A VISION FOR THE INDUSTRY - FUTURE POST-USE PRODUCT MANAGEMENT

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Summary

1. Introduction

The Canadian wood preservation industry is facing some of its greatest challenges and changes of the century as environmental and quality concerns converge through many current initiatives and activities. Most important of these are the Strategic Options Process (SOP), the preservatives re-registration process and ongoing globalization initiatives. The SOP has achieved unprecedented commitments by chemical suppliers, preservative treaters and users of industrial treated wood products to reduce environmental and health impacts at all stages of the treated wood life cycle by implementing best management practices. Anticipated decisions by PMRA on the re-registration of the major wood preservatives could have far-reaching impacts on the industry over a very short time frame. The various initiatives to harmonize standards and criteria for use of wood preservatives around the world will also have a large impact on the industry in the next millennium. The outcomes of some of these initiatives are impossible to foresee and so the task of predicting the future of the industry is difficult.

2. The future of the Canadian Wood Preservation Industry

We were tasked to address some specific questions and issues and I will deal with them now.

2.1. What was the greatest development in wood preservation in the 20th century?

In my opinion, the development that has had the greatest impact on wood preservation in the 20th century is the invention of chromated copper arsenate (CCA) preservatives by Sonti Kamesam in India in the 1930's. It involved development of a product that balanced needs for availability of active biocides against invading organisms with stability against leaching. It served the industry extremely well, long before mechanisms of fixation and other environment and health related issues were well understood or appreciated.

2.2 What will be the international trends and will North America follow them?

The current international trends are to:

1) Use less preservative, through use of alternative materials such as concrete ties, other materials for poles, use of untreated wood and movement to wood modification (chemical and thermal) to protect wood.
2) Decrease the accepted limits of pesticides in drinking water, surface water, soil, sediments, food etc. This makes it more difficult to comply with regulations and guidelines at all stages of the life cycle for certain preservatives.
3) Reduce use of arsenic, chromium, creosote and pentachlorophenol containing preservatives and probably in the longer term, copper containing preservatives. In parallel with this, the trend is for introduction of a much broader suite of alternatives, with main focus on organic preservatives.
4) Increase reliance on incineration for disposal of most spent wood including treated wood. For example, in 1991, Japan incinerated 40% of its waste wood (Honda *et al.*1991). Holland and Germany (by 2005) will both ban landfilling of waste containing more than a specified amount of organic material (Peek 1999).
5) Recover inorganic preservatives from treated wood by collecting and treating ashes and condensate from co-generation or incineration facilities (Italy and Finland).
6) Require manufacturers to take full life responsibility for their products.

These trends will continue internationally and they are relevant to North America partly from globalization issues, export of materials, ready access to knowledge of issues and practices in other countries. An often-heard argument for banning one preservative or another is that Germany or Japan has done so and therefore there must be a problem.

The most important current initiative that will direct the Canadian industry to conform with international trends is the work by the Organization for Economic and Community Development (OECD) working group on pesticides to harmonize health and environment risk assessment of wood preservatives by all member nations (including Canada).

2.3 Where will the industry be in 10 and 25 years? What part will the three major wood preservatives creosote, penta and CCA play?

The way wood preservatives and treated wood are viewed are difficult to predict as decisions on registration of preservatives and changes to criteria for different compounds in preservatives are impossible to predict. For example, if drinking water standards for arsenic and pentachlorophenol are dropped by 10 – 100 times as has been suggested from time to time, it would be very difficult to ensure that drinking water limits would not be exceeded near treating plants and landfills and in some use locations.

Over the next 10 – 25 years I expect the following developments

(i) There will be a greater and more varied "suite" of protective chemicals and technologies available with niche applications.

(ii) There will be greater use of synergistic combinations of wood and other materials to meet the durability and other performance requirements of products. There is potential to produce more valuable products that justify the added cost by better performance (less maintenance) and longer service life. A side benefit to this is the reduced need for waste management because of the longer service life. An example is railway ties. These products fail by splitting, crushing, decay or spike loosening as a result of the harsh combination of weathering, severe loading and biological attack. Softwood ties usually fail mechanically, while stronger, but poorer treated and lower durability hardwood ties tend to rot. Composite ties such as glued laminated wood or ties surfaced with polymer laminates engineered to meet all of the performance requirements and exposure conditions will last much longer.

(iii) Niche markets will be recognized and taken advantage of by new players, perhaps primary/secondary manufacturers or specialty product manufacturers such as designer/fabricators of modular decks or fences. This will introduce better quality of treatment of precut and framed components but also open opportunities for new preservatives considered to be safer and with lower environmental impact. The demands of the consumer for an attractive, maintenance free decorative but durable home accessories will lead to development of more dimensionally and colour stable products based on high quality stains and water repellents that will retard the splitting, checking and warping that are the bane of treated fencing and decks. The lower decay hazard and relatively short required life expectancy of many of these applications will be recognized and addressed with either strategic application of preservatives or reliance on water repellants or limited modification.

(iv) Efficient marriages of materials will be used to achieve better performance and environmental advantages; for example, coatings such as shrink-wrap, polymer coatings and effective water repellents to contain preservatives and reduce leaching, bleeding and volatile emissions, control dimensional changes and lower requirements for amounts of preservatives.

(v) A segment of the industry will take advantage of improved adhesives technology to manufacture products for treatment that are more strategically designed to meet the requirements of durability, appearance and performance. Newer isocyanate adhesives can bond wood at relatively high moisture content and there is some indication that they will effectively bond wood treated with creosote and other oil-based preservatives. Finger-jointing technology allows the attachment of treated portions for below ground portions of fence posts for example, and side laminating of treated wood to the edges of retaining wall timbers etc. is feasible. Laminated railway ties should be technically and economically feasible.

2.4 What part will alternative products and composites play?

There will be occasional substitution of other materials for treated wood. As other industries recognize the potential markets in residential construction, utility poles, railway ties and other products now dominated by wood, their marketing and research and development endeavors are increasing user acceptance of these alternatives. One example is wood polymer composites.

Problems with weight, cost, mechanical properties and even durability with early prototype decking, fencing and post products may make the treating industry complacent with regard to these products. However, the industry is actively searching for improved approaches, such as creating stronger material by surface modification of the wood and by engineered design of products such as hollow reinforced decking. Similarly the steel industry is actively working to develop more competitive steel poles. The wood industry as a whole has to do a better job of selling the very positive environmental benefits of treated wood products, and especially low energy consumption, low CO_2, SO_x, NO_x, oil and grease, hydrocarbon and other releases.

The industry should also investigate the potential of working with manufacturers of competing composite materials to provide solutions to both industries. For example. wood cement and wood plastic composites are potential recycling outlets for spent treated wood and both could benefit from inclusion of decay resistant wood fibre.

2.5 What are the biggest challenges in the next 10 and 25 years?

Here I will focus on my specific assignment – disposal of spent treated wood issues
As volumes of treated wood from service increase, reuse, recycling and destruction technologies will be more important. There is a high potential for reuse and recycling of utility poles as the condition of the treated wood is often still very good. For residential construction, the main problems are the lack of existing or foreseeable infrastructure for collection, transport, storage and reuse. At this time, the only possibility is for separation at the landfill. In Europe and USA where the problem is more concentrated, incineration is the preferred method of treated wood disposal, but in North America, there are concerns with ash disposal and air emissions. Combustion of wood in cement kilns appears to be the most viable option in Canada but it is limited by the costs of collection, transport, comminution, removal of metal contaminants and limitations on the amount of chromium that they can accommodate (CCA).

Restrictions may be placed on currently available options in the future and it is important that new options be developed. For example, the Ontario government recently changed their disposal regulation regarding hazardous wastes to consider that stabilized wastes were still "hazardous" even if they technically meet criteria for landfill disposal (e.g. Leachate Extraction Procedure (LEP) criteria). While this does not apply to treated wood at this time, it applies to treatment plant sludges and may ultimately impact treated wood. Similarly, several states in the USA now require that treated wood be placed in lined landfills (e.g., Minnesota).

There is a great problem separating treated wood from other construction and demolition (C & D) wastes (Solo-Gabrielle *et al.* 1999, Peek 1999) which is required where the C & D waste is incinerated (e.g., Florida) or placed in unlined landfills. One requirement is a reliable method of identifying treated wood for separation at the collection or treatment site. Some type of permanent identification marking system similar but more persistent marking as for grade stamping may become a requirement. Whether this be indelible stamp, bar code or embedded chip, it must be able to survive the service life exposure conditions to be of any use. Alternatively, we need effective ways to identify preservative treated wood and sort it from other wood. This will become a greater challenge as more preservatives are introduced. There is a need to identify a range of options for recycling/reuse/disposal of treated wood.

Industrial products such as poles (all treatments) and railway ties (creosote) offer the best potential because they are already collected and brought to central sites for re-grading, reuse, sale or disposal. Organic treatments, especially creosote, are most amenable to incineration for energy recovery, when reuse or recycling is not possible. Even here, it is becoming more important for producers to take a hand in the waste management of the material and to consider taking back product at the end of the life cycle.

CCA presents the greatest challenge because of the increasing quantities and the highest distribution as residential treatment. Eventually, it will be necessary to have a collection, transportation and processing infrastructure for this material. It may be modeled on the blue box system or based on centrally located collection areas. Alternatively, it may require a take-back approach by manufacturers or retailers, although this is much more practical for industrial products than for residential treated wood.

There is a growing demand by regulatory agents and consumers for "Extended Producer Responsibility" of all manufactured goods. Very simply, this is a "polluter/user pays" principle. The added cost to the manufacturer will eventually be passed on to the consumer, and the most successful manufacturer will be the one that minimizes the cost. The manufacturer must take responsibility for wastes generated by packaging of their product and for disposal of their product at the end of its life cycle. It is meant to motivate manufacturers to reduce packaging and to make their products more amenable to reuse, recycling and disposal. There are two European Union Directives dealing with automobiles and electronic equipment already, and in Germany, there has been such a program for packaging for some time. This program resulted in a significant reduction in packaging consumption in Germany and the success of this program is responsible for the more ambitious programs now being considered.

I believe that this or a similar principle will eventually be adopted for many products, including treated wood. What would this mean to the treated wood industry? The options would be to treat with a system that offers no particular difficulties in disposal or to develop a viable recognition and sorting system and recycling technologies for the treated wood.

There is some scope for optimism in recent research and industrial development of appropriate waste management options for preservative treated wood. These are discussed with their applicability below.

3.0 Options for Waste Management of Treated Wood and Their Future Potential in Canada

3.1 Recycling/refine for recycling

3.1.1 Wood Cement composites

The world market for wood cement based composites is large (1.1 million cubic meters in 1988 - Felton 1997) but, with the exception of wood fibre cement products, they are not extensively used in North America at this time. However, the potential domestic and export usage is enormous for building products (cast blocks and pads; pressed boards, cast roof tiles etc.). It has been shown that the incorporation of CCA treated wood in these composites has several potential advantages. The compatibility between the CCA treated wood and the cement is much higher than between untreated wood and cement. This results in a stronger product (Schmidt *et al.* 1994, Cooper *et al.* 1998, Huang and Cooper 1999, Wolfe and Gjinolli 1999) that will perform better in service and be more resistant to breaking up in service. Our studies show that both arsenic and copper are effectively bound by the cement binder and leaching losses from these products is 20-50 times less than from the equivalent amount of CCA treated wood in a solid wood product.

GENERAL PROGNOSIS: EXCELLENT POTENTIAL FOR THE DEVELOPMENT OF NEW COMPOSITE PRODUCTS

3.1.2 Conventional particleboard and fibreboard and exterior flakeboard products

Zhang et al (1997) showed that weathering of CCA treated wood did not appear to impact negatively on the bonding properties of the wood. CCA treated wood could be incorporated in flakeboard products, but there was some bond impairment unless additives were used. Munson and Kamdem (1998) showed that particleboard could be made using spent treated wood also. Such products would be suitable for siding, sheathing, flooring and exterior industrial products (Vick *et al.*1996). With current problems with fungal deterioration of building envelopes, there may be considerable benefits to including spent treated wood in OSB and other sheathing products. However, a recent survey by Smith and Shiau (1996), indicated that manufacturers of these products generally distrust the inclusion of CCA treated wood in their products. They would require that all CCA be removed from the furnish or that confirmation be obtained that there would be no health and safety implications or environmental impacts and that the quality of the product would not be reduced.

Technology exists for chipping creosoted railway ties and re-forming them into composites ties (Cedrite process). This has been attempted several times and the jury is still out on its applicability as a significant outlet for used ties. The reported ability of isocyanate adhesives to bond oil treated wood may make this approach more feasible.

GENERAL PROGNOSIS: UNPROVEN AND UNLIKELY TO BE A SIGNIFICANT FACTOR IN THE NEAR TERM

3.1.3 Chemical/biological extraction

Pentachlorophenol can be extracted from treated wood with alkaline solutions. Both penta and creosote can be biodegraded to some extent by a number of bacteria and fungi. It is important that the organism be able to completely mineralize the preservative rather than to produce byproducts with some toxicity.

Much of the CCA components can be extracted and recovered from finely divided CCA treated wood using mineral or organic acids, or organisms that secrete such compounds. Hot sulfuric or nitric acids (Honda *et al.* 1991, Kim and Kim 1993) aqueous ammonia solutions (Pasek 1995), acetic and formic acids (Stephan *et al.* 1993) and chelating organic acids such as citric and tartaric acids (Pasek 1995, Smith and Shiau, 1996) effectively remove much of the CCA from treated wood or contaminated wastes. Steam explosion maceration of CCA treated wood also results in release of significant CCA due to organic acids produced in the process (Smith and Shiau 1996) but this is less effective than concentrated citric acid extraction.. These treatments typically remove more than 90% of the CCA components but leave some residual material in the extracted wood. Generally, the extracted material meets leachate test criteria for landfill disposal, but do not always meet concentration requirements in jurisdictions such as Germany where concentration rather than leachability criteria are used.

Some copper tolerant brown rotting fungi can release some of the arsenic and chromium and tie up the copper as low solubility and low toxicity oxalate (Stephan and Peek 1992, Peek *et al.* 1993). Subsequent treatment by bacteria or ammonia extraction could remove much of the precipitated copper oxalate (Stephan *et al.* 1996). These treatments leave the wood in a much Acleaner@ state with potential for recycling in other products although there are always some levels of one or more of the contaminants left in the wood and there will be loss in fibre quality as a result of the bio-degradation. The scale up of this process (Leithoff and Peek 1998) was judged to be impractical, mainly due to the absence of an end use for the extracted wood and chemical and problems with contamination of the system by other organisms. There is also interest in metal leaching bacteria that are used to extract concentrated metals from piles of ore by a bio-leaching process. Clausen (1997) and Clausen *et al.* (1998) investigated bacteria detoxification of CCA treated wood. Bacterial extraction alone removed most of the copper, but lesser amounts of arsenic and especially chromium. Combination of bacterial extraction with oxalic acid extraction resulted in almost complete extraction of arsenic and very high removal of copper and chromium.

Since the above effects are attributed to the release of organic acids by the micro-organisms, better results may be obtained with synthetic organic acids or other extractants. These can be applied under optimal physical and chemical conditions (temperature, pH, time, concentration etc.) without problems with contamination by other micro-organisms. Stephan *et al.* (1993) showed that pulping of salt treated wood with acetic and formic acids resulted in useable pulp with less than 100 ppm contaminants in the pulp. The residual lignin must be further treated to remove the heavy metals. Kazi and Cooper (1999) also showed that under optimized extraction conditions, more than 95 % of the CCA components could be extracted from CCA treated wood with a number of organic acids and with hydrogen peroxide. Kamdem *et al.* (1998) reported that more than 95% of CCA components could be extracted from whole lumber and pole sections using citric acid with a chelating agent, thereby preserving the solid wood for different reuse options.

Less effort has been devoted to finding ways to re-use the extracted CCA components. There are claims of methodologies for extracting and recovering CCA components for recycling by the wood treating industry (e.g. Franco 1997) although the technology is not disclosed. To be compatible, the extracted CCA components must be treated to re-oxidize the chromium to the hexavalent state, and in some cases, the extracting compounds must be eliminated from the solution. Kamdem *et al.* (1998) successfully extracted most of the CCA preservative from full size wood products and reported that the recovered solution can be re-oxidized for reuse as CCA treating solution. We have successfully extracted most of the CCA components from treated wood using hydrogen peroxide. Further treatment with this oxidizing agent can convert most of the trivalent chromium to the hexavalent state and the resulting solution can be recycled in CCA treating solution without adversely affecting CCA solution stability or the quality of treatment (Kazi and Cooper 1999).

GENERAL PROGNOSIS: SOME POTENTIAL FOR TREATMENT OF MINOR AMOUNTS OF TREATED WOOD SUCH AS THAT PRODUCED AS A BYPRODUCT OF MILLING

3.1.4 Combustion/incineration/co-generation

The potential for combustion of spent creosote and pentachlorophenol treated wood is high because of the higher fuel content of these woods and the potential for destroying the preservative provided air emissions are well enough controlled to avoid toxic emissions. The potential for CCA treated wood is lower. Combustion of inorganic preservative treated wood results in concentration of the metals in the ash where it must be collected and dealt with. Also, under some combustion conditions, a significant amount is volatilized and must be trapped from the flue gas. The main difficulty is the general resistance in Canada to considering these options for disposal of waste materials. However, the Ontario Government has just classified electricity generated by burning of garbage and industrial waste as "green energy" (Toronto Globe and Mail, Oct. 14, 1999) suggesting a more favorable climate for this option in the future.

It appears that there may be three feasible approaches for the incineration of CCA treated wood.

3.1.4.1 Controlled environment incineration/co-generation

Incineration/combustion can be controlled to avoid significant releases of toxic combustion products of creosote and penta treated wood. Several facilities in the USA use this material for co-generation plants (Webb and Davis 1994) and there are reports of some chipped railway ties being used in BC for co-generation and to fuel pulpwood boilers (Stephens 1999).

Based on laboratory studies (Pasek 1999, Cornfield *et al.* 1993) it is possible in laboratory scale tests to ensure that most of the CCA components resides in the ashes under specific temperature and oxygen supply conditions of incineration. The ashes can be treated for disposal by stabilization in a concrete matrix. Preferably, the ashes will be treated to extract the CCA components for reuse. This was done with some success by Cornfield *et al* 1993 for some copper-based preservatives.

Digestion with concentrated nitric or sulfuric acid removed most of the CCA components from CCA treated wood incinerated at low temperature, but were less effective with high temperature incinerated wood. Solo-Gabrielle *et al.* (1999) had less success extracting CCA contaminated ashes with different organic acids. This controlled incineration approach must be confirmed at the pilot plant level and methods for extraction and recycling of the CCA components from ash need to be developed.

In the USA, some CCA treated wood is accepted at some co-generation facilities (Tetra Tech 1995) but the disposal cost is high (US$80-150 per ton). Incineration at registered toxic waste incinerators on the other hand can cost US $800/ton. The ash from these incinerators is subject to TCLP testing for suitability for disposal in normal landfills and in the case of CCA would require stabilization treatment prior to disposal or successful extraction of the ash to recycle the CCA components.

GENERAL PROGNOSIS: GOOD POTENTIAL FOR DISPOSAL OF CREOSOTE AND PENTACHLOROPHENOL TREATED WOOD AND SOME POTENTIAL WITH MORE DEVELOPMENT FOR WATERBORNE PRESERVATIVE TREATED WOOD

3.1.4.2 Cement kilns

Creosote treated wood can be used as fuel in cement kilns without restrictions because all combustible components are consumed by the high temperatures and high retention times. The amount of chloride allowed in cement clinker (0.75 kg/T clinker) is high enough that it does not limit the use of penta treated wood either (Bernardin 1995). All of the spent creosote and penta treated wood produced in Canada could theoretically be used to fuel cement kilns across Canada if approvals could be obtained.

Portland cement standards have limitations on levels of copper, chromium and arsenic in the clinker, but it is possible to incorporate some CCA treated wood as a fuel source in cement kilns. This recognizes the ability of cement to stabilize CCA components so leaching losses are practically eliminated (Daniali 1990). In Canada, chromium is the limiting element since the maximum permitted levels are 0.10 kg Cr/tonne clinker, compared to 1.0 kg Cu/tonne clinker and 0.27 kg As/tonne clinker (Bernardin 1995). For heavily treated wood such as sawmill residues from treated poles, estimated at 7.5 kg/m^3 (0.47 pcf), about 13 kg of CCA treated wood could be used per tonne of cement produced.

The feasibility of disposing of residues from a sawmill re-use facility for out-of-service poles (CCA, creosote and pentachlorophenol) in a cement kiln was evaluated by a consortium of pole and railway tie users, a pole producer and re-use facility and a St. Lawrence Cement Inc. (Millette and Auger 1997). St. Lawrence Cement now has a permit allowing burning of up to 90,000 tons treated wood per year (all preservatives). At 6 % CCA allowed, about 5000 tons (10,000 m^3) of CCA treated wood could be burned per year in the one facility (Stephens 1999). If all cement kilns in Canada accepted CCA treated wood, approximately 150,000 or about 1/3 of the current production of spent CCA treated wood in Canada could be disposed of in this way. Stephens (1999) estimates that by 2020, only 4-5 % of spent CCA treated wood could be used in cement kilns. For lower retention residential lumber, the capacity would be higher.

GENERAL PROGNOSIS: EXCELLENT POTENTIAL FOR DISPOSAL OF CREOSOTE AND PENTACHLOROPHENOL TREATED WOOD; POTENTIAL FOR CCA TREATED WOOD LIMITED TO A FRACTION OF WOOD GENERATED; APPROPRIATE FOR MILLING RESIDUES AND LOW RETENTION RESIDENTIAL WOOD

3.1.4.3 Energy and raw materials source at CCA production facility

The feasibility of processing CCA treated wood at an ore processing facility such as a copper smelter has been investigated in Finland (Nurmi and Lindroos 1994, Lindroos 1999). Chipped treated wood was fed into a flash smelting furnace at high temperature and oxygen supply (Nurmi and Lindroos 1994). This process recovered the copper as part of the copper recovery process and residual arsenic and some copper were used in CCA manufacture. The chromium was stabilized in the slag residue. An economic analysis of the feasibility of chipping waste treated wood for energy at dedicated co-generation plants (Syrjänen 1999) suggests that this would be feasible, but the plants would have to be well designed to scrub all of the volatile and particulate arsenic from the stacks. In a pilot plant evaluation of this (Lindroos 1999), it was shown that the CCA components (mainly arsenic) trapped in scrubber condensate could be oxidized and recycled in CCA treating solution while the ash could be treated at a copper smelter to recover CCA components for reuse.

GENERAL PROGNOSIS: EXCELLENT POTENTIAL FOR DISPOSAL OF CCA TREATED RESIDENTIAL LUMBER IF INFRASTRUCTURE FOR COLLECTION AND TRANSPORTATION IS DEVELOPED

3.1.5 Use for mulch or animal bedding

There have been a number of studies to evaluate the use of CCA treated wood for plant mulch. The shavings do not biodegrade resulting in long-term moisture holding and ground cover. Apparently, there is no effect on plant health or uptake of contaminants (Speir *et al.* 1992a,b). Also, there is interest in Australia in using CCA shavings as bedding for laboratory animals (Willis 1999). The use of CCA treated wood is claimed to reduce respiratory diseases in animals and reduce ammonia production in the facilities. The proponent also claims to biologically "detoxify/dilute" the material after use to allow disposal of the used bedding as a soil amendment.

Due to plant toxicity, contamination of animals and other factors, these are not acceptable options for creosote or penta treated wood.

GENERAL PROGNOSIS: WHILE THESE APPROACHES MAY BE TECHNICALLY DEFENSIBLE, IT IS UNLIKELY THAT THEY WOULD HAVE BROAD ACCEPTANCE AS A RECYCLING/DISPOSAL METHOD FOR CCA TREATED WOOD.

3.1.6 Use of fibres for asphalt shingles

There is some reported recycling of penta poles by Innovative Recycling Ltd. in Alberta who chip the wood, blend it with waste corrugating medium and newsprint to make a heavy dry felt paper product used for asphalt shingle manufacture (Stephens 1999). This could presumably be used for creosote treated wood also, but CCA treated wood is not considered acceptable by the proponents. The acceptability of CCA treated wood merits some study A total of 80,000 tons of wood based fibre is used for asphalt manufacture per year in Canada (Ibid. 1999), but the amount of treated wood that can be accommodated in the process is not known.

GENERAL PROGNOSIS: LIMITED POTENTIAL TO RECYCLE SOME OILBORNE PRESERVATIVE TREATED WOOD

3.2 Re-use

CCA treated wood removed from service for reasons other than physical or biological deterioration, such as poles removed for line changes or upgrades have high potential for re-use. Products like treated poles are usually well preserved and still in good condition for re-use. Many can be re-used for the initial intended purpose or for posts, land pilings and retaining walls. El Rayes (1998) reports that 75% of treated poles removed from service in Canada are reused. Also, provided that methods are available for handling of sawdust, slabs and edgings, re-sawing of poles into other lumber and timber products is feasible. There is currently one commercial wood pole resawing facility in British Columbia. Treated slabs produced by the milling are land-filled at this time. In a study of 454 poles removed from service in eastern Canada (Coomarasamy and Cooper 1995, Cooper *et al* 1996), it was estimated that almost 40% of the wood could be re-used as lumber products, 8% could be re-used as poles, 15% (cedar) could be used to manufacture shakes and shingles and 22% could be used for other products. About 15% would have to be land-filled. Preservative analysis of CCA treated poles removed from service after up to 50 years in service (Cooper *et al* 1996) indicates that poles still have more than enough residual preservative to continue protecting the wood for decades, while oil-borne treated poles may require re-treatment. Thus, used CCA treated poles can be used for round products without re-treatment.

Because of the history of pole treatment in Canada, most of these poles were creosote or pentachlorophenol treated; however, as more out-of-service CCA treated poles become available, similar results would be expected with even higher potential for re-use as various round products.

Creosote treated railway ties are historically re-used for landscaping timbers, but there isa limited market for these timbers.

Spent residential CCA treated lumber offers a greater challenge to re-use because of the high contamination with nails and other fasteners, methods of dismantling fences and decks and lack of infrastructure to collect and process the material. There are limited opportunities to develop new products such as deck, fence or patio block panels fabricated from small pieces salvaged from spent residential products. There is also limited potential for re-sale of salvaged treated wood at facilities that specialize in sale of salvaged building products.

GENERAL PROGNOSIS: GOOD FOR INDUSTRIAL PRODUCTS BUT OF LIMITED POTENTIAL FOR RESIDENTIAL TREATED PRODUCTS

LAND-FILL DISPOSAL

Standard leaching tests on CCA treated wood to determine its acceptability for land fill disposal at non-hazardous disposal sites (the Leachate Extraction Procedure (LEP) in Canada and the Toxicity Characteristic Leaching Procedure (TCLP) in the USA) generally show that CCA treated wood has acceptable leaching characteristics for this disposal method (McNamara, 1982, Webb and Davies 1995). Modeling studies of landfill disposal (Tetra Tech 1995) suggest that because of the high stability of CCA in treated wood and high sorption and precipitation of leached material in soil, the maximum contaminant levels (MCL) permitted at 150 m from landfills would not be exceeded in treated wood is disposed of by this method. However, this could change if MCL values are lowered, as is currently under discussion. Also, this is not a preferred option for waste management of CCA treated wood because it does not recover any value from the used product, may be costly, depending on the tipping fees, and may not be acceptable at individual land fill sites which control the materials they accept. Typical normal landfill costs are US $2 - 115 in the USA while hazardous waste landfills have tipping fees in the range US $65-350 per ton (Tetra Tech 1995).

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Table 1: **Estimated annual production of spent CCA/ACA, and oilborne preservative treated products in Canada (Stephens et al 1996a, 1996b) and USA (Stalker 1993) Thousands of cubic meters**

Product	**Year**					
	1995	**2000**	**2005**	**2010**	**2015**	**2020**
Consumer Lumber	102.	399.0	1032	1629	1683	1897
Poles	54.	118.4	135.3	166.3	197.3	197
Commercial Timber	8.5	11.3	28.2	56.4	112.7	141
Industrial Timber	2.8	11.3	22.5	47.9	101.5	127
Round Posts	11.3	28.2	56.4	84.6	112.7	141
Miscellaneous	2.8	5.6	8.5	11.3	14.1	17
Total CCA/ACA Canada	**181**	**574**	**1283**	**1996**	**2221**	**2520**
Total Oilborne Canada	**270**					**240**
Total CCA USA	**1,830**				**9,150**	