided a reproducible method for sediment sampling.

We have established both ACZA and creosote treated Douglas-fir piling in the pond and placed sachets immediately adjacent to the wood, 150mm, and 300 mm away from the



wood. Sachets have been removed at selected time intervals for assessment of polycyclic aromatic hydrocarbons (PAHs), or metals, depending on the piling involved. The metals were analyzed in the same manner as described for the water samples, with the exception that the sediment and sachets are acid digested prior to analysis. PAHs from the creosote treated pilings were extracted and analyzed as follows: collected sachets were frozen overnight then cut and divided into approximately three nine cm long sections (top, middle, and bottom). Each section was thoroughly homogenized and a 10 g sediment sample from a given segment was placed into a 40 mL amber glass scintillation vial. The entire sachet for each section was analyzed separately in the same manner. Twenty milliliters of a 2:2:1 acetone:ethylacetate:isooctane mixture was added to the scintillation vials. The vials were vigorously agitated for 5 minutes to ensure that the sediment was in intimate contact with the solvent. The samples were then treated with a salt mixture containing 6 g of magnesium sulfate and 1.5 g of sodium acetate. The mixture was again agitated for 5 minutes and then centrifuged for 5 minutes. A 1.5 mL aliquot of the supernatant was removed and added to a solid phase extraction (SPE) microcentrifuge tube, and agitated further for 5 minutes. These dual procedures were used to precipitate polar compounds, lipids, fatty acid, sterols and other compounds that would interfere with the PAH analysis. The tube was then centrifuged one last time for 5 minutes and a 1 mL aliquot of the supernatant was removed for analysis by GC-MS.

The samples were analyzed using a Shimadzu QP2010S GS-MS operated in SIM mode. The GC conditions were: Oven temperature: 70 to 275 °C, ion source temperature: 225 °C, interface temperature: 275 °C. The samples were analyzed on an RXI-5ms column (0.25 mm inner diameter by 30-mm long) at a flow rate of 1.0 ml/min.

Copper levels 1 and 3 months after installation of the posts were generally at background levels 1 and 3 feet away from the post; however, levels were elevated immediately adjacent to wood (Table 2). Arsenic was generally below the detection limit (0.1 ppm) except immediately adjacent to the posts at 3 months and even this level was below 1 ppm. The presence of elevated metal levels immediately adjacent is consistent with previous reports as is the sharp drop-off in levels with increasing distance from the wood. These posts will continue to be sampled over time to establish long term release data.

Table 2. Copper, zinc and arsenic levels in sediments exposed immediately, 1 foot away and 3 feet away from an ACZA treated Douglas-fir piling 1 or 3 months after installation.				
Time (months)	Distance from pile	Metal level in soil (ppm) <sup>a</sup>		
		Cu	Zn	As
1	1	3.05	4.00	<0.1
	3	3.35	4.55	<0.1
3	0	117.95	57.60	0.35
	1	4.65	5.55	<0.1
	3	3.85	5.00	<0.1

<sup>a</sup>Values represent means of two samples per time per location

PAHs were detected in the sediment (Table 3). We have spent a considerable amount of time this past year refining our collection and extraction procedures to improve our extraction recoveries and delineate levels for the 16 EPA priority pollutants, which we have used as our baseline. PAH's were naturally present at low levels in the native soil as well as in samples removed 1 and 3 feet away from the posts

PAH levels were elevated immediately adjacent to the posts, then declined sharply with increasing distance from the post. The soil in the sachets and the sachets themselves tended to selectively sorb PAH's from the surrounding sediment. This tendency results in a much higher probability of intercepting PAH's moving from the wood into the surrounding sediment; however, it also tended to produce slightly higher PAH levels since the sachet material was less available for microbial degradation.

Our access to this site was restricted for a period, but the sachets have remained in test. We plan to remove additional material for analysis in early 2016. We are also working to develop a more precise method for quantifying PAH's in the water column. Our preliminary work suggests that no PAH's are detectable; however, we need to be certain that the lack of detection reflects levels below the minimum detectable threshold rather than a method problem. We plan additional recovery trials with PAH-spiked water samples to determine our extraction efficiency.

#### *D. Concentration of Pentachlorophenol and Copper Naphthenate in Rainwater Runoff from a bridge in Western Oregon*

We have worked to establish field trials evaluating preservative migration from various treated wood commodities. Two years ago, we identified a bridge located near Sweet Home, Oregon that had been treated with pentachlorophenol in oil for the decking and copper naphthenate for the laminated beams supporting the structure (Figure 2). The House Rock Bridge spans the South Santiam River in the Willamette National Forest. Unfortunately, we did not learn about the bridge until it had been in service for several weeks and had been subjected to several rainfall events; however, we have been able to monitor the bridge since that time.



Figure 2. Photograph of the House Rock Bridge showing copper naphthenate treated laminated beams and pentachlorophenol treated decking.

The preservatives present in the runoff from the bridge were examined by constructing a rainfall runoff collection system beneath a section of the bridge that funneled water from the surface into a large container (Figure 3). Water in the container was weighed after each rainfall event, then a sub-sample was taken for later analysis. The total area of treated wood from which the runoff was collected was measured so that we could later determine preservative loss per square cm of wood surface area.

The penta runoff samples had to be processed immediately because of concerns about sample degradation. The rainwater runoff samples were collected in tared 250 mL glass volumetric flasks and weighed (nearest 0.1 g). The remainder of the water was weighed to determine total runoff after each rainfall event.



Figure 3. System used to collect water from the House Rock Bridge located near Upper Soda, Oregon.

2.5 mL 1N NaOH was added to each flask using a pipette. A Teflon™ stir bar was placed in each flask. The flasks were stirred for 1 min then allowed to stand for 30 min. This procedure converted the PCP to its sodium salt. Next 2.5 mL iso-octane was added to the flask and the flasks were stirred for 1 min. The solvent layer was removed with a disposable glass pipette and discarded. This iso-octane extraction was repeated with 2.5 mL iso-octane. This procedure removed residual oils and other organics from the PCP sample.

The sodium pentachlorophenate was converted back to PCP by adding 3.0 mL 1.0 N H<sub>2</sub>SO<sub>4</sub> using a pipette. The flask was stirred for 1 min and allowed to stand for 30 min. Then 2.5 mL iso-octane was added to the flask which was stirred for 1 min to extract the PCP. The iso-octane layer was transferred to a 20 mL glass vial and the extraction repeated with an additional 2.5 mL iso-octane. This second extract was added to the first.

High resolution gas chromatography – low resolution mass spectrometry (HRGC-LRMS) analysis was carried out by injecting 1 µL of sample into a Shimadzu HRGC-LRMS system class 5000 equipped with an RXI-5ms column (0.25 mm inner diameter by 30-mm long) at a flow rate of 1.0 ml/min.

The carrier gas was helium (grade 5) at a flow rate of 1.2 mL/min and the system was operated in the splitless mode. The injector and detector temperature were 250 and 280 °C, respectively. The oven was programmed to hold for 2 minutes at 40 °C, ramp to 80 °C at 40 °C /min, then ramp to 260 °C at 25 °C/min. The system was flushed with iso-octane between injections to minimize the risk of carryover.

The PCP standard (50 µg/mL) was scanned and identified using the National Institute of Science and Technology (NIST) Mass Spectral Library #107 software. The retention time for PCP was 9.70 min. The selected ion for PCP quantitative analysis was  $m/z = 266$ , the reference ions were 264 and 268. HRGC-LRMS auto tuning was performed with perfluorotributylamine. The calibrations were carried out with PCP concentrations of 0.1, 0.2, 0.5, 1.0, 2.0, 5.0, 10.0, and 20.0 µg/mL. A five point calibration was employed, i.e., for each single batch a minimum of 5 consecutive standards were selected depending on the range of concentration of the samples.

The volume of water collected was measured by weight. A density of 1.00 g/mL was assumed for water. The limit of detection (LOD) of this method was estimated to be 0.025 ng/mL cm<sup>2</sup>. The LOD is defined according to the Federal Register Part 136, Appendix B, procedure (b), as three times the standard deviation of replicate analyses of the analyte.

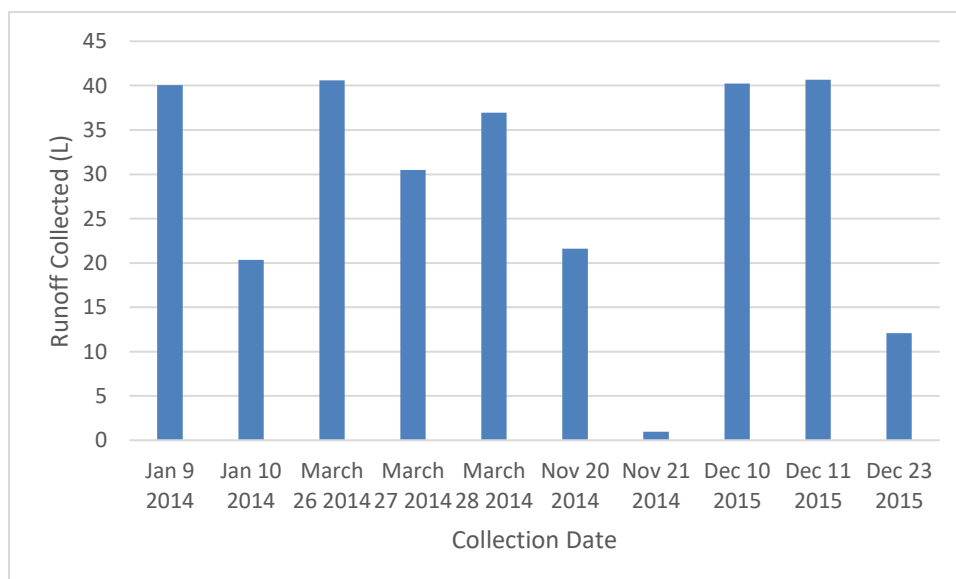


Figure 4. Amounts of water collected from the House Rock Bridge after various rainfall events.

Copper naphthenate in the runoff was analyzed on a copper basis as described previously by collecting a sub-sample of the runoff, acidifying this sample and then analyzing this sample by ICP. The results were expressed on a copper metal basis.

Rainfall amounts varied widely over the 9 collections from a low of 970 ml to over 40,000 ml (Figure 4). The bridge is located in the foothills of the Cascade Mountain Range and rainfall is normally steady, but light. Typical total daily precipitation might total 25 mm even though it rained all day. This precipitation pattern might be expected to result in near continuous wetting of exposed surfaces, which should facilitate solubilization and eventual loss of preservatives near the wood surface.

Pentachlorophenol was detected in water collected from all 9 rainfall events (Figure 5). The initial penta concentrations averaged 6 ppm, then declined to less than 2 ppm after 3 rainfall events. They declined even further to less than 1 ppm in the 6<sup>th</sup> and 7<sup>th</sup> collections. It is important to note that these water collections were not continuous over time because of the logistics of setting up and collecting water. As a result, the site received a number of rainfall events between individual water collections. However, previous studies of penta runoff from stored utility poles have shown that penta levels in water runoff are more a function of solubility than time or rainfall intensity once any surface deposits of chemical have been removed.

The relative insensitivity of penta to repeated rainfall exposure reflects the high concentrations of penta available near the wood surface coupled with the low water solubility of this biocide. Penta solution concentrations in most wood treatments range from 5 to 9 % in some type of hydrocarbon solvent. Assuming minimal loss of solvent following treatment, this translates to a concentration of 50,000 ng of penta/kg in a 5 % treatment solution. This leaves an abundant amount of penta available near the wood surface for potential interaction with precipitation. Penta has a water solubility of approximately 0.000014 g/g of water at 20 °C. The temperature of the rainwater in the current collections would range from 5 to 8 °C, further reducing the amount of penta that can be solubilized as precipitation strikes the wood. The lower concentrations of penta found in the runoff for several collections were perplexing and suggest that other factors such as interactions with leaves and other detritus on the deck may have resulted in the loss of some penta. Penta levels in the two most recent collections were again elevated at 8.7 and 5.7 ug/ml of water.

The lack of an effect of total rainfall at a given collection point on penta concentration can be seen by the lack of effect of increased water collection on concentration (Figure 6). The exception was the first water collection, which coincided with a very heavy rainfall, but would also have been expected to have a higher penta concentration by virtue of the potential presence of any surface deposited penta. The lack of consistency is also illustrated by the fact that one of the lowest penta concentrations

and the highest concentration both occurred with water collections levels greater than 40 liters of collected precipitation. Our previous studies of stored utility poles suggested that penta concentrations in runoff ranged from 3 to 8 ppm regardless of the amount of precipitation to which the poles were stored (Love and Morrell, 2014; Morrell and Chen, 2008, Morrell et al., 2010). This premise also appears to hold with the bridge deck. As a result, the effects of any preservative loss become more dependent on the characteristics of any receiving body of water coupled with the total amount of treated wood exposed to precipitation. The current study collects rainfall from an area representing 14% of the total area of treated wood in the bridge.

We will continue to periodically monitor this bridge to determine how weathering might affect penta migration.

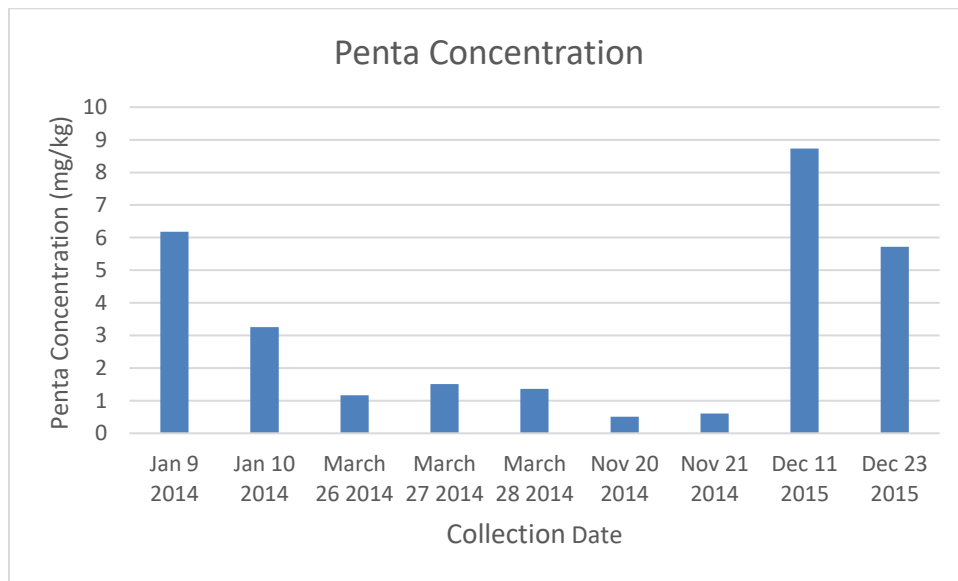


Figure 5. Pentachlorophenol concentrations in rainwater runoff collected from a section of the House Rock Bridge located near Upper Soda, Oregon.

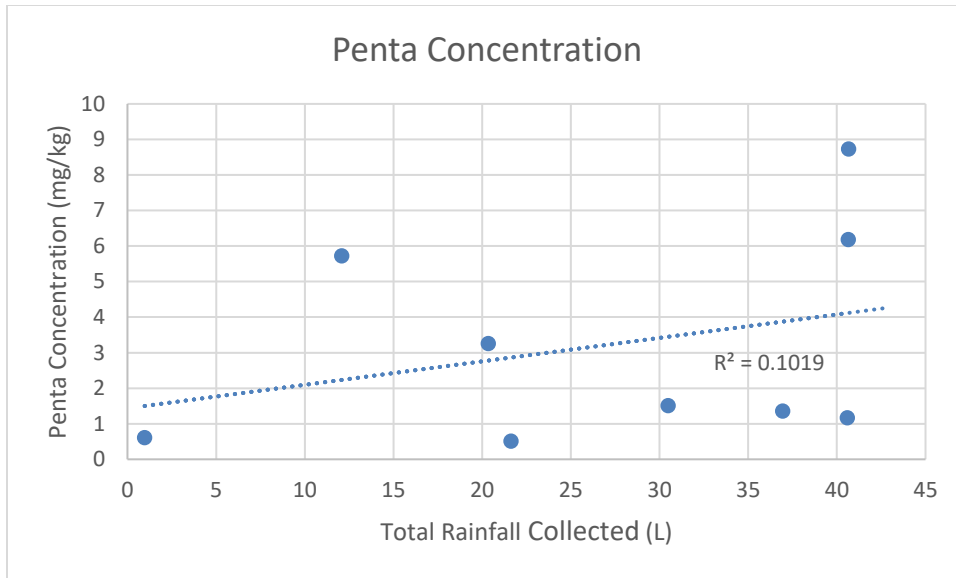


Figure 6. Concentrations of pentachlorophenol in rainwater runoff as a function of total rainwater collected from a section of the House Rock Bridge located near Upper Soda, Oregon.

Copper levels in rainwater runoff, as a measure of losses from the copper naphthenate treated portion of the bridge, followed trends that were initially similar to those found with penta in that levels were elevated for the first two collections then declined to approximately 10 ppm (Figure 7), but there was little relationship between metal losses and rainfall intensity (Figure 8). While these levels were slightly higher than the copper

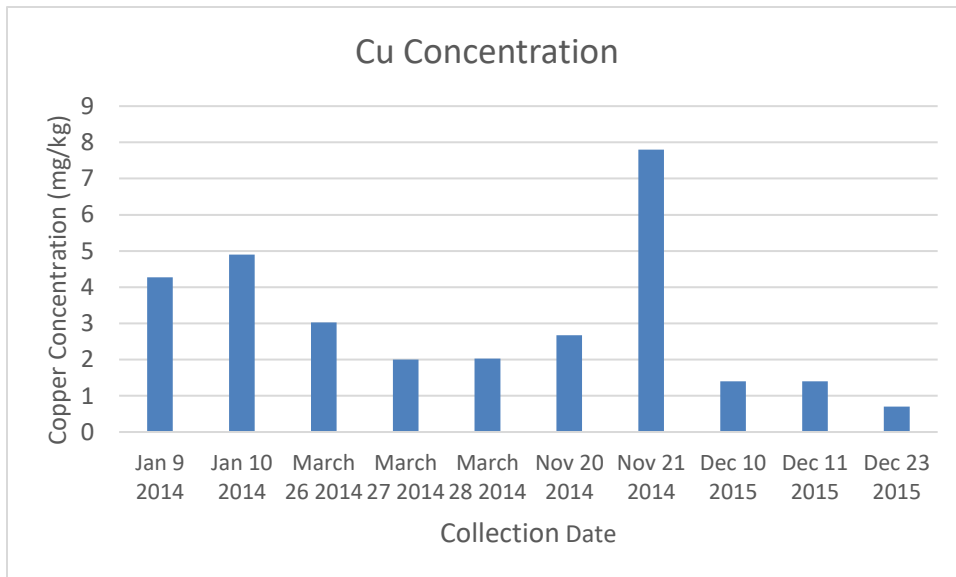


Figure 7. Copper concentrations in rainwater runoff collected at selected times from a portion of the House Rock Bridge near Upper Soda, Oregon.



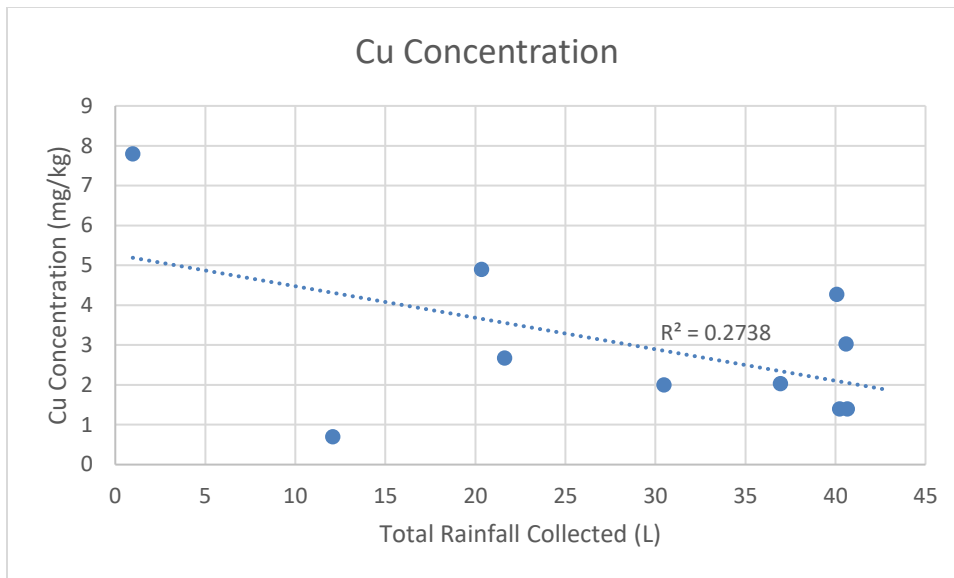


Figure 8. Copper concentrations in rainwater runoff collected at selected times from a portion of the House Rock Creek Bridge near Upper Soda, Oregon as a function of total rainwater runoff collected.

levels noted in runoff from copper naphthenate treated poles, there are few reports of copper migration from copper naphthenate treated wood. Over time, however, the levels of copper and penta in the runoff tended to deviate suggesting that there was little relationship between losses of the two chemicals (Figure 9). We will continue to monitor this test to determine if copper levels continue to decline over time.

Table 4. Concentrations of copper and pentachlorophenol in rain water runoff collected at various times from the House Rock Bridge near Upper Soda, Oregon.			
Date Collected	Total Runoff (L)	Runoff Concentration (mg/kg)	
		Pentachlorophenol	Cu Naphthenate
1/9/2014	40.07	6.18 (3.49)	4.27 (0.32)
1/10/2014	20.35	3.26 (0.21)	4.90 (0.26)
3/26/2014	40.60	1.17 (0.01)	3.03 (0.81)
3/27/2014	30.48	1.51 (0.05)	2.00 ( 0)
3/28/2014	36.49	1.36 (0.03)	2.03 (0.06)
11/20/2014	21.62	0.51 (0.01)	2.67 (0.58)
11/21/2014	0.97	0.61 (0.02)	7.80 (0.35)
12/10/2015	40.2	-	1.40 ( 0)
12/11/2015	40.66	8.73 (0.14)	1.40 ( 0)
12/23/2015	12.09	5.72 (0.04)	0.73 (0.02)

<sup>a</sup>Values represent triplicate analysis at each collection point.  
<sup>b</sup>Samples lost. Values represent

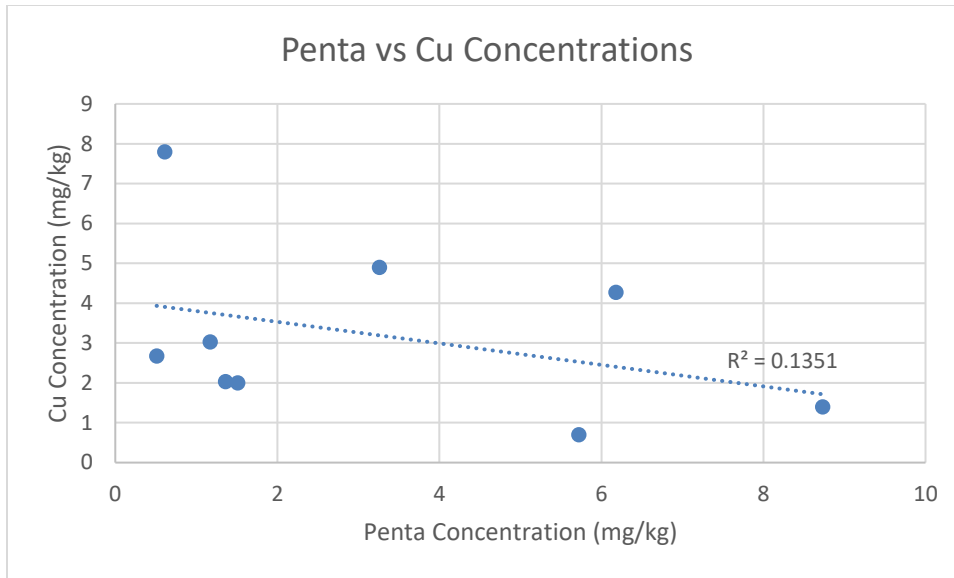


Figure 9. Relationship between pentachlorophenol and copper concentrations in rainwater runoff from the House Rock Bridge near Upper Soda, Oregon.

**Implications:** Developing data on the absolute amounts of chemical migrating from a structure is useful, but it must be placed in context with the potential impacts of the chemical on the receiving body of water. We used a stream gauge located at Cascadia State Park approximately 13 miles downstream from the bridge as the basis for our estimates of concentrations of penta and copper that developed in the receiving river beneath the bridge. Data for stream flow were taken as the high and low flow in liters per day for each collection period (Tables 3, 4). The bridge area from which the water was collected represented 14 % of the bridge surface area and all of the water was assumed to leave the bridge and enter the water. This value was multiplied to estimate migration from the entire bridge. All faces of the treated wood were considered to be capable of contributing to preservative migration. This was a bit of an over-estimate because there were short banks next to the bridge abutments that might capture some runoff. Penta levels in river ranged from 0.0017 ng/L to a high of 10.152 ng/L (parts per trillion) over the 9 collection periods when low flow at each sampling time was considered. These values decreased to 0.012 to 7.252 ng/L when the high flow for that collection point was used. Copper levels in the river downstream from the bridge would be 0.216 to 5.498 ng/L using the low flow rate and 0.083 to 1.649 ng/L for the high flow condition.

We do not have regular copper concentration data for this river, but the Brook’s Risk Assessment model uses an assumed 1.5 ug Cu/L of water as a baseline copper level (1500 ng/L)(Brooks, 2011). While it would be difficult to completely assess the toxicity of

added copper in this river, it is possible to look at the proportional increase in copper levels in the receiving water with varying precipitation levels. The highest copper concentration in runoff was 5.498 ng/L which would represent a 0.37 % increase in background copper levels. In most other cases, the changes were less than 0.1 % under the low stream flow condition and less than that at the higher flow rates. While one can argue that any change in copper concentrations could influence behavior, the levels noted herein would generally fall within the range of error for most analytical methods given the variability in flow conditions and collection methods.

Clearly, there should be no background penta in the river above the bridge. Thus any penta introduced from the bridge would need to be examined alone. The highest level of penta estimated to be in the stream below the bridge was 10.15 ng/L when the collection was made during a period of lower stream flow. The Risk Assessment Model uses a value of 9.8 ug/L (9.8 ppb) as an effects threshold (Brooks, 2010). The highest level detected in our nine collections would translate to 0.0102 ug/L, far below the level of concern in the model.

Table 4. Average pentachlorophenol and copper concentrations below the House Rock Bridge as determined by the total amount of chemical migrating from the bridge and low/high stream flows.								
Collection Date	Total Chemical Released (mg) <sup>a</sup>		Water Flow (ML/Day)		Low Flow Concentration (ng/L)		High Flow Concentration (ng/L)	
	Penta	Cu	Low Runoff	High Runoff	Penta	Cu	Penta	Cu
1/9/2014	3468.1	2393.2	3792.2	3131.6	1.107	0.764	0.915	0.631
1/10/2014	929.9	1396.0	4428.3	3669.9	0.253	0.380	0.210	0.315
3/26/2014	662.3	1723.9	2201.9	1590.3	0.416	1.084	0.301	0.783
3/27/2014	642.7	853.4	4403.8	2202.0	0.292	0.388	0.146	0.194
3/28/2014	704.6	1051.7	12722.2	4403.4	0.160	0.239	0.055	0.083
11/20/2014	153.1	807.1	489.3	146.8	1.043	5.498	0.313	1.649
11/21/2014	8.3	105.9	685.0	489.3	0.017	0.216	0.012	0.155
12/10/2015	-	788.6	685.0	489.3	- <sup>b</sup>	1.612	-	1.151
12/11/2015	4967.5	796.8	685.0	489.3	10.152	1.628	7.252	1.163
12/23/2015	967.2	122.9	685.0	489.3	1.977	0.251	1.412	0.179

<sup>a</sup>Values represent triplicate analysis at each collection point. ML= megaliters and ng= nanograms.  
<sup>b</sup>Samples lost.

The results indicate that preservative migration from the House Rock Bridge is well below the minimum effects levels. It is, however important to note that the river over which this bridge crosses has some exceptional characteristics in that there is little or no risk of migration during the warmer summer months when the flow is quite low and

precipitation is minimal, while stream velocities during the cooler winter months when rainfalls are heavier are such that any materials moving into the water are rapidly diluted.

*E. Migration of metals from decking: ACZA treated Douglas-fir decking exposed for 233 months near Corvallis, Oregon*

**Background:** There has been recent discussion regarding the potential for the EPA to require additional data regarding movement of preservatives into the environment surrounding treated wood structures. While most of our efforts have concentrated on material either continually immersed in water or over water, there are a variety of other environments where treated wood is used. One of these applications is as decking over areas subjected to periodic flooding. Seasonal wetlands are common across the United States and many communities have constructed walkways to allow public access for wildlife viewing. Treated wood is an excellent material for use in these applications because it is inexpensive and easily fabricated on site. It also ages to blend into the surrounding environment. One aspect of the use of treated wood in these applications is the potential for migration of preservative from the treated wood and into the surrounding environment where they can potentially affect non-target organisms (Morrell et al., 2003; Stilwell and Graetz, 2007; Stilwell and Kornly, 2001). There are relatively few data on the degree of movement of preservatives from these decks. As part of an earlier study on the preservative migration, we evaluated metal levels in soil beneath a deck composed of ammoniacal copper zinc arsenate (ACZA) Douglas-fir lumber in the Jackson Frazier wetland located north of Corvallis, Oregon. The site receives approximately 1.0 m of rainfall per year, primarily between November and May. The climate is Mediterranean.

The decks were a floating system composed of incised Douglas-fir lumber and timbers treated with ACZA to a target retention of 6.4 kg/m<sup>3</sup> according to the then AWPA Standard C2 (Now Standard U1)(AWPA, 2014). The materials were kiln dried following treatment and represent one of the earliest examples of Best Management Practice treated material in the region.

The walkways consisted of 150 mm thick by 300 mm wide by 1.8 m long timbers placed at approximately 2.4 m intervals perpendicular to the deck direction. Next, 75 mm thick by 125 mm by 1.8 m long stringers were placed perpendicular to the direction of the deck on top of the timbers, then 75 mm thick by 125 mm wide by 5.4 m long deck boards were placed on the stringers (Figure 10). The design allowed the deck to float whenever the wetland flooded. The timbers were subjected to direct soil contact, while the remaining materials were exposed above that level. The installation required that a number of cuts be made on the materials. Cuts were made over boxes to capture as much of the sawdust as possible to limit environmental contamination (Lebow and

Tipple, 2001). These cuts were supplementally protected by application of a copper/boron paste (CuRap20, ISK Biocides, Memphis, TN) normally used for below ground treatment of utility poles.

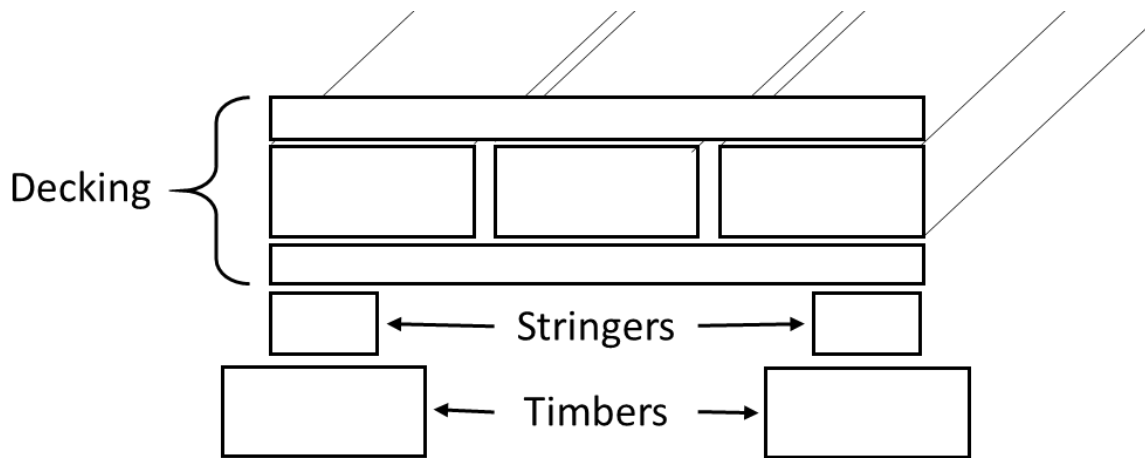


Figure 10. The arrangement of materials in the Jackson Frazier decks.

There are no major industrial metal sources above the wetland although there is a lumber mill that produces western redcedar located just to the north of the site. Any subsequent changes in metal levels should therefore reflect losses from the decking materials.

**Methods:** Background metal levels prior to installation were determined by removing soil cores from 6 sites located along the path of the intended deck. The 300 mm long cores were divided into zones corresponding to 0 to 25 mm, 25 to 150 mm and 150 to 300 mm from the surface. These zones were air-dried, then pulverized prior to being acid extracted. The extracts were analyzed for zinc, copper and arsenic using a Jarrell Ash Ion Coupled Plasma Spectrophotometer and corrected for the solution matrix employed. The results were expressed on a mg of metal per kg of dry soil. Arsenic sensitivity at first was limited to 20 mg/kg, but the detection limits improved thereafter to 5 mg/kg and finally to 1 mg/kg.

The potential for metal migration from the decks into the surrounding soils was assessed by removing soil cores from sites directly underneath the decks at sites as close to the original six sampling sites (Figure 11). Three cores were removed from each site in a triangular pattern with 2 samples 2 m apart on one side of the deck and an additional sample approximately 1 m from either of the first two sites. The cores were processed as described above. The site was sampled 5, 9, 14, 18 and 22 months after installation. Only one core was removed from each site after 14, 18, or 22 months. The decks were recently sampled 233 months after installation using the same three soil core sample per site and were processed as described above to determine the

concentrations of metals beneath the decks after prolonged exposure. As a follow-up, additional soil cores were removed from one side of the deck at each site 150, 450 and 610 mm away to determine if metal levels remained elevated with distance from the treated wood. These samples are still being analyzed.

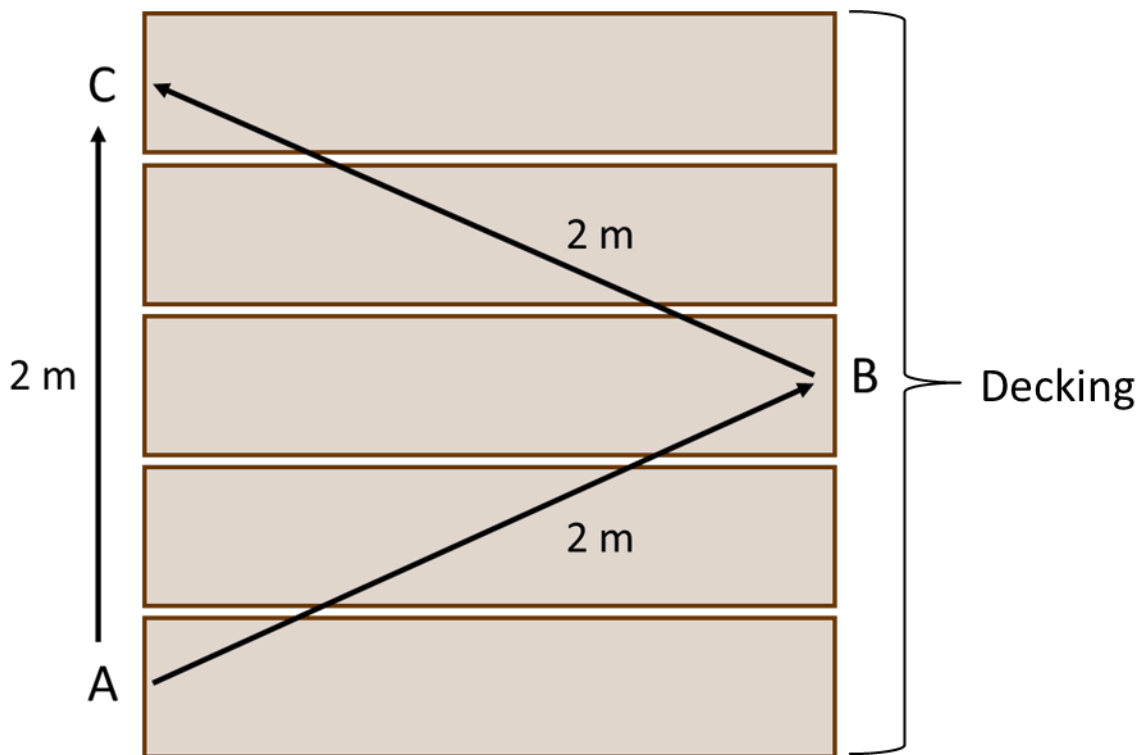


Figure 11. Overhead diagram showing the sampling scheme used to remove soil samples at each of the 6 sites at the Jackson Frazier wetland

**Results and Discussion:** Copper levels beneath the decks prior to installation averaged 46 mg/kg in the upper 25 mm of soil, and declined to 40 mg/kg with increasing depth (Table 5). Copper levels changed little with time after deck installation in the lower two zones (25 to 150 mm and >150 mm) for the first 18 months after installation. Metal levels were elevated in these two zones 22 months after installation but there was considerable variation in concentrations. Copper levels in the upper assay zone (0 to 25 mm) steadily increased over the first 22 months after installation although there was very high variation among the sampling sites (Figure 12). Some of these initial copper increases were attributed to the used of the copper/boron paste as an end treatment and the proximity of some sampling sites to these end cuts. The presence of elevated copper levels immediately beneath treated wood is consistent with previous reports. Copper levels in soil samples removed 233 months after installation were approximately 36 % higher than those found after 22 months. Copper levels in the two deeper zones were similar or slightly lower than those found after 22 months. The lack of increase with prolonged exposure suggests that copper levels had reached an equilibrium

beneath the decks. One aspect of the results that must be considered is the method of analysis. We dried the soil and broke up the resulting material for digestion and analysis. Wood decks tend to shed small amounts of cells into the surrounding environment as the surface wears. These cells would contain preservative, but the chemical would likely be immobilized within the wood and therefore not available to non-target organisms. Our procedures did not differentiate between free copper in the soil and copper in wood cells. We will consider methods for sorting these two components in any future sampling.

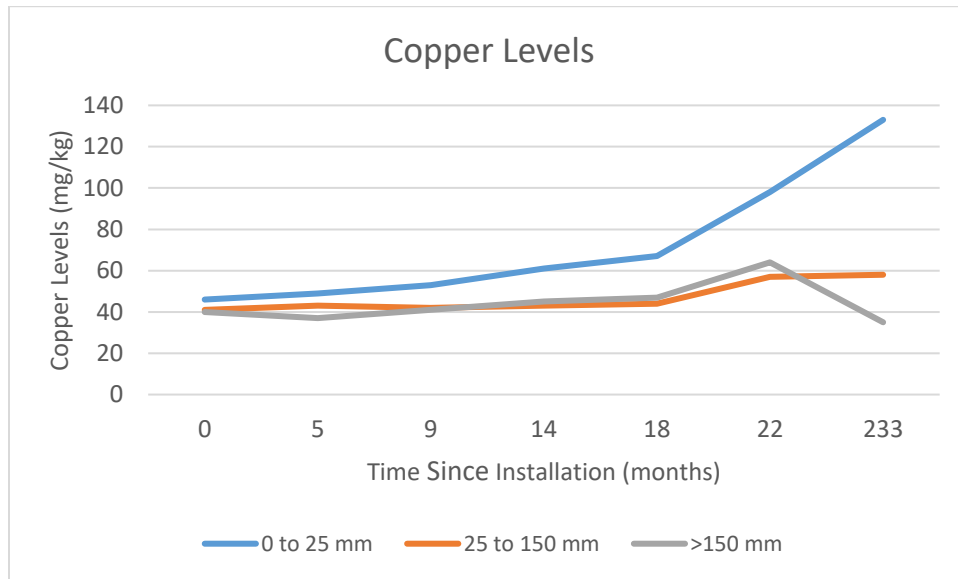


Figure 12. Average copper concentrations in soil at increasing depth beneath an ACZA treated Douglas-fir deck 0 to 233 months after installation.

Zinc levels were initially much higher in the soil prior to deck installation and often declined with time after installation (Table 6). Zinc levels in the upper sampling site (0 to 25 mm) were 17 % higher in this zone 233 months after installation, but this difference must be viewed with some caution since the standard deviations for the 0 and 233 month samples overlap. Thus, it would be difficult to say with any certainty that zinc levels increased with time after treatment in soils beneath these decks (Figure 13).

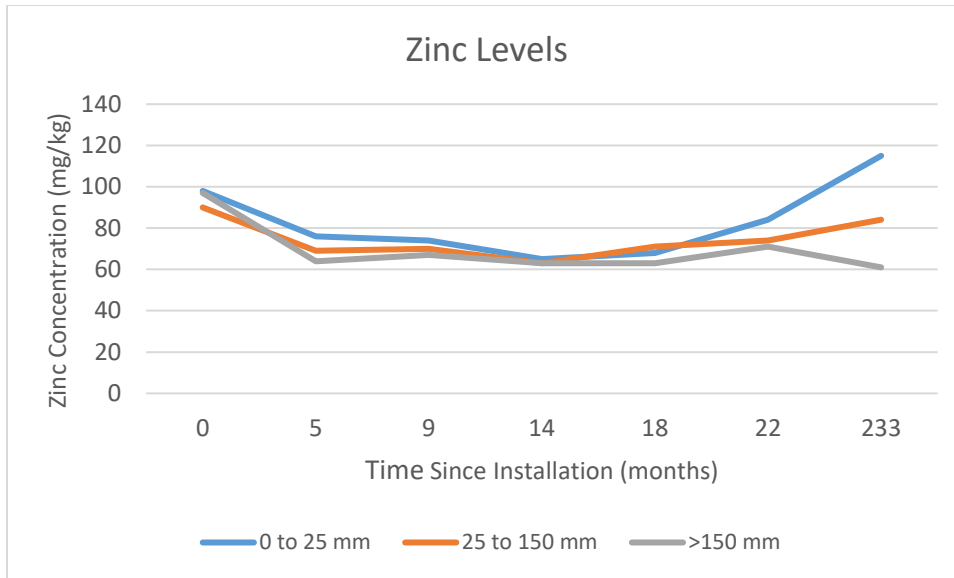


Figure 13. Average zinc concentrations in soil with increasing depth beneath an ACZA treated Douglas-fir deck 0 to 233 months after installation.

Arsenic levels must be viewed with some caution because the initial detection limits were 20 mg/kg for the 0 and 5 month samplings and then improved to 5 mg/kg for the 9 to 22 month assays. Arsenic levels above the minimum detection limit were present in 3 of the sites in 9 to 22 months after installation and there was a general trend towards higher arsenic levels nearer to the surface as well as an increase in levels between 18 and 22 months in the upper two sampling zones (Table 7). The detection limit in the most recent sampling improved to 1 mg/kg. Arsenic levels 233 months after installation were much higher than those found after 22 months. Arsenic levels ranged from 32 to 93 mg/kg in the upper assay zone with an average arsenic level of 63 mg/kg. Arsenic levels declined with depth, although the levels were still elevated 25 to 150 mm beneath the surface. Arsenic levels in the deepest zone assayed 233 months after installation were lower than those found after 22 months, suggesting that any arsenic migration was limited to the upper surfaces beneath the deck (Figure 14).



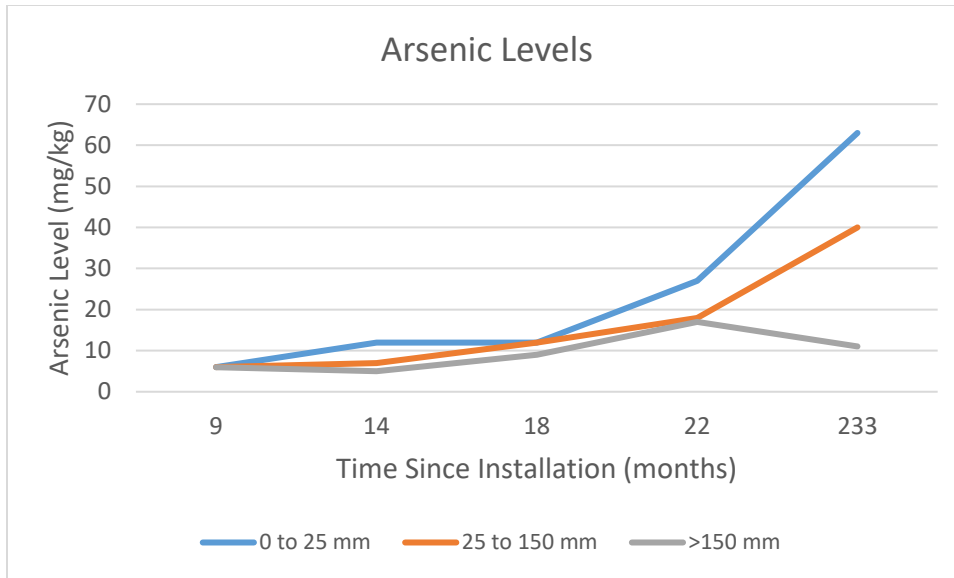


Figure 14. Average arsenic concentrations in soil with increasing depth beneath an ACZA treated Douglas-fir deck 0 to 233 months after installation.

Arsenic and zinc tend to interact during ACZA deposition in wood following treatment and would be expected to dissociate in the same manner in service (Lebow and Morrell, 1995). However, there appeared to be little relationship between changes in the levels of these two metals in soil over time. Arsenic levels increased at a much greater rate than the zinc levels, particularly 18 months after exposure. It is unclear whether these differences reflect differences in metal losses from the treated wood or the degree to which each metal interacts with the soil and therefore limits migration away from the deck.

**Conclusions:** Metal levels tended to be elevated immediately beneath ACZA treated Douglas-fir decks exposed in a seasonal wetland; however, copper and zinc levels were near the background levels deeper in the soil beneath the decks. Soil further away from the decks has been sampled but the results were not available in time for this report.

*F. Effects of coatings on migration of metal components from ACZA treated marine piling*

Port Authorities in many locations are returning to the use of preservative treated piling in place of concrete, but still have some concerns about the potential for preservative migration from these products. This is particularly true in ports where prior activities,

Table 5. Copper concentrations at selected depths in the soil directly beneath an ACZA treated Douglas-fir deck located in a seasonal wetland.

Site	Soil Depth (mm)	Copper Level (mg/kg)						
		0 mo	5 mo	9 mo	14 mo	18 mo	22 mo	233 mo
1	0-25	41 (7)	33 (1)	81 (87)	45	34	79	125 (30)
	25-150	32 (2)	32 (2)	53 (45)	58	47	82	35 (5)
	>150	37 (2)	32 (3)	53 (38)	66	103	99	36 (3)
2	0-25	39 (1)	42 (6)	33 (4)	53	31	60	169 (54)
	25-150	37 (3)	33 (7)	30 (1)	28	35	42	51 (12)
	>150	39 (1)	31 (4)	29 (3)	27	31	25	31 (93)
3	0-25	43 (6)	53 (5)	38 (13)	98	195	262	165 (78)
	25-150	33 (3)	38 (8)	28 (1)	50	50	88	72 (29)
	>150	36 (2)	30 (3)	31 (2)	35	40	128	33 (4)
4	0-25	57 (7)	57 (17)	51 (10)	74	52	82	100 (24)
	25-150	48 (9)	57 (17)	54 (9)	56	50	46	71 (8)
	>150	41 (6)	53 (12)	42 (11)	57	45	52	40 (7)
5	0-25	42 (4)	52 (10)	55 (26)	47	63	63	151 (10)
	25-150	48 (11)	45 (11)	27 (8)	40	41	41	74 (39)
	>150	44 (8)	35 (4)	44 (5)	29	46	46	37 (9)
6	0-25	53 (9)	57 (14)	48 (6)	39	43	43	90 (22)
	25-150	45 (6)	54 (20)	35 (6)	38	42	40	45 (7)
	>150	45 (5)	43 (5)	45 (9)	39	32	34	33 (1)
Mean	0-25	46 (6)	49 (9)	53 (24)	61 (22)	67 (63)	98 (81)	133 (36)
	25-150	41 (7)	43 (11)	42 (12)	43 (14)	44 (6)	57 (22)	58 (17)
	>150	40 (4)	37 (5)	41 (11)	45 (14)	47 (28)	64 (41)	35 (4)

<sup>a</sup>Values represent means of 3 samples except for the 14 to 22 month period when only one sample was analyzed per site. Figures in parentheses represent one standard deviation.

Table 6. Zinc concentrations at selected depths in the soil directly beneath an ACZA treated Douglas-fir deck located in a seasonal wetland.

Site	Soil Depth (mm)	Zinc Level (mg/kg)						
		0 mo	5 mo	9 mo	14 mo	18 mo	22 mo	233 mo
1	0-25	103 (12)	72 (1)	73 (10)	81	67	87	137 (34)
	25-150	101 (25)	71 (7)	71 (5)	73	72	77	84 (14)
	>150	93 (10)	68 (4)	75 (4)	68	66	67	74 (1)
2	0-25	93 (13)	80 (4)	75 (6)	83	61	87	131 (7)
	25-150	100 (7)	68 (10)	75 (3)	65	68	78	82 (12)
	>150	105 (3)	68 (6)	69 (9)	62	66	64	67 (3)
3	0-25	105 (15)	84 (6)	79 (12)	98	73	87	148 (48)
	25-150	75 (10)	70 (10)	70 (3)	84	82	83	104 (39)
	>150	92 (7)	61 (3)	72 (4)	61	70	85	60 (4)
4	0-25	104 (8)	74 (8)	74 (10)	76	69	93	93 (18)
	25-150	87 (8)	71 (8)	75 (8)	75	75	73	88 (20)
	>150	95 (12)	69 (9)	62 (10)	68	72	73	63 (12)
5	0-25	88 (14)	69 (11)	84 (18)	70	72	85	94 (10)
	25-150	91 (8)	65 (14)	72 (10)	27	64	69	82 (30)
	>150	104 (11)	56 (2)	68 (7)	60	47	72	50 (7)
6	0-25	94 (18)	74 (5)	60 (3)	59	68	63	86 (19)
	25-150	84 (12)	66 (9)	56 (7)	56	66	62	61 (5)
	>150	95 (4)	65 (4)	56 (10)	57	54	64	52 (2)
Mean	0-25	98 (13)	76 (6)	74 (10)	65 (33)	68 (4)	84 (10)	115 (23)
	25-150	90 (12)	69 (10)	70 (6)	63 (20)	71 (7)	74 (7)	84 (20)
	>150	97 (8)	64 (4)	67 (7)	63 (4)	63 (10)	71 (8)	61 (5)

<sup>a</sup>Values represent means of 3 samples except for the 14 to 22 month period when only one sample was analyzed per site. Figures in parentheses represent one standard deviation.

Table 7. Arsenic concentrations at selected depths in the soil directly beneath an ACZA treated Douglas-fir deck located in a seasonal wetland.						
Site	Soil Depth (mm)	Arsenic Level (mg/kg)				
		9 mo	14 mo	18 mo	22 mo	233 mo
1	0-25	7(2)	42	6	65	93 (35)
	25-150	5 (1)	14	16	27	19 (4)
	>150	8 (3)	7	15	10	11 (2)
2	0-25	5 (1)	11	14	18	59 (24)
	25-150	6 (1)	<5	20	8	39 (27)
	>150	6 (1)	<5	18	6	8 (1)
3	0-25	10 (9)	<5	36	47	83 (15)
	25-150	7 (2)	<5	19	60	82 (65)
	>150	6 (2)	<5	7	71	17 (10)
4	0-25	<5	<5	<5	13	51 (11)
	25-150	<5	<5	<5	<5	34 (5)
	>150	<5	<5	<5	6	14 (3)
5	0-25	<5	<5	<5	11	59 (22)
	25-150	<5	<5	<5	<5	54 (61)
	>150	<5	<5	<5	<5	9 (2)
6	0-25	<5	<5	<5	<5	32 (3)
	25-150	<5	<5	<5	<5	9 (5)
	>150	<5	<5	<5	<5	6 (1)
Mean	0-25	6 (2)	12 (15)	12 (12)	27 (24)	63 (18)
	25-150	6(1)	7 (4)	12 (7)	18 (22)	40 (28)
	>150	6 (1)	5 (1)	9 (6)	17 (26)	11 (3)

<sup>a</sup>Values represent means of 3 samples except for the 14 to 22 month period when only one sample was analyzed per site. Figures in parentheses represent one standard deviation.

notably the presence of many ships with copper based anti-fouling coatings has resulted in an excess of copper in the water and sediment. One possible solution for limiting additional copper input would be to coat the piling with an impermeable barrier to limit preservative migration. Salt water presents an especially rigorous environment for coatings and the risk of debris or ships damaging the wood surface further limits the potential coatings for this application. However, a number of polyurea-based systems have been developed for this application and are currently required for the use of preservative treated wood in several California ports. While these barriers have been reported to be effective, there are relatively little data demonstrating their effectiveness. In this report, we describe preliminary evaluations of polyurea coated piling treated to the marine retention (2.5 pcf or 40 kg/m<sup>3</sup>) with ACZA.

Coated piling were received from Thunderbolt Wood Treating (Riverbank,CA) as 0.9 m long by 250-300 mm diameter sections (Figure 15). The piling were placed into tanks containing 610mm of soil and then the tanks were filled with artificial seawater to a depth of 610 mm so that the base of the pile was in sediment but the top of the piling was not immersed. The tanks were stored at room temperature and periodically sampled for copper, zinc and arsenic levels. The sediment was removed immediately adjacent to the piling, oven dried, ground to a fine powder and then acid extracted. The resulting extract was analyzed for copper by ICP as previous described. Water samples were also collected, acidified and analyzed by IC.



Figure 15. Example of a polyurea coated ACZA treated Douglas-fir piling.

No copper, zinc or arsenic has been detected in the water column over the first 3 months of exposure nor have there been detectable changes in metal levels in the sediment. The results indicate that the polyurea barrier is performing as expected. Unfortunately, the cooperator did not have non-coated piling at the start of the test; however, non-coated ACZA treated piling have recently been installed in a similar set up and these results will be provided in future reports.

*G. Migration of ACQ from the Section 36 trail bridge*

In 2006, a trail bridge was constructed in the McDonald Dunn Research Forests operated by the Oregon State University College of Forestry. The bridge constructed using four 150 mm by 300 mm by 12 m long beams set 300 mm apart from one another. The stringers were braced and then nominal 75 by 150 mm by 1.2 m long decking was attached. The bridge crossed a seasonal stream and was designed to support both trail vehicles and the occasional horse. All of the wood was treated with alkaline copper quaternary to a target retention of 9.6 kg/m. The stringers were parallel stranded Douglas-fir timbers while the decking was Douglas-fir lumber. The stringers were kiln dried over a period of more than 8 weeks to a target moisture content of 25 %.

The bridge was originally supposed to regularly sampled to determine if elevated copper levels developed beneath the decks, but this was never undertaken. This past year, we initiated a small sampling effort on the bridge. Soil samples (0 to 75 mm) were removed from five locations along the bridge, directly underneath the deck as well as from five additional locations 600 mm above and below the bridge. Each sample was air dried, ground to a fine powder and then analyzed for copper content by ICP as described for the other samples.

Table 7. Copper levels in soil upstream, underneath and downstream from an ACQ treated Douglas-fir bridge installed 10 years earlier near Corvallis, Oregon			
Replicate	Copper Content (mg/kg)		
	Above Bridge	Under Bridge	Below Bridge
1	191.11	222.04	172.75
2	232.47	322.63	213.34
3	166.63	312.52	188.40
4	223.47	342.05	206.45
5	162.87	488.71	209.01
Mean (SD) <sup>a</sup>	195.71(28.47)	337.59 (86.09)	197.99 (15.22)
<sup>a</sup> Values represent means of 5 replicates while figures in parentheses represent one standard deviation.			

Copper levels in the upper 75 mm of soil ranged from 163 to 232 mg/kg (ppm) above the bridge and 173 to 213 mg/kg below the bridge (Table 7). Copper levels directly beneath the bridge ranged from 222 to 489 mg/kg. The average copper values for samples removed from up and down stream of the bridge were similar (196 vs 198 mg/kg, respectively), while the average copper level directly under the bridge was 338 mg/kg. The presence of higher copper levels directly beneath the bridge is consistent with the results found with other waterborne preservative systems and illustrate the relatively limited mobility of copper away from treated wood. We plan additional sampling to more closely refine the copper distribution around this bridge.

## 2. Develop standardized accelerated methodologies for assessing treated wood risks

We are working to develop a number of standardized methodologies that can be used to assess preservative mobility under varying regimes. These include the small scale

BMP verification procedures, the sachets used to detect preservative migration in aquatic environments, and our efforts to quantify the levels of PAH's in the water column that have been described earlier. Our intent is to publish the results of these tests in peer-reviewed journals and, once they are accepted in that venue, to move to make these methods standards under the appropriate organizations.

### **3. Work cooperatively to develop and improve models to predict the risk of using treated wood in various applications**

There has been no additional activity in cooperation with Dr. Robert Perkins at the University of Alaska.

We were actively engaged with the State of Washington regarding a study for creosote migration from railroad ties in the Puget Sound area. We, along with a number of other companies and associations, participated in one planning meeting and provided comments regarding these plans. The study, however, was never undertaken because of the difficulty in identifying a site that was agreeable to all participants. The State wanted a site on a rail line in the Puget Sound, but was not concerned about the potential for prior contamination that might complicate the study. The other participants felt that any study of potential PAH releases should be set up on a clean field so that other factors would not complicate the results. None of the railroads with right of way in this region were planning to construct any new line, making it difficult to identify a suitable site.

### **4. Identify improved methods for reducing the potential for migration**

No work was undertaken under this objective; however, the studies undertaken to evaluate the effects of the various BMP's on metal migration from ACZA, CA and ACQ treated Douglas-fir lumber have provided valuable information on the effects of the BMP's on metal migration from wood treated with the various preservative systems. We intend to use these data to explore improved methods for reducing metal losses

### **5. Evaluate the environmental impacts and identify methods for reuse, recycling and/ or disposal of preservative waste wood taken out of service**

We have continued to examine treated wood entering the recycling stream. The Recycling Center where we have performed these studies has changed their operation, making it difficult to regularly access the site. We are working with the facility to identify a system that meets their safety concerns, while allowing us access to the materials in a timely fashion.

## **6. Deliver educational outreach programs on the proper use of treated wood in relation to the Best Management Practices**

We co-sponsored one workshop this past year at the Washington Department of Ecology in Lacey, Washington using a more traditional in-person format. The workshop was successful, but attendance was limited to State of Washington employees. These workshops expose state employees who have oversight on the use of treated wood to wood treatment, the model premise and give them some hands-on experience with the model; however, their reach is limited.

We will co-sponsor another workshop February 18 in Portland, OR for the U.S. Army Corp of Engineers. This workshop is particularly important given the Corps' reluctance to adopt the screening criteria.

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