Conclusions and Summary Report Environmental Life Cycle Assessment of Highway Guard Rail Posts

ISO 14044 Compliant

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Conclusions and Summary Report

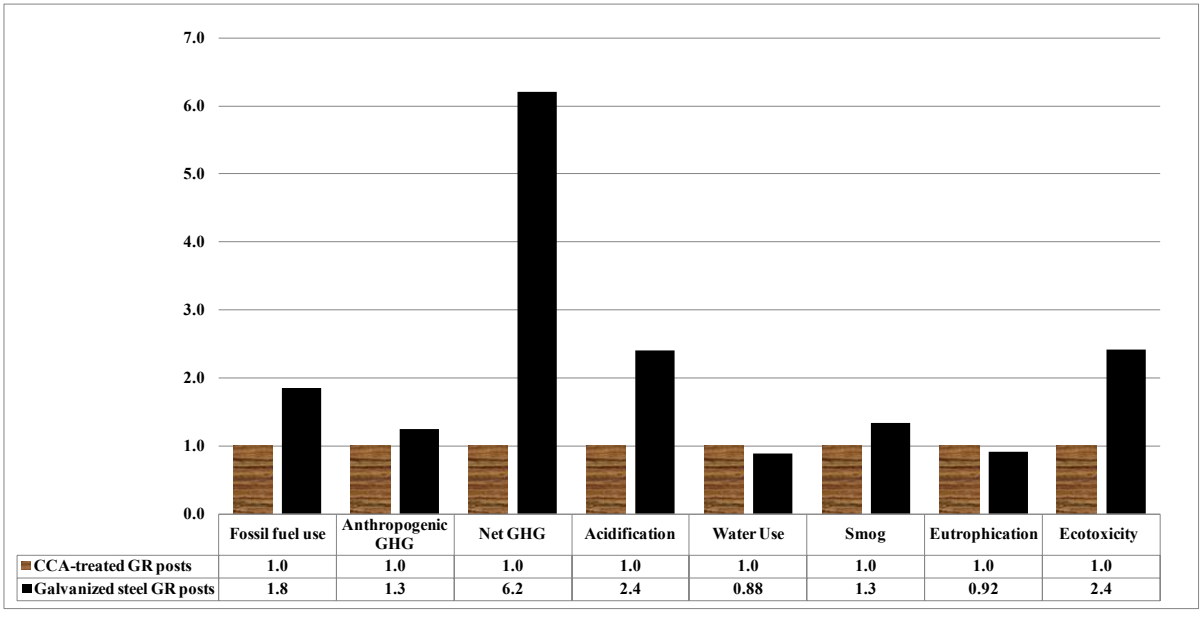
1. Conclusions & Executive Summary

The Treated Wood Council has completed a quantitative evaluation of the environmental impacts associated with the national production, use, and disposition of treated wood and galvanized steel highway guard rail posts using life cycle assessment (LCA) methodologies and following ISO 14044 standards. The results for treated wood guard rail posts are significant.

- **Less Energy & Resource Use:** Treated wood highway guard rail posts require less total energy and less fossil fuel than galvanized steel highway guard rail posts.
- **Lower Environmental Impacts:** Treated wood highway guard rail posts have lower environmental impacts than galvanized steel highway guard rail posts in five of six impact indicator categories assessed: anthropogenic greenhouse gas, total greenhouse gas, acid rain, ecotoxicity, and smog-causing emissions.
- **Offsets Fossil Fuel Use:** Reuse of treated wood highway guard rail posts for energy recovery in permitted facilities with appropriate emission controls will further reduce greenhouse gas levels in the atmosphere, while offsetting the use of fossil fuel energy.

Impact indicator values were normalized to better support comparisons between products and to understand the quantitative significance of indicators. Product normalization sets the cradle-to-grave life cycle value of treated wood highway guard rail posts to one (1.0) with galvanized steel highway guard rail post impact indicator values being a multiple of one (if larger) or a fraction of one (if smaller). The normalized results are provided in Figure 1.

Figure 1 Normalized impact indicator comparison (treated wood guard rail (GR) posts = 1.0)



	Fossil fuel use	Anthropogenic GHG	Net GHG	Acidification	Water Use	Smog	Eutrophication	Ecotoxicity
CCA-treated GR posts	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Galvanized steel GR posts	1.8	1.3	6.2	2.4	0.88	1.3	0.92	2.4

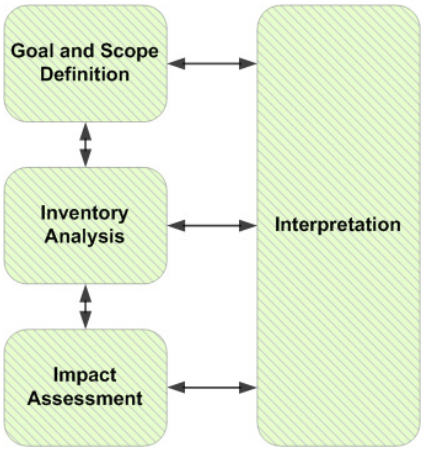
2. Goal and Scope

The goal of this study is to provide a comprehensive, scientifically-based, fair, and accurate understanding of environmental burdens associated with the manufacture, use, and disposition of highway guard rail posts using LCA methodologies. The scope of this study includes:

- A life cycle inventory of two guard rail post types: preservative-treated wood (round and sawn) and galvanized steel. Chromated copper arsenate (CCA) was chosen as a representative preservative for assessment of treated wood highway guard rail posts.
- Calculation and comparison of life cycle impact assessment indicators: anthropogenic greenhouse gas, total greenhouse gas, acid rain, smog, ecotoxicity, and waterborne eutrophication impacts potentially resulting from life cycle air emissions.
- Calculation of energy, fossil fuel, and water use.

3. Quality criteria

This LCA study was done in accordance with the principles and guidance provided by the International Organization for Standardization (ISO) in standards ISO/DIS 14040 and ISO/DIS 14044. The LCA procedures and findings were evaluated by a panel of external reviewers in accordance with Section 6 of ISO 14044. The external reviewers confirmed that the LCA followed the ISO standards and that the comparative assertions were done using equivalent functional units and equivalent methodological considerations.



4. Manufacturer Information

This LCA addresses two highway guard rail post products.

- The LCA for treated wood highway guard rail posts includes weighted averages of primary data (i.e., survey responses from U.S. treaters of wood highway guard rail posts).
- The LCA for galvanized steel highway guard rail posts represents a general product category. The galvanized steel highway guard rail posts LCA was prepared using secondary data sources and provides a basis for general comparison of products.

5. Product Description and Functional Unit

Guard rail posts are used as the vertical supports for highway guard rails. The horizontal guard rails attach to the post and generally are made of galvanized steel, except in rural areas or areas where decorative or less industrial applications are necessary. The guard rail posts can be made of either wood or steel and include blocking of steel, wood, or composite materials.

Scope: Cradle-to-grave

Functional unit: one highway guard rail post

- sawn wood product is 6 inches wide and 8 inches deep (nominal)
- round wood product is 7.5 inches in diameter
- galvanized steel product is W6x8.5 I-Beam
- all products are 6 feet long

Service life: 40 years

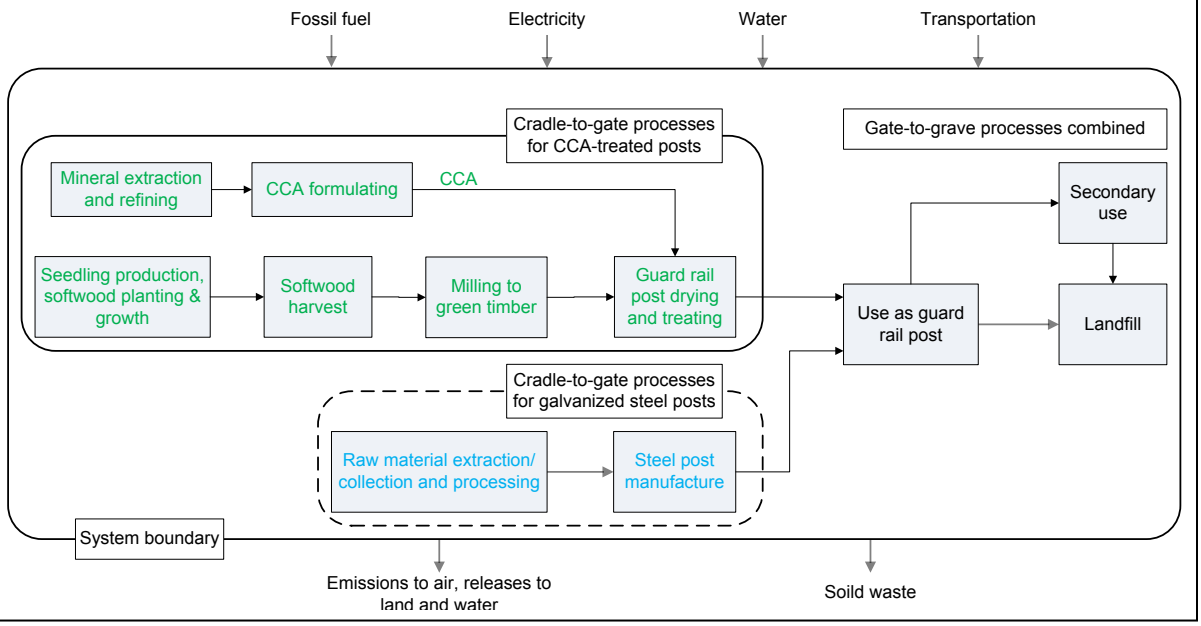
System boundary: from the extraction of the raw materials through processing, transport, primary service life, reuse, and disposal of the product.

Geographic boundary: U.S.

6. Life Cycle Inventory

The inventory analysis phase of the LCA involves the collection and analysis of data for the cradle-to-grave life cycle of the highway guard rail post. For each stage of the product life cycle, inputs of energy and raw materials, outputs of products, co-products and waste, and environmental releases to air, water, and soil are determined.

Figure 2 System boundary and process flows for highway guard rail posts. Cradle-to-gate processes for treated wood are shown in green and galvanized steel are shown in blue. Gate-to-grave processes are shown in black as combined.



The system boundaries include all the production steps from extraction of raw materials from the earth (cradle) through to final disposition after service life (grave). Figure 2 illustrates the system boundaries and process flow for both wood and non-wood highway guard rail posts assessed in this study.

The length of time a highway guard rail post remains in highway service is dependent upon a number of factors. Often, posts are removed from service before the end of their useful service life, such as for highway upgrades. Assumptions used in this LCA for disposition of highway guard rail posts after service life include:

- Treated wood posts are recycled for secondary use or disposed in a solid waste landfill
- Galvanized steel posts are recycled

7. Environmental Performance

The assessment phase of the LCA uses the inventory results to calculate total energy use, impact indicators of interest, and resource use. For environmental indicators, USEPA's Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts (TRACI) is used to assess anthropogenic and total greenhouse gas, acid rain, smog potential, ecotoxicity, and eutrophication impacts potentially resulting from air emissions. The categorized energy use, resource use, and impact indicators provide general, but quantifiable, indications of environmental performance. The results of this impact assessment are used for comparison of highway guard rail post products as shown in Table 1.

Table 1 Environmental performance (per post)

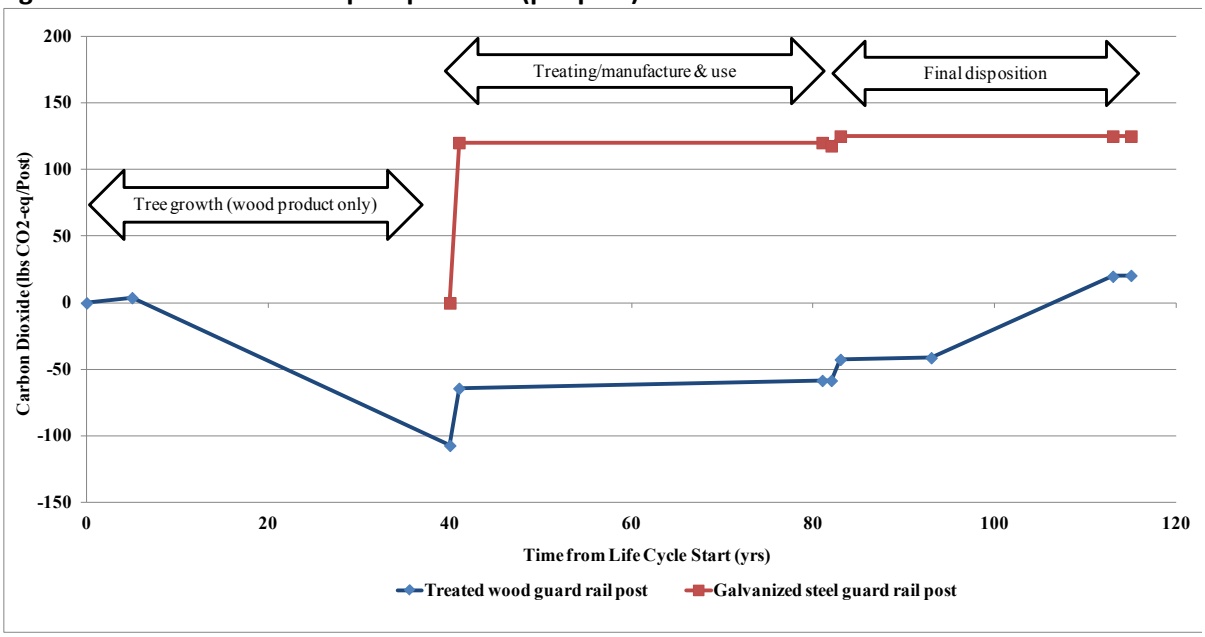
Impact category	Units	Treated wood post	Galvanized steel post
Energy use			
Energy input (technosphere)	MMBTU	0.28	0.20
Energy input (nature)	MMBTU	0.16	0.47
Biomass energy	MMBTU	0.10	0.0080
Environmental indicators			
Anthropogenic greenhouse gas	lb-CO_2-eq	98	123
Total greenhouse gas	lb-CO_2-eq	20	125
Acid rain air emissions	lb-H+ mole-eq	18	44
Smog potential	g NOx / m	0.11	0.15
Ecotoxicity air emissions	lb-2,4-D-eq	0.16	0.40
Eutrophication air emissions	lb-N-eq	0.0067	0.0062
Resource use			
Fossil fuel use	MMBTU	0.33	0.60
Water use	gal	12	11

Wood products begin their life cycles removing carbon from the atmosphere (as carbon dioxide) and atmospheric carbon removal continues as trees grow during their approximate 40-year growth cycle, providing an initial life cycle carbon credit. Approximately half the mass of dry wood fiber is carbon. Transportation and treating operations are the primary sources of carbon emissions in the manufacture of treated wood products.

The galvanized steel post begins its life cycle either as a raw material or with the recycling of steel products. Both processes result in carbon emissions. Burdens associated with recycling, including transportation, sorting, cleaning, and melting, must be included in the manufacturing stage.

Minimal impacts are required for both treated wood and galvanized steel in the service life stage. Following the service life stage, wood posts are recycled for secondary uses or disposed in landfills. Galvanized steel guard rail posts are assumed recycled. The carbon balance of highway guard rail posts, through the life cycle stages, is shown in Figure 3.

Figure 3 Carbon balance for post products (per post)



8. Additional Information

This study is further detailed in a Procedures and Findings Report completed October 5, 2011 and is available upon request from the Treated Wood Council at www.treated-wood.org/contactus.html.

This study has been published in the peer-reviewed *Journal of Transportation Technologies* (Vol. 3 No. 1, January 2013, pp 58-67) and is available at http://www.scirp.org/journal/jtts.