# Wood-Based Mulch: Are You Covered? Part One of Two

Dry wood-based mulches are effective for wildfire burn areas, mine land reclamation, wetlands rehabilitation, road construction and on construction sites. In addition to recent contracts, the United States Forest Service has funded a number of scientific tests and field studies to examine the use of wood-based mulch products as an effective erosion control measure. With an abundance of scientific data discussing coverage ratios, sediment control and impacts on regeneration of new plant life, the only piece that seems to be missing in support of using wood-based mulches is logical discussion of the economics. This first article of a two-part series provides an overview of wood-based mulch products and highlights a few simple facts to help project managers determine which type of product to use on their respective projects. Part Two, which will run in the January 2013 edition, will review relevant research data and cost factors to further assist managers in their decision-making process.



## By Trent K. Jones

Trent K. Jones is the controller for Rogue Resources, Inc., a provider of hazardous tree removal and excavation services based in Steamboat Springs, Colo. Mr. Jones also is president of Mountain Pine Manufacturing, Inc., Colorado's only manufacturer of wood strand erosion control mulch. He graduated with honors from the University of Colorado at Boulder with a Masters in accounting and a Bachelors in finance. Mr. Jones has five years of experience as a Certified Public Accountant (C.P.A.) and has spent the last six years providing accounting services to the logging and lumber industry. He can be reached at email: trent@rogueinc.us or Phone: 970-879-7861.

In recent years, the United States Forest Service appears to be trending toward the use of dry wood-based mulch, such as wood shreds and wood strand erosion control mulch, for hillslope stabilization. The United States Forest Service has all but solidified this trend with three recent contracts, all of which specify the use of wood-based mulch on 3,423 acres of ground within the Waldo Canyon Fire, High Park Fire and Seeley Fire burn areas in Colorado and Utah. These contracts, awarded in September of 2012, have provided a new use for hazard trees impacted by the Mountain Pine Beetle Epidemic. In response to this trend, Mountain Pine Manufacturing, Inc. was inspired to construct a new facility in Colorado for the sole purpose of producing engineered wood strand erosion control mulch.

## What is Wood Strand Mulch?

Wood strand mulch is a very precise engineered form of dry mulch that holds strict limitations to the size, shape and mixture of wood strands. "Engineered Wood-Based Mulch Product" is the technical name for wood strand mulch, defined under United States patent number 6,729,068, which describes the product as a 50:50 blend of geometrically regular wood-based shapes that meet the following dimensions:

- Long Piece: 5 <sup>1</sup>/<sub>2</sub> 6 <sup>1</sup>/<sub>2</sub> inches long x 3/16th inches wide x 1/16th 3/16th inches thick
- Short Piece: 2 2 ½ inches long x 3/16th inches wide x 1/16th 3/16th inches thick
- · Fines: Less than 10 percent fines or pieces less than 1 inch in length by mass

Wood strand erosion control mulch was developed by Forest Concepts, LLC. of Auburn, Washington with the help of the United States Forest Service Rocky Mountain Research Station, Washington State University and with financial assistance from the United States Department of Agriculture's Small Business Innovation Research Program. According to Mike Perry, CEO of Forest Concepts, LLC., "Wood strand mulch was specifically engineered to withstand high winds, is by nature 100 percent free of any weeds, pesticides or chemicals, will last greater than four years and animals will not eat it. Wood strand mulch also keeps moisture in the soil, intercepts rainfall and helps prevent rilling of the soil."

Over the past six years, wood strand mulch has been tested, purchased and



Wood strand mulch applied via helicopter on the Nancy Mine Gulch Fire in 2011

applied on project sites throughout the Western United States and the Rocky Mountains to mitigate wildfire burn areas, for road and trail construction, for watershed and wetlands protection, mine reclamation, pipeline construction, ski area construction and after grading and paving activities.

Today, only two manufacturers of wood strand mulch currently exist in the United States, including Forest Concepts, LLC., of Auburn, Washington and Mountain Pine Manufacturing, Inc. of Steamboat Springs, Colorado. Both of these companies use a Wood Muncher<sup>™</sup> machine that shears feedstock to exact dimensions, and an industrial baler which allows the product to be compressed and neatly packaged for shipping, long-term storage and handling.

Wood strand mulch typically is available in regular-sized bales 18 - 22 inches long x 14 inches wide x 18 inches tall (approximately 30 to 50 pounds each), as well as in large bales 42 - 54 inches long x 30 inches wide x 40 inches tall (approximately 500 to 600 pounds each).

It is very important for wood strand mulch to maintain consistent sizing and mixture of the individual pieces to ensure that the same percent ground cover is met every time the product is applied. Wood strand mulch provides the following percent ground cover given the respective number of bales used, as shown in Table 1.

Wood strand mulch can be applied by hand, by using a mechanical straw blower or by aerial application using helicopters. Staples or tackifiers are not necessary in the application of wood strand mulch, providing for simple and economical installation. Wood strand mulch also meets the National Ambient Air Quality Standards that have been set, making the product safe for workers applying the mulch and safe for local communities as well.

## **Wood Shreds Overview**

Wood shreds provide many of the same benefits of wood strand erosion control mulch. Both products are manufactured from a wood-based feedstock, such as trees, logs and/or slash, helping to provide a home for hazard trees or trees impacted by recent insect infestations. Installation of wood shreds also does not require staples or tackifiers, animals will not eat it and wood shreds can be applied by hand or by aerial application using helicopters.

Typically, the use of large commercial equipment, such as horizontal grinders and tub grinders commonly found in the logging and lumber industry, can help keep processing costs low for contractors manufacturing wood shreds. Another advantage of wood shreds is the ability for contractors to mobilize hori-



Photo taken by a Boulder City Homeowners' Association following mitigation efforts on the Fourmile Canyon Fire in Colorado

zontal or tub grinders directly to a project site, allowing them to use any available on-site wood source as an acceptable feedstock. Finally, the mobility of the equipment also suggests that a significant reduction in transportation expenses may be possible on large projects using wood shreds.

However, unlike wood strand mulch, wood shreds are not defined by a patent and do not adhere to a specific size, dimension or mixture. Instead, wood shreds appear to be generally defined as shredded, variable-sized wood particles produced by a horizontal grinder or tub grinder utilizing a 2-inch to 4-inch screen. Due to the lack of a clear definition in the scientific community, a wood shred could be defined as any wood-based mulch product that does not meet the definition of wood strand mulch, as specified in the patent.

The recent Waldo Canyon fire mitigation contract issued by the United States Forest Service described wood shreds as particles between 4 inches and 8 inches in length, typically not to exceed 1 inch in diameter. A review of other United States

Table 1				
Slope	Recommended Soil Cover	Regular (50lb) Bales/Acre	Large (600lb) Bales/Acre	
Flat Ground < 5%	40% soil cover	80	7	
Moderate Ground < 33%	50% soil cover	150	13	
Steep Ground < 33%	70% soil cover	276	24	



Wood Muncher<sup>TM</sup>

Forest Service contracts involving wood shreds also found that exact dimensions of the wood particles are not required, and the percentage of acceptable fines is sometimes not addressed, leaving room for various blends of the mulch that can be used on a site.

The lack of specification over product dimensions or percentage of fines can present a risk to project managers. If the blend of wood shreds purchased for a mitigation or reclamation site does not match the blend of wood shreds examined in scientific studies, there is no guarantee that the product will perform to expectations. In addition, if the shape, size or percentage of fines changes from batch to batch, the project manager will need to adjust the number of tons of wood shred applied per acre.

Project managers should be careful to test the percent ground cover provided by wood-based mulch products prior to purchasing those products. If size dimensions, blend and limitations on fines are not clearly specified in contracts using wood-based mulch, a project manager may not get what he or she bargained for in terms of ground cover or in terms of effective erosion control.



Wood strand feed stock

Stay tuned for Part Two of this article which will examine results from scientific studies and cost factors associated with using dry wood-based mulch products.



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6430 East 49th Drive, Commerce City, CO 80022 USA Wood-Based Mulch: Are You Covered? Part Two of Two



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Part One of this article in the last issue discussed the increasing number of contracts that have specified dry wood-based mulch for mitigation and erosion control efforts. Part One also highlighted the differences between the two most common forms of wood-based mulch - wood strand mulch and wood shreds. Part Two of this article is intended to assist project managers in determining the right wood-based mulch to use in their respective contracts. In this article, several recent scientific studies are examined as well as some in-house research aimed to help project managers compare and determine the cost/benefits of installing different types of wood-based mulch.

#### **The Science Behind Wood-Based Mulch**

Project managers are encouraged to read the following scientific studies in their entirety before purchasing a blend of wood-based mulch. A concise summary of the findings from these studies follows.

## Study # 1 – Effective For Erosion Control

The Joint Fire Science Program produced a comprehensive report in 2010 titled "Post-Fire Treatment Effectiveness for Hillslope Stabilization"<sup>1</sup> that examines a number of erosion control methods applied to wildfire burn areas. This report suggests that new developments in aerial application have made it more cost-effective to use dry mulches, such as wood strand mulch and wood shreds. This report also suggests that the use of erosion barrier treatments, such as contour-felled logs and straw wattles, as well as wet mulches like Hydromulch, are becoming less popular as post-fire treatments due to the cost of installation.

According to the Joint Fire Science report, dry mulches have been shown to increase soil infiltration capacity, to decrease soil compaction, to decrease sediment runoff and to improve the germination of seeded grasses by increasing soil moisture and by protecting grass seeds from

being washed downslope. This report provides a discussion of the various forms of erosion control products used for post-fire treatments and highlights the advantages and disadvantages of each product. In conclusion, the Joint Fire Science Program report states that "dry mulch treatments have quickly gained acceptance as effective... post-fire hillslope stabilization treatments and are frequently recommended when values-at-risk warrant protection."



Coverage Test Graph

#### Study # 2 - Percentage of Fines

Foltz and Wagenbrenner 2009<sup>2</sup> compared three blends of wood shreds, including wood shreds with all fines, wood shreds where 50% of the fines were removed, and wood shreds where 100% of the fines were removed. The results of this study showed that only the mixture where 100% of the fines were removed was effective in preventing sediment erosion during

both rainfall and concentrated flows. This study suggests that wood shred blends that include a significant percentage of fines may not work to prevent erosion or soil loss.

## Study # 3 - Percent Ground Cover

Foltz and Copeland 2008<sup>3</sup> tested a blend of wood shreds at a rate of 30% ground cover, 50% ground cover and 70% ground cover and determined that 30% coverage was not adequate to significantly prevent erosion. Further, this study rec-



Coverage Test with Wood Shreds



Coverage Test with Wood Strand Mulch

ommends particle sizes between 25mm (1-inch) and 200mm (8-inches) in length, as problems were experienced with both smaller and larger particles. Finally, this study determined that an application rate of 70% coverage was no more effective than an application rate of 50% coverage; therefore, the study recommends that a "wood shred cover of 50% is recommended for most applications."

## Study # 4 - Field Results

Foltz and Copeland 2007<sup>4</sup> monitored the effectiveness of wood strand erosion control mulch, wood shreds and agricultural straw on larger-sized plots covering a road obliteration site. Testing covered the following aspects: 1) soil loss; 2) erosion mitigation; 3) reduction in treatment cover; and 4) revegetation. The study came to the following conclusions with regards to the products tested:

- Erosion Mitigation: "Wood strands had the highest level of mitigation at 80% when both soil types were combined. Agricultural straw followed closely at 79%. Wood shreds were a distant third at 41%."
- Reduction in Treatment Cover: "Both the straw and wood shreds lost a statistically significant amount of ground cover over the first year, while the wood strands did not. The straw lost 29% of its initial ground cover over the first year. The wood shreds lost 36% of its initial ground cover over the first year. Wood strands maintained their original cover over the first year."
- Revegetation: "On the finegrained soil, each of the mitigation treatments caused a significant reduction in revegetation...On the coarse-grained soil, revegetation was unaffected on the wood strands plots but was significantly reduced on the straw and wood shreds treatments."

Based upon a review of the scientific studies above, it appears that wood strand mulch is proven to be more effective than wood shreds in terms of erosion mitigation, durability and potential for revegetation. The recommended coverage for both wood strand mulch and wood shreds is 50% coverage for most applications. Finally, it is recommended that pieces smaller than 1-inch in length and pieces larger than 8-inches in length be screened out of the mixture prior to application, as these size particles negatively affect the performance of any blend of wood-based mulch.

## **In-House Sampling & Measurements**

None of the studies reviewed give any indication of the economic factors involved with transportation, application or storage of wood shreds or wood strand mulch. In addition, some of the scientific studies have excluded helpful information about product weight or volume. Therefore, some basic in-house research was conducted by this author. Measurements were taken from a sample of wood shreds and a sample of wood strand mulch to provide project managers with additional information driving the economics of wood-based mulch.

For purposes of the in-house testing process, wood strand mulch was provided by Forest Concepts, LLC, and wood shreds were manufactured by Rogue Resources, Inc., a hazardous tree removal contractor. Wood shreds were manufactured using dead lodge-pole pine logs roughly 9-inches in diameter and 8-feet in length. The pine logs were passed through a Vermeer HG6000 Horizontal Grinder using a 4-inch screen. The grinder used in the test operates a single screen system. Both samples were air-dried in Steamboat Springs, Colorado during the summer season for a period of greater than three months, leaving very little moisture content in the wood.

Fines were identified as any wood particles less than 1-inch in length and were hand-sorted using a screen with 1.25-inches by 0.75-inch holes. In order to ensure that all useable material was captured, the fines were sifted through the screen a total of five times for both the wood strand mulch and wood shred.

## **Percentage of Fines**

The percentage of fines, or small particles less than 1-inch in length, is one of the most important factors when selecting a wood-based mulch. Table A highlights the results of the in-house sample.

The wood strand mulch contained only 7% fines, while the wood shreds processed directly off of the horizontal grinder

TABLE A % of Fines vs. % Useable Test	Wood Strand Mulch	Wood Shreds Including Fines
1 Cu Y rd of Mulch =	115 Lbs	237 Lbs
Fines (< 1") screened from 1 Cu Y rd of Mulch	8.3 Lbs	116 Lbs
% of fines screened from each product	7% Fines	49% Fines
% of useable product	93% Useable	51% Useable

consisted of 49% fines. The percentage of fines produced by any horizontal grinder or tub grinder typically is very high. Wood shreds should not be applied for erosion control purposes without first requiring the supplier to screen the majority of fines out of the blend.

# **Percent Ground Cover**

It is recommended that project managers require 50% ground coverage for wood-based mulch projects. A higher percent ground cover would simply add costs without adding erosion control benefits on all but the steepest slopes. To determine how much woodbased mulch is necessary to achieve 50% ground cover, the following in-house test was performed. ground cover using wood strand, wood shreds without fines and wood shreds including fines, respectively. Wood strand mulch requires dramatically less mass than wood shreds, because wood strand mulch is engineered to be no more than 3/16-inch thick and is manufactured to consistent lengths. The smaller 2-inch strands help increase ground cover, because they have a tendency to lie flat on the soil, while the larger 6-inch strands help form a matrix which prevents the smaller particles from being washed down slope or from blowing away in high winds.

Wood shreds require a very large mass to achieve 50% cover, because many of the particles in wood shreds are greater than <sup>3</sup>/<sub>4</sub>-inch thick. Only the piece of a wood particle that lies on the soil

TABLE B     50% Ground Cover Test	Wood Strand Mulch	Wood Shreds Without Fines	Wood Shreds Including Fines
Area of Test Plot in Sq Ft	100 Sq Ft	100 Sq Ft	100 Sq Ft
Divided by: # of Lbs Used to Cover Area = to 50% Cover	14.45 Lbs	25.66 Lbs	50.31 Lbs
Every 1 Lb Covers X Sq Ft to = 50% Cover	6.920 Sq Ft	3.898 Sq Ft	1.988 Sq Ft
Divided by: 1 Acre = 43,560 Sq Ft	43,560 Sq Ft	43,560 Sq Ft	43,560 Sq Ft
Tons Needed to Cover 1 Acre at 50%	3.15 Tons	5.59 Tons	10.96 Tons

Using the same sample of wood strand mulch and wood shreds, a ground coverage test was performed using the point intercept grid method. Each product was spread over a 100-square foot test plot, and ground coverage was measured with a 48-point grid with 1.5inch spacing to determine percent ground cover. Product was either added or removed until each test plot reached exactly 50% cover. Each product was then weighted, and the results were calculated in Table B above.

Assuming there is very little moisture content in the mulch, 3.15 tons, 5.59 tons and 10.96 tons are required to achieve 50%



Three Blends of Wood-Based Mulch

surface will help prevent sediment loss; therefore, any amount of material that sits above ground level is waste. In addition, any fines in the wood shred blend also will add weight without adding soil erosion benefits, because they will likely wash down slope, blow away or be incorporated into the soil.

#### **Transportation and Application Costs**

Often project costs become the most important factor when selecting an erosion control material. With wood-based mulch, more material required equates to higher transportation and application costs as shown in Table C.

The initial purchase price of wood strand mulch typically is higher than the purchase price of wood shreds. However, a project manager needs to consider the cost of transporting the mulch and applying the material to the disturbed area. The calculations performed reveal that the cost of transporting wood strand mulch is 2.3 times cheaper than transporting wood shreds without fines and 3.4 times cheaper than transporting wood shreds including fines. The calculations also reveal that the cost of aerially applying wood strand mulch using a helicopter is 1.8 times cheaper than applying wood shreds without fines, and 3.5 times cheaper than applying wood shreds including fines. The differences in costs are directly linked to the additional mass required to achieve 50% soil cover.

TABLE C       Transportation & Application Costs	Wood Strand Mulch	Wood Shreds Without Fines	Wood Shreds Including Fines
Assumption: 1 Tractor trailer will transport a maximum	672 Bales	120 Cubic Yards	120 Cubic Yards
Multiplied by: Weight of Mulch	42 Lbs Per Bale	182 Lbs / Cu Yard	237 Lbs / Cu Yard
1 Tractor trailer will carry a maximum	14.11 Tons/Truck	10.89 Tons/Truck	14.22 Tons/Truck
1 Acre of soil requires X tons of mulch to = 50% Cover	3.15 Tons/Acre	5.59 Tons/Acre	10.96 Tons/Acre
1 Truck will carry X Acres of soil cover	4.48 Acres/Truck	1.95 Acres/Truck	1.30 Acres/Truck
Assumption: 1 Helicopter Net will carry an average of	1,900 Lbs Per Net	1,900 Lbs Per Net	1,900 Lbs Per Net
1 Acre of soil requires X tons of mulch to = 50% Cover	3.15 Tons/Acre	5.59 Tons/Acre	10.96 Tons/Acre
Helicopter Flights / Acre to = 50% Cover	3.32 Flights/Acre	5.88 Flights/Acre	11.54 Flights/Acre

TABLE D	Wood Strand	Wood Shreds	Wood Shreds
Installation by Hand	Mulch	Without Fines	Including Fines
1 Acre = 43,560 Sq Ft	43,560 Sq Ft = 1 Acre	43,560 Sq Ft = 1 Acre	43,560 Sq Ft = 1 Acre
Test Plot: Time required to spread mulch with 1 laborer	587 Seconds	805 Seconds	1,091 Seconds
Test Plot: Area (67' x 13') or 1/50th of an Acre	871 Sq Ft	871 Sq Ft	871 Sq Ft
Multiplied by: Time Needed to Cover 1 So Ft by Hand	0.674 Seconds/Sa Ft	0.924 Seconds/Sq Ft	1,253 Seconds/Sa Ft
1 Acre Site Would Require # of Hours	8.2 Labor Hours	11.2 Labor Hours	15.2 Labor Hours

The method of packaging also plays a role in application costs. Wood strand mulch is sold in bales, while wood shreds are sold "loose leaf." The ability to move product on-site in bales as opposed to in bags or via wheel barrow will result in savings in both time and money.

Also performed in-house was a rough test of application time



Wood Shred Vermeer Grinder

using test plots equal to 1/50th of an acre in size. Wood strand mulch was applied by carrying bales manually and by spreading product by hand, and wood shreds were applied using a flatbladed shovel and wheel barrow. The time to move product and spread material on the test plots is recorded in Table D.

Based on the in-house test, it would take 8.2 labor hours to spread wood strand mulch, 11.2 labor hours to spread wood shreds without fines and 15.2 labor hours to spread wood shreds including fines over one acre of ground. These time estimates assume that the project site is flat enough to use a wheel barrow for spreading wood shreds.

For slightly larger project sites, a traditional straw blower could be used to apply wood strand mulch. According to Mike Perry, CEO of Forest Concepts, LLC, "Wood strand mulch has been successfully applied using traditional straw blowers on a number of contracts over the past six years, and workers usually comment about the lack of dust during application."



Wood Strand Truck

This author is not aware of any contractors applying wood shreds via straw blower. The large particles in wood shred blends do not appear practical or safe to apply via blower, but this theory has not been tested by Mountain Pine Manufacturing, Inc.

## Conclusion

Dry wood-based mulch can be a cost-effective means of preventing soil erosion and improving the germination of grass seed without the risk of spreading noxious weeds, pesticides or chemicals. Wood-based mulch also can be effectively applied without the use of staples, tackifiers or water, and it offers long-lasting benefits.

The two most common forms of dry wood-based mulch are wood strand mulch and wood shreds. Project managers are cautioned, because not all blends of wood-based mulch offer the same results in terms of effective erosion control or revegetation. Scientific studies prove that wood strand mulch is more effective than wood shreds in terms of erosion mitigation, durability and revegetation.

The percentage of fines, the percent ground cover and the packaging of the material are the largest factors driving both effectiveness and cost of wood-based mulch. The basic measurements recorded in this article will help determine the costs involved with using wood-based mulch. The author recommends that project managers assess the effectiveness, the cost of purchase, the cost of transportation and the cost of application of each blend of wood-based mulch before contract specifications are written.

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