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## GreenFiber Insulation Products

Green-Buildings' team of LEED® Accredited Professionals performed a benchmark analysis of GreenFiber's insulation products, which are made with 85% recycled paper fibers, and determined that their natural fiber insulation may:

- A. **Conserve Energy for Heating and Cooling**
- B. **Improve Building Durability**
- C. **Improve Indoor Environmental Quality**
- D. **Reduce Demand for Raw Materials**



## EXECUTIVE SUMMARY

As the largest producer of natural fiber insulation in North America, GreenFiber has been helping schools, churches, housing complexes, businesses and other organizations with their paper recycling needs since 2000. The company's products contain 85% recycled paper fiber. Acquiring this fiber with GreenFiber's recycling process is the first step towards development of an insulation product that helps reduce incremental demand for landfill space, educates youth on the importance of recycling, and other environmental attributes that benefit the communities around the manufacturing facilities. GreenFiber, based in Charlotte, North Carolina, worked with Green-Buildings.com ("Green-Buildings") to complete a review of their insulation products.

GreenFiber manufactures a range of insulation products used in attics, floors and walls of residential and commercial new construction and re-insulation applications. For the purposes of this certification review, the product analysis included:

### United States:

- GreenFiber Loose Fill Attic Insulation (INS515LD)
- GreenFiber Stabilized Attic Insulation (INS500)
- GreenFiber All Borate Stabilized Wall Spray Insulation (INS735)
- GreenFiber All Borate Loose Fill Attic and Wall Insulation (INS760LD)
- GreenFiber Premium All Borate Retrofit Wall Insulation (INS770LD)
- GreenFiber Blow in Natural Fiber Insulation (INS541LD)

### Canada:

- GreenFiber Loose Fill Attic Insulation (INS552LD-CAN)
- GreenFiber Stabilized Attic Insulation (INS500-CAN)
- GreenFiber All Borate Stabilized Wall Spray Insulation (INS735-CAN)
- GreenFiber Premium All Borate Retrofit Wall Insulation (INS770LD-CAN)
- GreenFiber Blow in Natural Fiber Insulation (INS550LD-CAN)

GreenFiber natural fiber insulation products have been certified by Scientific Certification Systems (SCS) for a minimum 85% recycled paper fiber content, with at least 55% post-consumer and the balance (30%) pre-consumer recycled content, on a dry weight basis.

Green-Buildings' team of LEED® Accredited Professionals evaluated GreenFiber's natural fiber insulation and determined that this product may:

- A. Conserve Energy for Heating and Cooling**
- B. Improve Building Durability**

- C. **Improve Indoor Environmental Quality**
- D. **Reduce Demand for Raw Materials**

Green-Buildings believes that several characteristics of GreenFiber's insulation are congruent with green building principles and, as such, the product may be considered applicable to high-performance building.

## DETAILS

GreenFiber natural fiber, cellulose-based insulation products are produced from recycled newsprint and other recycled paper sources. GreenFiber products deliver consistent thermal performance while helping to reduce air infiltration and the transmission of sound by filling gaps and voids in walls, attics and floors. This 85% recycled content product provides outstanding thermal performance, fire-resistance and sound control, and is produced and applied in a virtually waste-free, low embodied energy manufacturing process.

### ***A. Conserve Energy for Heating and Cooling:***

According to the U.S. Department of Energy, buildings are responsible for approximately 39% of the energy consumed in the United States. It is estimated that a significant portion of this energy use would be unnecessary if all buildings were properly insulated.

GreenFiber natural fiber insulation provides excellent thermal resistance and can play a significant role in reducing the energy used in heating and cooling residential and commercial buildings.

By reducing the transfer of heat in either direction through a building's envelope, GreenFiber's insulation products help to minimize the amount of energy needed to heat and cool a building. This can lead to reduced greenhouse gas (GHG) emissions, such as CO<sub>2</sub>, commonly produced by coal-fired and gas fired power plants during energy generation.

Thermal and moisture protection of GreenFiber thermal and sound insulation products were evaluated by ES Reports via ESR-1996 reissued October 2, 2008. The scope of the evaluation included compliance with the 2006 International Building, Mechanical, Energy Conservation and Residential Codes and evaluated the various product properties. Various R-value goals can be attained using these products depending on the specifics of the assembly location, product type, and application method. GreenFiber natural fiber insulation products have therefore proven to be highly energy-efficient.

The thermal conductivity properties of typical residential insulation materials ranges from 0.19 – 0.90 Btu·in/hr·ft<sup>2</sup>·°F; GreenFiber's products are in the lower end of this conductivity range, meaning they are highly effective in reducing heat transfer in building assemblies for all products evaluated.

Moreover, the high R-value and density of natural fiber insulation provides an excellent thermal barrier, particularly in climates with either hot summers or cold winters. Natural fiber insulation has been shown to perform better than some loose-fill fiberglass products when the difference between indoor and outdoor temperatures increases. For example, cellulose insulation has been shown in laboratory testing to avoid convective heat losses when the temperature drops in winter in attic spaces.

Finally, the energy required to manufacture natural fiber insulation products has been documented to be far less than that of fiberglass insulation, further reducing greenhouse gas emissions and carbon footprint. Additionally, there is very little cellulose insulation waste produced at the job site because all of the insulation can be recycled on the site or into the next site. This is not true of fiberglass batt and some foam insulation products.

In summary, Green Fiber natural fiber insulation can help reduce the transfer of heat across a building envelope, thereby minimizing the energy required to condition the indoor environment.

## ***B. Improving Building Durability***

A key green building principle is the improvement of building quality and durability to reduce or eliminate the frequency of building maintenance, replacement and repair. Often, the greenest buildings are those that do not need to be replaced. Products that help promote a durable design and ongoing performance enhancements may result in a building that will last longer, thereby avoiding future downstream waste.

GreenFiber natural fiber insulation products may be used in flat ceilings, walls, cathedral ceilings, under floors and in basements. Due to its product density, GreenFiber may also act as a soundproofing material, helping to create a quieter home environment.

The fire safety of GreenFiber's products is regulated by the Consumer Product Safety Commission (CPSC) under 16 Code of Federal Regulations (CFR) Parts 1209 and 1404. The CPSC requirements are tested and met every day at all of GreenFiber's plants. The International Building Code (IBC) also has a requirement under 2012 IBC Section 720. In addition, all of GreenFiber's products are classified by Underwriters Laboratories (UL) for product fire performance characteristics and for the integrity of the company's Quality Control/Quality Assessment programs. The company's test results

show that GreenFiber consistently meets or exceeds the fire safety requirements of the CPSC and the IBC.

The loose-fill, lightweight nature of blown-in natural fiber insulation provides the benefit of filling in around pipes, wires and electrical boxes. This blown-in process eliminates the air gaps and voids that are common with some other insulation products. Gaps and voids may lead to a reduction in R-value, unwanted air and moisture infiltration, and/or gaps in a fire barrier.

The use of insulation in new construction, or adding more insulation to an existing structure, increases that building's ability to manage thermal, moisture vapor, ventilation and acoustical properties, while at the same time reducing the structure's greenhouse gas emissions and carbon footprint. In summary, GreenFiber natural fiber insulation products contribute to improved building durability.

### ***C. Improve Indoor Environmental Quality:***

Providing a comfortable thermal environment while improving indoor air quality enhances occupant health, productivity and well-being and is an essential goal for any green building.

The U.S. Environmental Protection Agency (EPA) estimates that indoor pollution and/or contaminant levels may be two to five times (and potentially up to one hundred times) greater than outdoor levels. Potential threats to indoor environmental quality include the presence of hazardous chemicals, high concentrations of airborne fibers, smoke, and microorganism contamination.

GreenFiber natural fiber insulation is mold resistant per ASTM C 1338 and, when properly installed and maintained, will not contribute to mold germination and growth. Boric acid is used as a fire retardant in GreenFiber's natural fiber insulation and is also an EPA registered fungicide.

GreenFiber natural fiber insulation also offers excellent acoustical performance. It has proven extremely effective in controlling sound transmission based on its inherent density, its ability to install evenly in irregular spaces and its natural tendency to eliminate air gaps where sound would travel. Independent test results by Architectural Testing, Inc. indicate that GreenFiber natural fiber insulation provides equal or superior sound transmission control when compared to 4" Sound Control Batts designed for Sound Transmission Class (STC) and Outdoor Indoor Transmission Class (OITC) ratings. STC and OITC acoustical tests were conducted in compliance with ASTM E 90-09 Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions, ASTM E 413-04 Classification for Rating Sound Insulation, ASTM E 1332-90 Standard for Determination of Outdoor-Indoor-

Transmission-Class and ASTM E 2235-04 Standard Test Method for Determination of Decay Rates for Use in Sound Transmission Test Methods.

In summary, GreenFiber natural fiber insulation products may improve indoor environmental quality by helping to reduce sound transmission into and around the home, and maintaining a more thermally constant environment.

## ***D. Reduce Demand for Raw Materials***

By incorporating recycled content into building materials, green builders not only reduce the impact that results from the extraction and processing of raw materials, but also reduce the volume of solid waste that is produced as a byproduct of our built environment.

According to the Cellulose Insulation Manufacturer's Association (CIMA), over 38% of municipal solid waste in landfills in the U.S. is comprised of paper products. GreenFiber's products are manufactured from materials comprised primarily of recycled paper (recycled material). Its manufacturing process diverts materials from landfills across North America. GreenFiber natural fiber insulation products have been certified by Scientific Certification Systems (SCS) for a minimum 85% recycled wood fiber content, with at least 55% post-consumer and the balance (30%) pre-consumer recycled content, on a dry weight basis.

All GreenFiber plants use the same manufacturing process: shred paper, fiberize, add additives, compress into bales, and pack into bags. When paper is received, each load is inspected according to internal procedures to ensure quality, minimizing any risk of contaminants from the paper stream prior to fiberization. Quality control sampling tests verify package weight, design density, thermal resistance, flame spread and smolder combustion resistance, moisture and odor. GreenFiber's raw materials and products are produced, sourced and sold regionally, decreasing the greenhouse gas emissions associated with transportation and storage.

## **LEED CREDITS**

To earn certification under the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED®) rating system, projects must not only satisfy all LEED system prerequisites, but also earn a minimum number of credits.

Projects may earn a range of sequentially higher LEED certification ratings as determined by their compliance, as well as exemplary performance, in the credit categories within each system.

When applied properly, Green Buildings believes that GreenFiber's natural fiber insulation products will contribute materially toward earning points in a LEED

certification in the following prerequisite(s) and/or credit(s)<sup>1</sup> under the **LEED Green Building Design and Construction Rating System (BD+C, 2009)** and **LEED for Homes Rating System**.

Note that no individual material or product enables a credit or certification within the LEED rating system due to the fact that each category is dependent on the aggregate of all materials and their proportionate relationship to the total dollar cost of all materials. See individual product data sheets for details and check with local sales representative for appropriate product applications and eligibility.

Table 1 - LEED BD+C LEED Contribution Chart

LEED Category and Credit	LEED Requirement	Product Contribution
<b>Energy &amp; Atmosphere (EA)</b>		
<b>Prerequisite 2: Minimum Energy Performance</b>	Demonstrate a 10% improvement in the proposed building performance rating for new buildings and 5% in major renovations when compared with the baseline building performance rating as calculated per ASHRAE 90.1-2007 Appendix G using a computer simulation.	GreenFiber products maximize energy performance in many applications exceeding LEED requirements. GreenFiber insulation products help deliver an energy-efficient building envelope thereby reducing energy associated with heating and cooling a building. In addition, proper application of insulation and continuous coverage helps ensure the thermal properties of the building envelope.
<b>Credit 1: Optimize Energy Performance (1-19 points, New Construction OR 3-21 points, Core &amp; Shell)</b>	Demonstrate a percentage improvement over the prerequisite amount in the proposed building performance rating compared to the baseline building using a computer simulation.	
<b>Materials &amp; Resources (MR)</b>		
<b>Credit 4: Recycled Content (1-2 points)</b>	Use materials with recycled content such that the sum of post-consumer recycled content plus ½ of the pre-consumer content constitutes at least 10 or 20%, based on cost, of the total value of the materials in the project.	GreenFiber insulation has been certified by Scientific Certification Systems (SCS) to contain a minimum of 85% recycled wood fiber content (55% post-consumer and 30% pre-consumer) on a dry weight basis. For more information on SCS, please visit <a href="http://www.scs-certified.com">http://www.scs-certified.com</a>

<sup>1</sup> While Green-Buildings.com believes that certain products have characteristics that may contribute to a LEED® certification, only the Green Building Certification Institute (GBCI) and/or the U.S. Green Building Council (USGBC) may award points and grant certification. Accordingly, Green-Buildings.com does not make any assurances, guarantees, representations, or warranties, express or implied, and specifically disclaims all warranties or representations regarding the performance of this product or products, or that products described herein will earn LEED points, or that any project that utilizes such products, will receive LEED® certification. LEED is a registered trademark of the U.S. Green Building Council. Leadership in Energy and Environmental Design, LEED, LEED AP and USGBC are registered trademarks of the U.S. Green Building Council. GBCI is a registered trademark of the Green Building Certification Institute. The U.S. Green Building Council (USGBC) is not affiliated with Green Buildings Online, Inc., does not publish Green-Buildings.com and does not participate in the development or administration of Green-Buildings.com content. The USGBC does not endorse Green-Buildings.com. Green Buildings Online, Inc. is not affiliated with USGBC or GBCI, and does not administer the LEED program. USGBC and GBCI do not endorse or recommend the products or services offered by Green Buildings Online, Inc.

<b>Credit 5: Regional Materials (1-2 points)</b>	Use building materials or products that have been extracted, harvested or recovered, as well as manufactured, within 500 miles of the project site for a minimum of 10 or 20%, based on cost, of the total materials value.	With seven manufacturing facilities around the US, GreenFiber products meet regional materials requirements for many project sites around the country. For manufacturing facility location information, please visit: <a href="http://greenfiber.com/locations_corporate.html">http://greenfiber.com/locations_corporate.html</a>
<b>Indoor Environmental Quality (IEQ)</b>		
<b>Credits 7.1: Thermal Comfort, Design (1 point)</b>	Design HVAC systems and the building envelope to meet the requirements of ASHRAE Standard 55-2004, Thermal Environmental Conditions for Human Occupancy.	GreenFiber insulation contributes to a comfortable indoor environment through its insulating properties.
<b>Prerequisite 3: Minimum Acoustical Performance (LEED BD+C for Schools)</b>	Design classrooms/core learning spaces to include sufficient sound-absorptive finishes to comply with ANSI standards and meet maximum background noise levels for HVAC systems of 45 dBA.	GreenFiber insulation contributes to an acoustically-sound indoor environment.
<b>Credit 9: Enhanced Acoustical Performance (LEED BD+C for Schools)</b>	Design classrooms/core learning spaces to include sufficient sound-absorptive finishes to comply with ANSI standards to an STC rating of 35 and meet maximum background noise levels for HVAC systems of 40 dBA.	GreenFiber insulation contributes to an acoustically-sound indoor environment, and may aid in enhanced acoustical control when applied in interior and exterior walls and ceilings

Table 2 - LEED for Homes Contribution Chart

LEED Category and Credit	LEED Requirement	Product Contribution
<b>Energy &amp; Atmosphere (EA)</b>		
<b>EAp1.1: Performance of ENERGY STAR for Homes</b>	Improve the overall energy performance of a home by meeting or exceeding the performance of an ENERGY STAR labeled home.	GreenFiber fiber insulation contributes to an energy-efficient home.
<b>EAc1.2: Exceptional Energy Performance (1-34 points)</b>	Exceed the performance of ENERGY STAR for Homes. Home Energy Ratings Standards (HERS) index is utilized to determine number of points received in the LEED for Homes rating system.	
<b>EAp2.1: Basic Insulation</b>	Install insulation that meets or exceeds the R-value requirements listed in Chapter 4 of the 2004 International Energy Conservation Code. And, install insulation to meet the Grade II specifications set by the National Home Energy Rating Standards.	GreenFiber insulation meets Grade I specifications set by the National Home Energy Rating Standards.
<b>EAc2.2: Enhanced Insulation (2 points)</b>	Install insulation that exceeds the R-value requirements listed in Chapter 4 of the 2004 International Energy Conservation Code by at least 5%. And install insulation to meet the Grade I specifications set by the National Home Energy Rating Standards.	GreenFiber insulation installation practices ensure that gaps and incomplete fill amounts will be less than the 2% maximum required to meet this credit.
		GreenFiber insulation meets Grade I specifications set by the National Home Energy Rating Standards.
<b>EAp3.1: Reduced Envelope Leakage</b>	Meet the air leakage requirements shown in Table 17 of the LEED for Homes Reference Guide.	GreenFiber insulation has excellent density and when properly applied, can contribute to reducing air infiltration and envelope leakage.
<b>EAc3.2-3: Greatly Reduced Envelope Leakage (2 points) and Minimal Envelope Leakage (3 points)</b>	Meet the air leakage requirements shown in Table 17 of the LEED for Homes Reference Guide.	
<b>Materials &amp; Resources (MR)</b>		
<b>Credit 2.2: Environmentally Preferable Products (0.5 – 8 points)</b>	Use building component materials that meet one or more of the criteria as noted in the LEED for Homes Reference Guide.	GreenFiber natural fiber insulation is composed of 85% recycled materials and over the minimum requirement of 25% postconsumer, and may apply for credits under subcategory c, local production, as well.

## CONCLUSION

GreenFiber natural fiber insulation products meet four significant criteria used in green building initiatives. Through its sustainable sourcing, high recycled materials usage, fire resistant material qualities and excellent thermal and acoustical insulating properties, GreenFiber natural fiber insulation can conserve energy for heating and cooling, improve building durability, improve indoor environmental quality, and reduce demand for raw materials.

All of these characteristics make GreenFiber a product that Green-Buildings.com would recommend for any project with sustainable design or performance goals or any project that is pursuing LEED certification.

## CASE STUDY: THIRD CREEK ELEMENTARY SCHOOL

As schools everywhere go green, **GreenFiber** natural fiber insulation provides measurable benefits that are uniquely appropriate to the ideal indoor learning environment.

**GreenFiber** natural fiber insulation was incorporated into the design and development of the Third Creek Elementary School in Statesville, North Carolina. Third Creek Elementary is the first K-12 educational facility to earn **LEED Gold Certification** from the U.S. Green Building Council.

### Highlights

- **Project name:** Third Creek Elementary School
- **Location:** Statesville, NC
- **Building type(s):** New Construction
- **Project scope:** 92,500 square foot educational facility with outdoor amenities
- **Project cost:** \$9,956,438
- **Architect:** Moseley, Harris & McClintock Architects
- **General contractor:** Brooks General Contractors
- **Setting:** Suburban Setting
- **Owner:** Iredell-Statesville Schools, Local Government
- **Occupancy:** Approximately 800 students, faculty and staff daily

### Details

When the Iredell-Statesville Board of Education made the decision to consolidate two of its existing schools, one elementary and one kindergarten, into a new facility to serve the growing population of Iredell County, high-performance building became a centerpiece of the design.

The new educational facility provides students, faculty and staff with a variety of environmental features including thermal comfort, natural day lighting in all classrooms, high quality indoor air, efficient energy and water systems and building materials that incorporate recycled content.

The building also serves to educate students and the community on the benefits of environmental stewardship via a successful public outreach program.

### GreenFiber and Green Schools

The ideal learning environment for both students and teachers combines thermal comfort, excellent acoustics, natural light and high quality indoor air. Third Creek Elementary used a variety of methods to achieve these conditions while maximizing energy, water and building materials efficiency. These methods included:

- Developing a super insulated building envelope to minimize heating and cooling loads by using **GreenFiber** natural fiber insulation in both the ceilings and walls
- Introducing separate daylight and vision glazing systems
- Utilizing lighting controls and technologies
- Employing high-performance mechanical systems
- Installing low-flow plumbing features and waterless urinals

**GreenFiber** natural fiber insulation was chosen because of the appropriateness of its characteristics as they pertain to the educational environment.

By employing **GreenFiber INS500** for its excellent thermal resistance, Third Creek's attic was insulated to R-45. Third Creek Elementary's walls were insulated to R-22 using **GreenFiber INS735** which is designed for spray applied wall applications. Both products, offer excellent fire resistance and contains at least 85% recycled content, by weight.

In addition to its high R Value and its fire resistance qualities, **GreenFiber INS500** helps address issues such as classroom acoustics and sound control. It is generally recognized by the National Institute of Building Sciences that acoustical quality matters in schools, and that children can benefit from good acoustics in classrooms and school spaces.

Over fifty percent of the materials used in the Third Creek Elementary School contain, in aggregate, a minimum weighted average of 20% post-consumer recycled content or a minimum weighted average of 40% post-industrial recycled content<sup>2</sup>. **GreenFiber INS500 and INS735** contain at least 85% recycled content by weight, and contribute significantly to raising the recycled content of the entire structure. In addition, GreenFiber's products are made in electrically powered plants using an on-demand process with a small fraction of the energy of a fiberglass plant, which operates large furnaces with a significant carbon footprint.

Indoor lighting and air quality was improved while simultaneously achieving energy savings by using operable windows and employing dual lighting zones in classrooms. The dual-zone lighting system is augmented with high-efficiency T8 fixtures on occupancy sensors. Ample windows and light shelves are featured which act to send exterior light deeper inside the building, reducing the need for electric light.

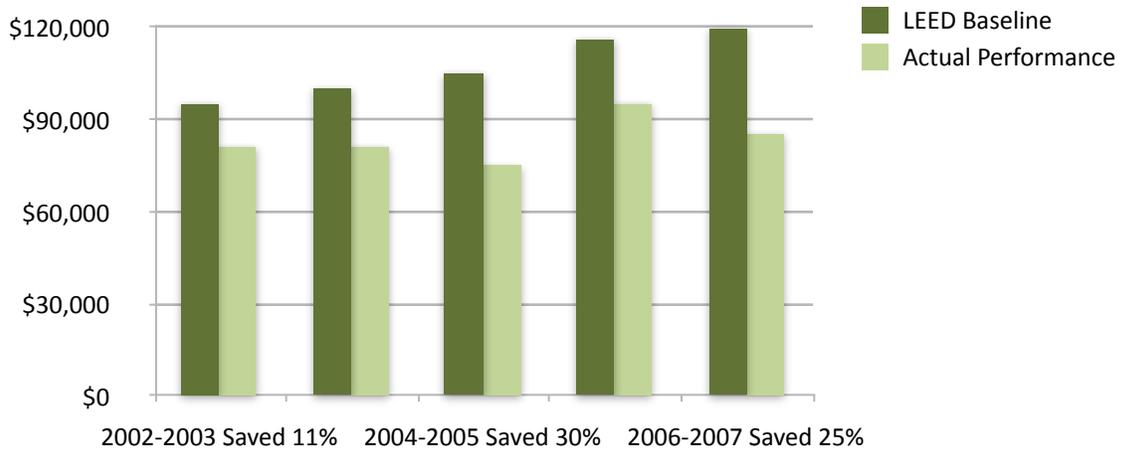
The mechanical systems used at Third Creek include high-efficiency water source heat pumps (14.5 EER, 4.4 COP), energy recovery ventilators and high-efficiency condensing, two-stage boilers. The HVAC system uses variable frequency drives for its interior air flow and exhaust.

In compliance with the LEED rating system, an energy model was developed to determine the performance of these various features. The model projected a 23% energy savings beyond ASHRAE 90.1-1999, the benchmark for LEED 2.0 at the time of development. In 2007, Moseley, Harris & McClintock Architects conducted a study of the Third Creek Elementary school to compare predicted savings with actual performance and found that the building was outperforming both the state of North Carolina's energy code and LEED's energy code each year.

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<sup>2</sup> U.S. Green Building Council

### Actual Energy Performance vs. Projected Performance



Finally, indoor water use reduction was achieved through the use of waterless urinals, metering faucets and low-flow faucets and showerheads. Outside water use is virtually eliminated as Third Creek Elementary has no irrigation system on site. Instead, drought resistant and indigenous vegetation landscaping (aka “xeriscaping”) was introduced that serves as both a series of “learning gardens” where students can learn about plant species and as future shade for the impervious surfaces, such as asphalt.

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