



2004-2005

WNC GREEN BUILDING DIRECTORY

A regional resource guide to environmental building

FREE

**MOUNTAIN
Xpress**



Printed with soy ink & recycled paper.

This directory includes:

listings of green-building professionals, materials and suppliers, as well as educational articles on green-building methods and local examples of green building

HELPING TO BUILD A SUSTAINABLE COMMUNITY





WNC Green Building Directory Feedback Form:

We need your help to continue to improve this directory and the services we are providing to the community. Please help us by mailing, e-mailing, or calling in your thoughts and suggestions:

WNC Green Building Council
P.O. Box 8427, Asheville, N.C. 28814
directory@wncgbc.org
WNCGBC Hotline: (828) 232-5080

1. Have you found this directory to be useful? If so, in what ways?
2. If not, what did you need that you couldn't find?
3. Where did you find your copy of the directory? (business location, *Mountain Xpress* display rack, referred by someone else, special event, Web, etc.)
4. If your business is listed, did you receive more clients because of the directory?
5. If you are a homeowner, did you find a local business or organization to provide reliable information and service for your green project?
6. What else would you like to see (or not see) in the next edition?
7. What other events, or services could the Council provide that you would attend?

Thanks — your time and insight are greatly appreciated.

Duncan McPherson
Editor, WNC Green Building Directory

LISTINGS

APPLIANCES

Sundance Power Systems, Inc.

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925 Beauty Spot Cove
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(828) 689-2080
Fax: (828) 680-9798
info@sundancepower.com
www.sundancepower.com
See "Solar & Alternative Energy" for a complete listing.

ARCHITECTS

Camille-Alberice Architects, PA

Peter Alberice
32 Broadway
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pya@camille-alberice.com
www.camille-alberice.com
Camille-Alberice Architects incorporate numerous sustainable and efficient building practices in our design: use of low energy strategies integrating daylighting, energy-efficient equipment and passive solar design in commercial and institutional buildings. Open office plans use less wall material, more natural light and more efficient use of heat, cooling and ventilation. Renovation of existing buildings recycles land use. We use energy-efficient doors, windows, equipment and natural material like linoleum, homosote, mdf, etc. Peter Alberice is a LEED Certified Professional.

Camille Victour Architect

Camille Victour
223 E. Chestnut St., Suite2
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Cvictourarchitect@charter.net
We strive for harmony and balance among the owner, builder and designer in all aspects of our projects. We also focus on cost and efficiency, the big picture and the details, and artfulness and functionality. We believe green-design principles are the best

approach for the building owner as well as the greater community. We work on almost any type of project — no matter how small — and are flexible to meet your needs.

Alice F. Dodson Architect

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www.greendragondesign.net
We provide architectural design for custom residential projects and small commercial projects. Our experience includes work with solar design; alternative-building materials; sustainable, energy-efficient, non-toxic materials and finishes; feng shui; and sacred geometry. Our emphasis is "Architectural Design for Healthy and Harmonious Living."

Ken Gaylord Architects/Black Hawk Construction

Ken Gaylord
109 S. Main St.
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kjpg@kengaylord.com
www.kengaylord.com
Integrating passive/active solar, recycled materials, timeless design and the best customer service, Ken Gaylord Architects and Black Hawk Construction take your project from initial conception to occupancy. From custom homes to performance theaters, to children's educational and play facilities, we are one group of design and construction professionals committed to sustainability and total project excellence.

Glazer Architecture, PA

Laurie Miller
78 1/2 Patton Ave.
Asheville, NC 28801
(828) 254-5853
Fax (828) 254-5856
info@glazerarchitecture.com
Glazer Architecture does innovative commercial and residential, site-sensitive design. We offer complete architectural services including adaptive reuse of existing building, new construction, co-housing communities and feng shui. Experience in sustainable design techniques includes passive solar, daylighting, energy-efficient appliances and lighting, geo-thermal heating and cooling, porous parking, cistern water collection, cupola heat release, radiant heating, use of SIPs panels and other energy-efficient sustainable building materials.

Gresham Architecture

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Griffin Architects, PA

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Commercial and residential architecture that achieves superior economic and environmental performance to meet our clients' programs and achieve a better building environment for their physical needs. Green buildings provide a more healthful working and living environment, with greater benefit to the broader community.

William Langdon Architecture, PA

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(828) 252-0296
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Wlangdon@aol.com
Sustainability has been a primary goal in our firm's work for 25 years. Our early work demonstrated high-aperture, high-performance passive solar homes including heat storage walls and attached sunspaces, in addition to direct-gain windows. We support green architecture with climate-specific details to create healthy and dry building envelopes. In design, we consider the client's ideas and needs to be paramount. We listen. We design. We help you find your dream.

Mathews Architecture, PA

Jane Mathews
34 Wall St., Suite 307
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firm@mathewsarchitecture.com
www.mathewsarchitecture.com
Mathews Architecture, PA, is a customer-focused firm that incorporates environmental design and green-building principles in all aspect of its work-renovation, remodeling and new construction for residential, commercial and institutional clients. All members of the design team are LEED Certified Professionals. Current "green" projects include the Gateway Visitors Center at the N.C. Arboretum; Prospect Terrace, an affordable-housing community

in Asheville; and French Broad Terrace, a New Urbanist artists' studio, retail and residential community.

Christopher A. Rogers, Architect

Chris Rogers
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una@earthlink.net
www.carogersarchitecture.com

Residential and small commercial architectural design in the mountain-rustic natural style. Sensitive planning for steep-slope sites and woodland settings, new construction and renovation/adaptive reuse, solar-responsive siting and passive energy building principles. Designs emphasize outdoor/indoor seasonal living.

Samsel Architects, PA

Jim Samsel
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Throughout our 15-year history, a key design principle of Samsel Architects has been the thoughtful integration of the natural and built environment. We incorporate these qualities into all our projects: high-efficiency building envelopes, solar-energy considerations, water-conservation techniques, and resource-efficient healthy materials. We provide architectural services for residences, commercial buildings, institutions, renovations and historic-preservation projects. Each of our designs draws on the special character of our region as well as the individual features of the project site.

Sun Plans Inc.

Debbie Coleman
sunplans@earthlink.net
www.sunplans.com

Passive solar house plans with inviting exteriors. House plan book, blueprints, CAD files and study plans as well as custom design and custom changes. Average of 50 percent reduction in your heating and cooling usage. Sunny interiors.

Mitchel Sorin Architect, AIA

Mitchel Sorin
586-A Brandon Road
Black Mountain, NC 28711
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msorin@earthlink.net
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Mitchel Sorin has more than 20 years experience and provides site planning and architectural design services for residential and commercial clients. The emphasis is on environmentally-responsible design

and integrating passive solar design, energy efficiency and other sustainable design principles to create healthy, healing places that support the environment, promote our physical and emotional well-being and sustain the human spirit.

Verdi-SE

Rusty Hunter
9 Pack Square SW #302
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(& in Charleston, S.C.)
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info@verdi-se.com
www.verdi-se.com
Verdi means "green" - and SE means Southeast. Verdi Architecture has expanded its services and has a new office in Charleston, S.C. Our staff of architects, designers and developers has expertise in green-building design, construction and marketing. Our whole-systems approach integrates quality design with sustainable materials, energy-efficient systems and natural site planning. Call for more information about our architecture and development services as well as green-building consulting. Learn more about us on our Web site at www.verdi-se.com.

Yurko Design & Architecture, PA

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www.yda-online.com

YDA believes in a holistic approach in all areas of a project. A building that is properly sited and landscaped to take advantage of solar and weather patterns, supported with energy-efficient systems, and built with recycled and renewable resources is not only a responsible approach, but healthier and more pleasing in the end.



Advantage Wall Systems

Rob Robinson
P.O. Box 656
Montreat, NC 28757
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mrtblidr@charter.net
www.advantagewall.com

Advantage Wall Systems promotes, sells and trains people to use Reward insulated concrete forms. The business also sells related products, including EnerFoam, energy-recovery ventilators, termite-

resistant waterproofing and synthetic stucco. Advantage Wall System also offers financing to owners and builders who used Reward products.

Appalachian Sustainable Development

Anthony Flaccavento
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(276) 623-1121
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asd@eva.org
www.appsusdev.org

Sustainable Woods manages, harvests and processes timber under a rigorous set of standards designed to ensure long-term biodiversity, soil stability, watershed protection and stable production. Our wood comes from private landowners in southwestern Virginia and northeastern Tennessee that participate voluntarily. We produce quality kiln-dried lumber at our processing center in Russell County, Va. using solar energy and wood waste. A wide variety of hardwood products, species and grades are available via our locally based production partners.

Carolina Colortones

Page Campbell
10 Industrial Drive
Arden, NC 28704
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info@charter.net
www.carolinacolortones.com

Since 1979, Carolina Colortones has been the Southeast's leader in pre-finished siding and exterior home products. By applying paints and stains in our factory, customers are assured a more consistent, custom finish. Factory finishing also allows for less waste, reduced labor costs and the recycling of paint products. We stock a large inventory of high-quality wood and fiber cement exterior products and several national brands of finishes. Customers are also able to furnish their own materials as well.

Earthaven Forestry Cooperative

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forestrycooperative@earthaven.org
www.earthaven.org/fc/fc.htm
See "Forestry" for a complete listing.

EZ Block

Jerome Chambless
2589 U.S. Hwy. 70
Swannanoa, NC 28778
(828) 713-6415
Fax: (828) 628-0855
ezblock@charter.net

Healthy homes for the 21st century means quick and easy construction of affordable homes that are safe,

comfortable and energy-efficient. EZ BLOCK uses cellular concrete that handles as easily as wood but does not decay. Now it is possible to build floors and walls of durable, insulating concrete that is non-toxic and proof against fire, termites and mold/mildew. EZ BLOCK is a full-service company with the capability to design, engineer and construct.

Preservation Hall

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55 N. Main St.
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preshall@ioa.com
www.preservation-hall.com
See "Salvage & Deconstruction" for a complete listing.

Shelter Ecology

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sheltereco@charter.net
www.shelterecology.com
See "Environmental Consultants" for a complete listing



CONSTRUCTION BUILDERS

Appropriate Building Solutions, Inc.

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Phone: (828) 350-0451
Fax: (828) 350-0354
abs@buildsustainable.com
www.buildsustainable.com
Appropriate Building Solutions, Inc. is a company dedicated to sustainable, green building through construction, design and consultation. In partnership with the owner, Appropriate Building Solutions focuses on the three tenets of sustainability, which are environmental, economic and social considerations. Continuing our comprehensive approach to construction, we are committed to versatility, quality and dependability.

Bald Mountain Homes, Inc.

John Senechal
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Asheville, NC 28802
(828) 252-9357
Jasenechal@aol.com
buncombe.main.nc.us/~senechal/bmh
Bald Mountain Homes builds solar/non-toxic housing.

We use a wide range of standard and alternative techniques. See our Web page for past projects and photos.

Blue Ridge Energy Systems

Joe Yanik
28 Sourwood Lane
Fletcher, NC 28732
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marjhn@yahoo.com
Blue Ridge Energy Systems has built more than 30 homes in Ravenwood Estates and around Buncombe County that incorporate energy efficiency and passive solar design. The Woodward home, located at 28 Sourwood Lane in Ravenwood Estates in Fairview, is a 4,400-square-foot passive solar, super-insulated house. The heating and cooling bill averages less than \$250 per year.

Construction Logic, Inc.

Jamie Titus
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Our firm has the knowledge and staff to perform commercial construction services with the highest regard for our mountain environment. Our company specializes in providing design-build services from the ground up for discriminating clients throughout the region. Construction Logic, Inc. is known for being a company that seeks creative solutions on commercial construction projects. Please contact us for new commercial and commercial-renovation projects.

Earhaven Forestry Cooperative

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forestrycooperative@earthaven.org
www.earthaven.org/fc/fc.htm
See "Forestry" for a complete listing.

Earhtone Builders

Greg McGuffey
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(828) 628-6436
earthtone@surfglobal.net
Earhtone Builders is a full-service design and construction company, specializing in beautiful, environmentally friendly homes. We are committed to build-

ing with quality, integrity and environmental awareness. We offer everything from straw-bale homes to stick frames, always incorporating passive-solar design and non-toxic and natural materials. We give our clients options and alternatives in order to create a unique and personal environment in which to live. Authentic timber frame, bamboo floors and clay plaster walls.

The EcoBuilders, Inc.

Rob Moody
ecomooody@theecobuilders.com
www.theecobuilders.com
The EcoBuilders, Inc. is a residential remodeling and building company in the Asheville area specializing in the incorporation of environmentally sustainable building products and practices. We emphasize affordability and customer service. We welcome owner-builders. Honest, competent and fully insured. Free estimates.

EZ Block

Jerome Chambless
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Fax: (828) 628-0855
ezblock@charter.net
See "Building Supplies" for a complete listing.

Forward Construction Inc.

Jim and Sue Forward
24 Smokey Road
Asheville, NC 28803
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Fax: (828) 298-2444
sef28803@aol.com
Forward Construction provides environmentally conscious homebuilding with a reputation for quality custom homes. We complete one project at a time, thereby giving full attention to each home constructed. We work with each client's needs and have used reclaimed lumber, antique flooring, water-based stains, sealants, etc.

Heartwood Renovation and Building, Inc.

Allen Roderick
29-1/2 Page St.
Asheville, NC 28801
(828) 253-8537
Fax: (828) 253-7868
rallenrod@excite.com
www.heartwoodrenovations.com
Heartwood Renovations & Building Inc. (HRB) renovates both commercial building and homes. We spe-

cialize in historical, adaptive reuse and recycling existing structures. HRB pays homage to both the traditional attention to detail and the modern use of innovative products and techniques. We take pride in our positive involvement within our industry and community. At Heartwood, our business is building with the experience and expertise to build your future.

HomeSource RE and Construction, Inc.

Tim Alexander
PO Box 9631
Asheville, NC 28815
(828) 298-0201
Fax: (828) 298-8003
info@homesourcebuilders.com

HomeSource specializes in residential construction in the Asheville area. HomeSource's past projects have included many green-building practices, including energy-efficient designs and construction techniques, resource efficiency, passive-solar concepts and indoor-air-quality issues while trying to keep the project in budget. HomeSource's past projects include many of the "not so big house" concepts.

Innova Homes, LLC

David Bennert
P.O. Box 6334
428 Haywood Road Suite C
Asheville, NC 28816
(828) 252-9998
dbennert@innovahomes.net

Innova homes builds small- to medium-sized, Energy Star certified homes. We strive to build affordable homes with easy access to business areas and bus routes in an effort to support "smart development" in the Asheville area.

Ken Gaylord Architects/Black Hawk Construction

Ken Gaylord
109 South Main St.
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(828) 692-4550
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kjg@kengaylord.com
www.kengaylord.com
See "Architects" for a complete listing.

Living Tradition Timber Frames

Jody Goukas
(828) 216-0914
Jgoukas@yahoo.com,
www.lt-timberframe.com

Living Tradition Timber Frames builds custom timber frame structures using handcrafted joinery congruent with the American tradition. We specialize in using recycled and/or on-site timber, and we take pride in creating structures intended to last for generations.

Paul's Custom Woodworking

Paul Schmitz
46 Pearl St.
Black Mountain, NC 28711

(828) 669-7160
schmitzwoodworking@yahoo.com

Paul's Custom Woodworking offers building services specializing in old-house renovations and repairs as well as timber-framed structures. Rehabilitation of existing buildings respects the embodied energy of labor and materials. Work is approached with historical sensitivity, and with sound building construction. Paul's Timber Framed structures utilize traditional mortise and tenon joinery. Timber Frame trusses and floor systems are offered to complement a variety of building systems: rammed earth, straw bale, masonry, etc.

Rare Earth Builders, Inc.

Mark Bondurant
5183 Beaverdam Road
Canton, NC 28716-6748
(828) 648-0009
rareearth@earthlink.net

Rare Earth is a custom home builder striving to build homes of high performance and exceptional beauty while minimizing negative environmental impacts. Higher performance is attained with such technologies as passive-solar design, solar domestic hot water and space heating, high-quality windows, air sealing, beefed-up insulation and whole house dehumidification and air filtering. Our building aesthetic derives from the beauty of natural, minimally refined materials — wood, stone and plasters. In addition to creating energy-efficient homes, other ways we lighten our environmental impact is by segregating and recycling waste when possible and using low-maintenance, durable materials where feasible.

Southeast Ecological Design

Kevin Ward
1043 Old Fort Road
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seedesign@hotmail.com

We are a collaborative team of designers, builders and landscapers organized to approach land use, building and development holistically and sensibly. Our commitment to environmental and social sustainability, combined with a focus on artistic and creative design, is aimed at improving the quality of life for people and the Earth. We offer ecological land-use consultation, permaculture design, sustainable forestry and portable sawmilling. Also a full range of natural building, design and construction services and high-quality, custom, organic landscapes.

Thompson-Rhodes Builders, Inc.

Don Thompson
273 Ball Gap Road
Arden, NC 28704
(828) 650-6422
Fax: (828) 650-6484
don@thompson-rhodes.com
www.thompson-rhodes.com

Thompson-Rhodes Builders, Inc. specializes in high-quality custom homes with attention to the fine

details that make each home unique. We are Energy Star Partners and we make every effort to build in the most environmentally friendly way possible through our programs of erosion control, waste management and energy efficiency as well as our environmentally conscious use of materials and construction methods. Visit us at our Web site.

CONSTRUCTION CONCRETE & MASONRY

Advantage Wall Systems

Rob Robinson
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See "Building Supplies" for a complete listing.

EZ Block

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See "Building Supplies" for a complete listing.

CONSTRUCTION ELECTRICIANS

Bald Mountain Homes, Inc.

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See "Construction - Builders" for a complete listing.

CONSTRUCTION WOODWORKERS

Living Tradition Timber Frames

Jody Goukas
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www.lt-timberframe.com
See "Construction-Builders" for a complete listing.

DEVELOPERS**Verdi-SE**

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(& in Charleston, S.C.)
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See "Architects" for a complete listing.

**EDUCATION &
OUTREACH****Appalachian Voices Sustainable
Forestry Program**

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(828) 262-1500
Fax: (828) 262-1540
forester@appvoices.org
www.Appvoices.org

Appalachian Voices Sustainable Forestry Program educates private forest landowners about sustainable management options to conserve their land and create economic returns if desired. We provide information about how sustainable forest management fits into a sustainable economy and how landowners can best utilize their land. The Sustainable Forestry Program also connects landowners with forest managers and loggers and helps builder and processor find sustainably managed source materials.

Arthur V. Martin Associates, Inc.

Arthur Martin
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Waynesville, NC 28786-0926
(828) 926-8195
Fax: (828) 926-4454
martina@aircertification.com
www.aircertification.com
See "Indoor Air Quality" for a complete listing.

Fortune Building

Jonah Goldwag
727-729 Haywood Road
Asheville, NC 28806
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info@thefortunebuilding.com

The Fortune Building is a physical space housing and promoting businesses and services which are working toward global change. As a developing model of

sustainable commercial renovation, we offer short- and long-term leasing of office, meeting and classroom space. Retail/ballroom/studio workspace and an educational networking source for green-building materials and techniques will be available in the future.

Southeast Ecological Design

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seedesign@hotmail.com
See "Construction — Builders" for a complete listing.

William Langdon Architecture PA

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See "Architects" for a complete listing.

**ELECTROMAGNETIC
FIELDS****Advanced Tachyon Technologies
International, Inc.**

Beth Wooten
2225 Coleman Mountain Road
Waynesville, NC 28785
(828) 627-8764
bethwooten@earthlink.net
www.tachyon-partners.com/beth

Advanced Tachyon Technologies can neutralize the negative effects of electromagnetic fields in buildings. Tachyonized Silica disks are very effective in re-aligning the EMF fields, restructuring them back to their natural state of coherency. They can be used on circuit boxes to organize chaotic energetic fields. They can also be used for spot placement on computer monitors, cell phones and power cords of various appliances and tools.

**ENERGY
EFFICIENCY
TESTING****GLC Services, Inc.**

Guy Cox
92 N. Main St.
Canton, NC 28716
(828) 648-8400
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glcservices@charter.net

www.glcservices.net

See "Mechanical & HVAC" for a complete listing.

Home Energy Partners, Inc.

Isaac Savage
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Asheville, NC 28806
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info@HomeEnergyPartners.com
www.HomeEnergyPartners.com

Home Energy Partners (HEP) provides high-performance building consultation and services to homebuyers, contractors/builders, organizations, real estate agents and lenders. We use state-of-the-art diagnostic equipment and building science techniques to assess and repair health, comfort and energy concerns within a building. HEP is an Energy Star partner and an affiliate of ZeroDraft, a commercial weatherization company. Home Energy Partners is also Western North Carolina's only certified Home Energy Rating System (HERS) raters.

White & Williams Co., Inc.

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Asheville, NC 28805
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rsales@bellsouth.net
See "Mechanical & HVAC" for a complete listing.

ENGINEERING**Consider Design, PA**

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www.considerdesign.com

Your sustainability project demands creative and holistic thinking. Consider Design, with our broad experience and diverse skills, can help you succeed in meeting your commitment meaningfully. Projects large and small receive personal attention that show in custom results. We have experience in renewable energy systems design, rainwater collection, and energy-efficient design of buildings and all building systems.

EZ Block

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See "Building Supplies" for a complete listing.

Sud Associates, PA

Jerome Hay
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sudwest@sudassociates.com

Sud Associates provides mechanical, electrical and plumbing design for commercial and institutional buildings with an emphasis on energy conservation. Past designs have included geothermal heat pumps, solar heating and hot water, daylighting controls and rainwater catchment. We also do energy conservation and indoor-air-quality studies.


**ENVIRONMENTAL
CONSULTANTS**
**Equinox Environmental
Consultation and Design**

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64 Biltmore Ave
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www.equinoxenvironmental.com

See "Landscape Architecture & Design" for a complete listing.

Indoor Air Services, Inc.

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dvandyke@charter.net
www.indoorairservices.com

See "Indoor Air Quality" for a complete listing.

Nine Pearls of Wisdom - Feng Shui

Helen Emmet
P.O. Box 1019
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(828) 669-1836
ninepearlsofwisdom.com

See "Interior Design" for a complete listing.

Shelter Ecology

Cindy Meehan-Patton
43 Pine Ridge Drive
Asheville, NC 28804
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Fax: (828) 262-1540
forester@appvoices.org
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Shelter Ecology

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Earthaven Forestry Cooperative

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1025 Camp Elliot Road
Black Mountain, NC 28711
(828) 664-1732
Fax: (425) 930-2026
forestrycooperative@earthaven.org
www.earthaven.org/fc/fc.htm

The Earthaven Forestry Cooperative has brought together wood-lot management and low-impact felling and skidding with custom sawmilling, site

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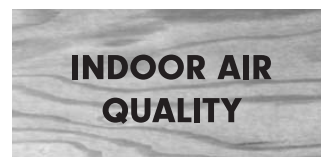


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INTERIOR
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www.EcoDwell.net

EcoDwell is a division of Home Energy Partners that specializes in interior design, consultation and green product specification for builders, architects and homeowners. We are committed to creating environmentally sustainable interiors that nurture the aesthetic, functional and economic aspirations of our clients.

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Jane Mathews
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See "Architects" for a complete listing.

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LANDSCAPE
ARCHITECTURE
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Dirt Girl Designs

Rebecca Daun-Widner
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Asheville, NC 28803
(828) 274-0691
dirtgirl_designs@yahoo.com

Dirt Girl Design offers environmentally balanced landscape consultation and design. Through conscious soil building and the use of native and non-invasive plants, we can create a beautiful and sustainable landscape for your home or business. Whether you just need some pointers or want a full-scale plan, I offer a down-to-earth, friendly approach to education and design. Workshop inquiries are welcome!

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(828) 645-1047
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Fax: (828) 255-4949
sudwest@sudassociates.com

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Fax: (828) 665-8507
bestnest@juno.com

See "Solar & Alternative Energy" for a complete listing.

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Sun Plans Inc.

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Sundance Power Systems, Inc.

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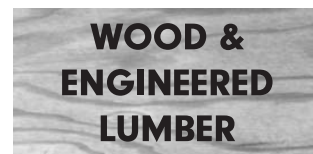
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"To the degree we're not living our dreams, our comfort zone has more control of us than we have over ourselves."
— Peter McWilliams, author

ARTICLES

FEATURE ARTICLE: MOISTURE CONTROL IN BUILDINGS

PUTTING BUILDING SCIENCE IN GREEN BUILDING

by Alex Wilson

Reprinted from Environmental Building News

I am continually surprised by how little emphasis the green-building movement places on building science. As we examine the many priorities of green building — from land-use planning to energy efficiency, material selection and indoor air quality — the basic science of how we design and build structures to ensure long life and healthy indoor environments should be at (or near) the top of the list.

Excess moisture is at the center of many problems relating to durability and indoor air quality — not just in homes but in all types of buildings in a wide range of climates. If we build structures that won't rot or support mold growth, we will both increase the longevity of those buildings and reduce the health risks of living in them.

This article examines the physics of moisture in buildings and addresses design and construction strategies for (a) keeping buildings dry and (b) allowing those buildings to dry out if they do get wet. While the emphasis and examples are largely focused on houses, most of the ideas apply more broadly.

Moisture 101

Moisture exists in three commonly known forms or phases: liquid, gas (vapor), and solid (ice), along with an additional adsorbed state that is somewhat between liquid and vapor in characteristics. All these forms come into play in buildings, though it is liquid water that results in most of the problems. With water vapor, the greatest concern is that it will condense into liquid water on a surface.

Common sources of moisture in buildings are listed in the [accompanying] table.

The movement of moisture from one place to another is governed by physical forces. The principal forces affecting moisture flow are listed below, with brief explanations.

- **Gravity.** Rain falls to earth; water runs down roofs and walls.
- **Capillarity.** Water can be pulled through thin air spaces or pores through a process called capillarity. Capillarity occurs because intermolecular forces cause water to stick to itself (surface tension) and to many other materials. (These same intermolecular forces allow water to cling to the bottom of a joist, running along horizontally until a gap is reached where the water accumulates into a drop large enough that gravity becomes the dominant force.) Capillarity is a powerful force — strong enough to raise water hundreds of feet into the air (counteracting gravity) in tall trees. This is the primary mechanism of moisture movement through porous materials, such as concrete floor slabs and wood siding.

- **Convection.** Airflow can carry moisture in both liquid and vapor forms. This movement occurs through air pressure differences. Wind blows rain into the walls of buildings, for example, and forced or passive airflow carries water vapor (humidity) with it.

- **Diffusion.** Water vapor can diffuse through permeable materials. This process is driven by partial pressure (vapor pressure) differences across the material. Vapor pressure as a driving force is confusing. In any mixture of gases, such as air, each separate gas has its own concentration or vapor pressure. If the vapor pressure of a gas in one area is greater than in another area, those vapor pressures will try to equalize through the movement of gas molecules from one air mass to the other. This is why it's very difficult to keep part of a building dry through air-conditioning if other parts of the building operate at ambient humidity levels. (Experts once thought diffusion was the primary mechanism through which moisture got into wall cavities, and we installed poly vapor retarders to block that diffusion; they now believe that airflow *convection* is a much greater source of such moisture migration.)

- **Temperature differential.** Moisture is known to move from hot to cold within a material. When brick siding gets soaked from rain, for example, and then the sun heats the outside of the brick, moisture in the brick is driven through the wall to the interior. Although the mechanism is not fully understood, it involves phase-change, according to physicist and building scientist Terry Brennan, of Camroden Associates in Westmoreland, New York. As liquid water is warmed, the evaporation rate goes up rapidly. The vapor pressure goes up rapidly as well because the number of water molecules in the gas state has gone up. The net result of this is that a great deal of moisture can be driven through a porous siding or roofing material.

These various mechanisms of moisture movement interact in complex ways in buildings. Capillarity may deliver water through a concrete slab, for example. That water then evaporates (it might never even appear as liquid water or dampness) and is distributed throughout the building via convection and vapor pressure differences.

Integral to the moisture dynamics in a building is the issue of relative humidity and the phase change between liquid and vapor. Humidity is a measure of the moisture content of air — the concentration of water-vapor molecules in a particular air mass. Usually, we refer to relative humidity (RH), which is the amount of water vapor in the air, as a fraction of the total moisture that air could contain. "I think of RH as the fraction of the way we are between totally dry and condensation," says Brennan. The amount of water vapor a given volume can hold

is dependent on temperature — more water vapor can exist in a space if it is warm than if it is cold. As a mass of air and water vapor is cooled, the relative humidity increases, until the mass reaches 100 percent RH, when liquid water condenses out (changes phase from gas to liquid). This point is known as the dew point.

This process has a huge bearing on moisture problems in buildings. If warm indoor air flows into the wall cavity through cracks in the drywall during cold weather, for example, that air mass may cool enough to reach the dew point within the wall cavity. When this occurs, the insulation in the wall cavity or the inner surface of the exterior sheathing gets wet — and that can cause big problems.

Moisture storage capacity is also very important. Some materials can absorb and release large quantities of water. Both wood and masonry materials have large moisture-storage capacity; metals, plastics, and many of today's panel products have low moisture-storage capacity. "Wood is a fantastic material because it's a hygric buffer," says Joseph Lstiburek, principal of Westford, Massachusetts-based Building Science Corporation. While the moisture content of wood is typically 3-8 percent (by weight), that moisture content can safely increase to 15 percent, he says. In other words, wood can safely store up to 10 percent of its weight in water — between 50 and 100 gallons (190-380 l) for a typical house.

Brennan notes that the moisture dynamics of wood are climate dependent. "For northern climates, the moisture content of wooden materials in houses with ordinary vapor loads and ventilation rates cycles between 5-10 percent in winter and 12-18 percent in summer," he says. In milder climates, wood doesn't dry out as much, according to Brennan, and 10-15 percent is a typical minimum. However, excursions above this level can safely occur.

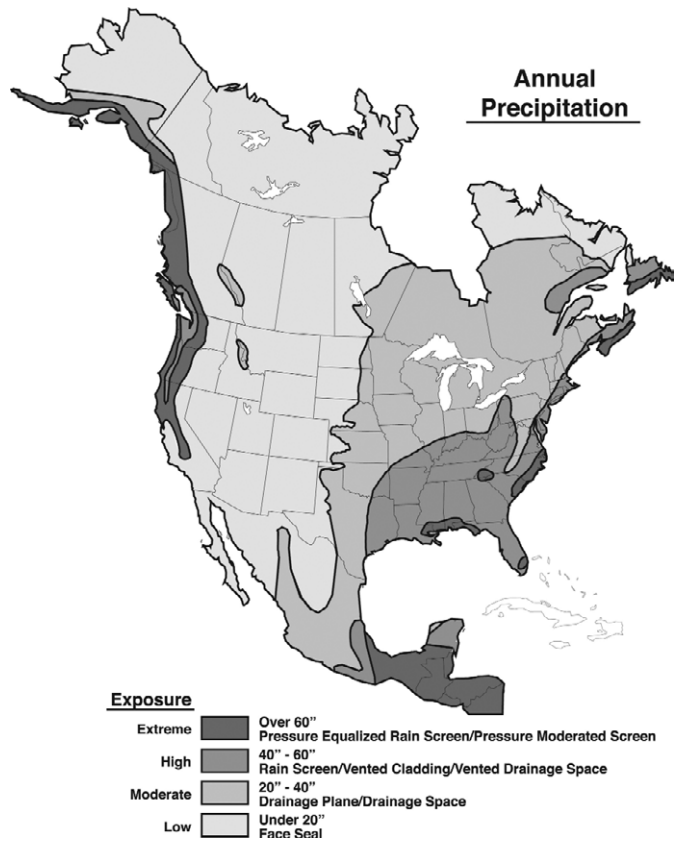
"Wood can safely store moisture up to even 30 percent moisture content if it only has to do it for a few days," says Brennan.

Because of this dynamic moisture-storage capacity, Lstiburek argues that wood-framed walls can be superior to steel-framed walls. The wood framing helps to regulate moisture in buildings.

Risks of moisture in buildings

Excess moisture in buildings is bad. Decay of wood and other cellulosic materials is dependent on moisture and temperature. With moisture content in framing lumber over about 20 percent (28 percent according to some experts) and typical room temperatures, decay is possible. There are actually two issues, according to Lstiburek: We may see mold growth on surfaces with moisture content as low as 16 percent, but decay fungi that grow within wood require higher moisture content (a minimum of 20-28 percent, depending on which expert you ask). Keep in mind that the fungal spores that cause both surface mold and decay are ubiquitous and can become established whenever the right conditions present themselves.

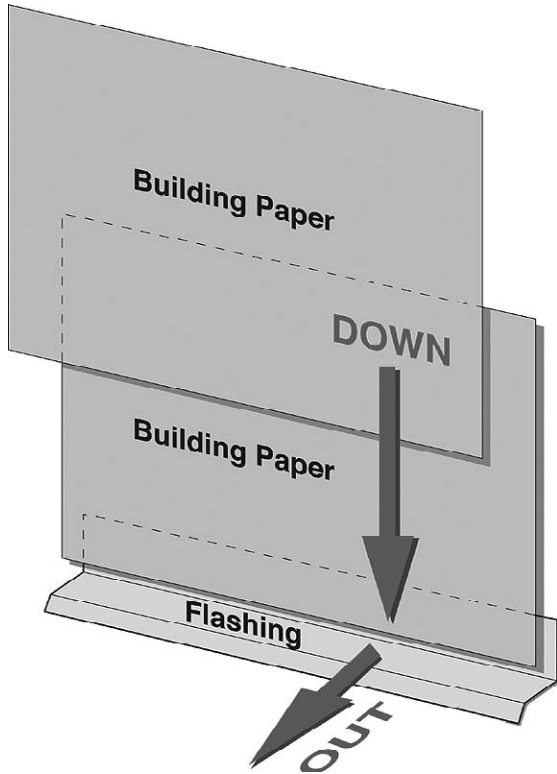
The duration of high-moisture events, as well as the substrates, influences whether mold will grow. Thesis research conducted by Susan Doll, at the Harvard School of Public Health, found that liquid water on oriented strand board (OSB)



North America is divided into four zones, based on annual precipitation, with suggested cladding system approach for each zone. Image courtesy of Building Science Corp.

and plywood produced mold in just three and six days, respectively. Without liquid water but sitting in chambers at 95 percent RH, it took 24 days for mold to become established on OSB and 42 days on plywood. Below 85 percent RH, mold did not appear at all during a 60-day test period. Brennan speculates that the difference between OSB and plywood has to do with the fact that each wood strand in OSB is surrounded by a fairly impermeable layer of glue. "You're reaching a higher moisture

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Lapping the materials properly and ensuring that surfaces are sloped to drain are essential in an effective drainage plane. *Image courtesy of Building Science Corp.*

content at the surface of the OSB quicker," he believes.

In addition to causing wood decay, moisture can corrode — and eventually destroy — steel structural members and fasteners. Steel does not have to be wet to begin rusting. Corrosion can occur whenever the relative humidity is above 70-80 percent, according to Lstiburek, though corrosion problems worsen when pipes or fasteners actually become wet through condensation, leaks, and so forth. In coastal areas

with high salt content in the air, the humidity threshold for corrosion drops for reasons that are not fully understood.

Keeping humidity levels within an acceptable range is an important strategy both for ensuring a long life for buildings — longer-lasting buildings are greener buildings — and for ensuring health of the occupants. While differences of opinion exist as to the optimal indoor humidity range, a consensus seems to be emerging that the relative humidity should not be lower than about 25 percent (to prevent dry eyes and throats, shrinking of wood flooring, and static electricity problems on carpeting) or higher than about 60 percent in the center of a room. The 60-percent level is intended to keep the relative humidity from exceeding 70 percent at surfaces, such as walls and floors, according to Lstiburek. The relative humidity near surfaces is typically higher than it is in the center of a room. When the relative humidity at surfaces is above 70 percent, mold growth can occur.

When the RH is high (say 95 percent), a surface has to be only a few degrees cooler than the air for condensation to occur, according to Brennan, and for mold growth to follow within a few days. At 70 percent RH, you need a surface temperature that is 11 degrees F (6 degrees C) cooler for condensation to occur, and at 50 percent RH, the surface temperature needs to be 20 degrees F (11 degrees C) cooler for condensation to occur. Just as significant, things dry out more slowly when the humidity level is high. At 75 degrees F (24 degrees C) and 70 percent RH, over 600 lbs (270 kg) of water will evaporate from 1,000 ft² (90 m²) of water surface in a day; at 95 percent RH, the evaporation drops to less than 100 lbs (45 kg) per day. Thus, at higher relative humidity levels in a building, even a fairly small source of liquid water can become a big problem.

Controlling moisture in buildings

A multipronged approach is required for dealing effectively with moisture in buildings. Broad strategies include the following: keeping water out, avoiding (or managing) plumbing leaks, avoiding condensation inside the building or within the building envelope, controlling the entry of humid outside air, controlling indoor sources of humidity, designing building assemblies to dry out, providing mechanical ventilation, and providing mechanical dehumidification. Each of these broad strategies is described below, followed by a more detailed checklist of specific recommendations relating to keeping water out and designing building assemblies that can dry out.

Keeping water out

A key priority in avoiding moisture problems in buildings is preventing rainwater and groundwater from entering the building. *Drain, drain, drain*, is the mantra echoed by building scientists Brennan and Lstiburek. Keeping rainwater out necessitates quality flashing details at all window and door openings, roof penetrations, and roof-wall intersections. Specialized flashing systems, including pan flashing and formable flashing, are illustrated in the [accompanying] figures. Less obvious but also very important is the need for drainage planes in walls to prevent water from getting through siding and sheathing. Building Science Corporation has developed a convenient annual precipitation map of North America keyed

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to drainage requirements in wall assemblies. Capillary breaks are also needed to keep groundwater from moving through foundation walls and floor slabs. Rainwater can be kept away from the building walls with overhangs, properly installed gutters and downspouts, and an adequately sloped ground surface around the building. Detailed strategies for keeping water out of buildings are provided in the [accompanying] checklist.

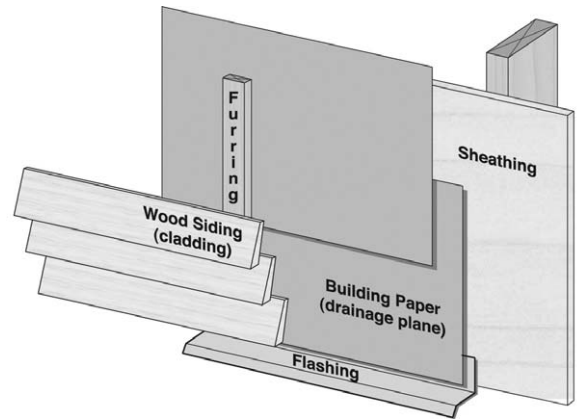
Avoiding moisture problems from plumbing leaks

Consider it a given that, sooner or later, leaks will develop in most plumbing systems. In fact, Lstiburek considers plumbing leaks to be *more significant than any other factor* in causing moisture problems in buildings. Based on his company's experience, he estimates that one-third of all houses develop plumbing leaks within the first five years! These leaks should be planned for in the design and construction of buildings. Most building science experts recommend installing all plumbing in interior rather than exterior walls. Brennan even suggests leaving pipes fully exposed to provide full access — as he sometimes sees in older buildings.

When pipes are installed in interior walls, leaks are more likely to be noticed and fixed quickly — before mold, decay, and other moisture-related damage occurs. To reduce damage, minimize use of standard drywall and other porous materials in locations where leaking pipes or appliances are most likely (bathrooms and kitchen walls with sinks, dishwashers and refrigerators). In place of standard drywall, use one of the recently introduced mold-resistant drywall products (U.S. Gypsum's Humitek or Georgia Pacific's DensArmor), monolithic (non-paper-faced) drywall, such as USG's Fiberock, or where leaks and other moisture problems are most likely — cement board. If standard drywall must be used, at least raise the drywall panels a few inches off the floor and cover the space with baseboard (taking care not to compromise the airtightness of the wall). If practical, install clothes washers and water heaters in spaces with floor drains or in watertight pans, and provide clearly visible shut-off valves. (When floor drains empty into a building's sewer line, provision should be made to keep the trap filled with water to prevent the entry of sewer gases into the building; specialized trickle-flow products that do this are commonly used in commercial buildings but not [yet] as often in houses.) Flooring in spaces prone to leakage should be water resistant, such as tile. Avoid carpeting in these locations.

Avoiding condensation

Condensation can occur in buildings whenever an indoor surface temperature drops below the dew point of the indoor air (which depends on the humidity). In cold climates, condensation is common on poorly insulated window glazings, on non-thermally broken window frames, and when uninsulated concrete walls or steel framing results in a thermal bridge to the outdoors. Condensation can also occur in warmer months when humidity is high and cold-water pipes are significantly cooler than the air temperature. When such condensation is severe, water can accumulate and cause mold or decay. Risk



An example of a rain-screen assembly that provides a high level of protection from rain penetration. *Image courtesy of Building Science Corp.*

of condensation can be reduced or eliminated through careful attention to energy-efficient building practices (high-performance glazings, proper wall insulation, insulative sheathing on steel framing, foundation and slab insulation, etc.) and by insulating all water pipes (see EBN Vol. 11, No. 10).

Controlling humidity

High humidity in buildings can come from either indoor or outdoor sources. The concern is typically much greater in summer months, when outdoor humidity levels are high. While experts used to recommend ventilating unheated basements during the summer months, most now discourage that practice in humid climates (even though codes may still require it), because the ventilation introduces more moisture than it removes. Building science expert Don Gatley, of Gatley and Associates in Atlanta, Georgia, says that for outdoor ventilation to dry a building out, the outdoor dew point must be 55 degrees F (13 degrees C) or lower.

Preventing the entry of humid outside air involves creating a tight building, installing a poly-vapor retarder on the ground in crawl spaces, and avoiding conditions that will depressurize the building. The most common interior sources of humidity —

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showering and cooking — are best dealt with through spot ventilation at the source (see below). Avoid storing firewood indoors, venting clothes dryers indoors, and using unvented gas heaters — the last because unvented heaters produce significant quantities of water vapor as well as other combustion products.

Designing building envelopes to dry out

Because we can't always succeed in keeping moisture out of our buildings and building assemblies, the second line of defense should be to design our structures to dry out. Think of this as an insurance policy. Some strategies for improving a building's drying potential have ancillary benefits, such as longer life for paint. How you should design a building envelope to dry out depends on the climate. Experts used to say that you should always put the vapor retarder on the warm side (on the interior in cold climates and on the exterior in warm climates),

but Lstiburek now argues that in most climates the envelope should have some drying potential in both directions — because moisture-driving forces change dramatically throughout the year. Only in the very coldest climates does Lstiburek still recommend interior vapor retarders.

CertainTeed has begun marketing MemBrain, developed by a German subsidiary of CertainTeed's parent company, Saint-Gobain. This so-called "smart" air/vapor barrier, made from 2-mil nylon, becomes more permeable as the humidity increases, moving from below 1 perm at 50 percent RH to 36 perms at 95 percent RH-57 to 2070 ng/(sm²Pa). This product should permit the use of an air/vapor barrier on the inside of walls even in climates where drying to the interior should be possible some of the time. It may even be effective as an exterior housewrap product in hot, humid climates. Specific recommendations for designing building envelopes to dry out are provided in the [accompanying] checklist.

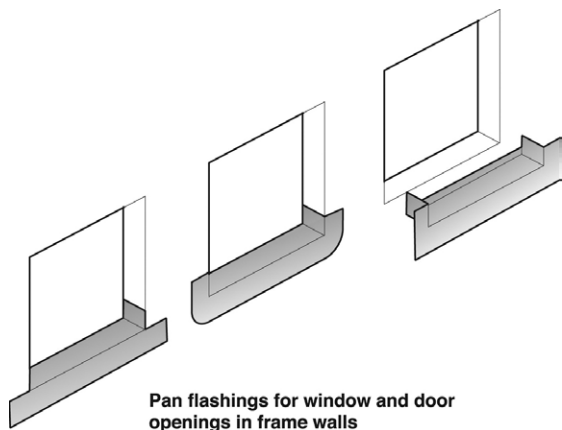
Providing mechanical ventilation

Mechanical ventilation should always be part of the moisture-control strategy for buildings. Spot ventilation at locations where a lot of moisture is generated — kitchen ranges and bathrooms — is the first priority. Beyond that, whole-building, continuous mechanical ventilation—even in homes — is recommended in most climates. The proposed ASHRAE 62.2 residential ventilation standard has just been approved by a key committee at ASHRAE and is awaiting publication — despite strong opposition by the National Association of Home Builders and the Gas Appliance Manufacturers Association. This standard, for those municipalities that adopt it, would require continuous mechanical ventilation rated at 7.5 cubic feet per minute (cfm) per occupant plus 1 cfm for every 100 ft² of usable floor area — 3.5 liters per second (l/s) plus 0.5 l/s for every 9 m². Homes in hot, dry climates and most of California would be exempt, under the assumption that windows could provide effective ventilation.

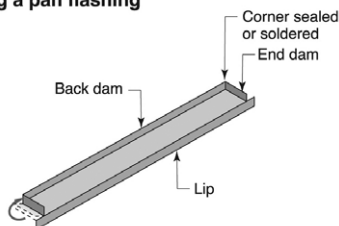
Providing dehumidification

As a last resort in the control of moisture, mechanical dehumidification can be used. As noted above, experts recommend that indoor RH levels should be kept below 60 percent, and there may be conditions in which this cannot be achieved without some form of dehumidification. Generally, dehumidification is needed only if a space is cooled by air-conditioning or earth contact. Unfortunately, most air conditioners do not dehumidify well, especially if the need for sensible cooling is small, which is often the case in energy-efficient buildings.

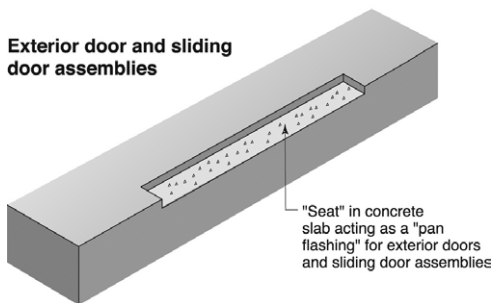
Fortunately, wood, concrete, and some other building materials help to regulate humidity by absorbing moisture when the air is humid and releasing moisture when the air is dry — so some excursions above the 60 percent limit are acceptable. This enables a building to operate with cycling humidity — higher in the summer, lower in the winter, but generally within the 25-60 percent range. When dehumidification is required, a high-efficiency dehumidifier or a high-efficiency air conditioner with a high moisture-removal rating should be used.



Constructing a pan flashing



Exterior door and sliding door assemblies



Final thoughts

By making use of today's best building science, we can not only design and construct buildings that will last well over a century but also greatly reduce the risk of moisture-related health problems, including exposure to molds and other allergens. To apply building science, we have to address the interactions among components in a building — looking to manufacturers for solutions at the level of their individual product isn't enough. There is rarely anyone filling the role of building scientist on design teams today. It is up to architects to either learn enough to play that role, or hire consultants who can work through every detail of the envelope and mechanical and plumbing systems with them.

For more information

For more information, contact Building Science Corporation, 70 Main St., Westford, MA 01886; call (978) 589-5100, (978) 589-5103 (fax), or check out www.buildingscience.com. Excellent resources are available on the Web site, including *Read This Before You Design, Build or Renovate*.

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COMMON SOURCES OF MOISTURE IN BUILDINGS

Sources of liquid water

Precipitation: Rain and other forms of precipitation are the most significant sources of water in many homes — though the entry might not be direct.

Groundwater: In areas with high water tables, groundwater entry into buildings can be a huge problem. Note that groundwater (a "rising water table") is often incorrectly blamed when rain saturates the soil around a foundation faster than that water can drain away.

Leaking pipes: Leaking pipes are surprisingly prevalent in buildings and a leading source of moisture problems. Building science expert Joe Lstiburek, of Building Science Corporation, believes leaking pipes to be the single largest source of moisture problems in houses.

Cleaning and other maintenance: Poor cleaning practices can leave carpeting, upholstery, and other surfaces too wet to adequately dry out before moisture-related problems occur.

Condensation: While not truly a moisture source, condensation of water from humid (or even not-so-humid) air can produce liquid water on windows, exterior walls, foundation walls, and other surfaces that are significantly cooler than most surfaces in a building. Condensation can occur when there is a small temperature difference but high humidity, and it can occur when there is fairly low humidity but a large temperature difference (a surface being much colder than the surrounding air).

Sources of water vapor

Moist air from outdoors: Depending on the location and the season, the entry of moist outdoor air into buildings can be a very large source of moisture. Humid air entry is greatest in the summer.

Soil moisture: If a building operates under negative pressure, moist air from the ground can be brought into a building through the foundation walls and floor slab. According to building science expert Terry Brennan, of Camroden Associates, soil air can be a significant moisture source/problem either when the ground around a building is particularly porous so that soil air accounts for a large fraction (10-20 percent) of total ventilation, or when soil air is able to infiltrate a cavity between a foundation wall and an inner finished wall.

Vaporization of liquid water: Any wet materials that dry out or water that evaporates indoors will contribute water vapor to the building. Rainwater entering crawl spaces and basements is the most common source of this evaporative water vapor.

Showers: Atomized hot water from showers can contribute large quantities of water vapor.

Cooking: Nearly all cooking activities, but especially boiling water, contribute significant amounts of water vapor.

Dishwashing: Dishwashers release water vapor into the kitchen during their drying cycle. Hand washing of dishes also releases water vapor as they dry.

Cleaning and other maintenance: Many cleaning activities involve wetting surfaces, which releases water vapor into the air through evaporation.

Respiration: People (and their pets) release substantial quantities of water vapor through their breathing. A typical adult exhales water vapor at a rate of 1 pound per day (450 g/day) when resting, 2.8 pounds per day (1.3 kg/day) standing, 4.5 pounds per day (2 kg/day) doing light work, and 7 pounds per day (3.2 kg/day) doing moderate work.

Unvented combustion: Unvented (vent-free) gas heaters and fireplaces produce significant quantities of water vapor as one of the two primary combustion products (see EBN Vol. 5, No. 3). Gas ranges and ovens introduce smaller amounts of water vapor.

New building materials: Building materials can be large sources of water vapor — particularly concrete, joint compound, paint, wet-spray cellulose insulation, framing lumber, and any materials that got wet on the job site. Improper storage of building materials on the job site is a surprisingly large source of mold problems in buildings (see EBN Vol. 11, No. 5).

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SPECIFIC FACTS ABOUT MOLD AND MOISTURE IN WNC

by Cindy Meehan-Patton

Western North Carolina is in the *extreme* annual precipitation zone for North America. This brings us awesome natural beauty — along with constant sources of mold and fungi. As noted in Alex Wilson's article, "Moisture Control in Buildings," when outdoor mold moves indoors, it becomes toxic to people, and to the structure itself.

A majority of days in mid- to late spring, plus all of summer and portions of the fall months, are humid beyond safe levels mentioned in Wilson's article. This means that air conditioning and dehumidification are essential in all homes — whether leaky or tight, new or old. It also means that because a majority of the homes in WNC are not currently air-conditioned, they potentially have toxic mold in their structures as well as in their interiors.

Regarding moisture control in buildings — as it specifically pertains to WNC's moisture issues — it is more practical to design our new homes so that all interior spaces are conditioned, if possible. Instead of designing with crawl spaces, opt for something more usable, such as a basement that is properly constructed to deter moisture from coming in,

and is heated, air-conditioned and dehumidified as needed. It is also more practical to eliminate the attic (or condition it, if it is a necessary part of your design).

Put your HVAC, plumbing and any additional mechanical equipment in your conditioned space. This strategy will increase the life of your equipment, increase equipment efficiency and empower you to monitor any condensation or leaks easily. Creating a tight envelope with the use of mechanical ventilation also allows you to control your indoor-air quality that much more. (Please refer to the article "Bridging the Gap Between Solar and Healthy-Home design" in this directory for more details on this subject.)

A tight building envelope enables you to control your indoor-air quality. And while a leaky envelope may allow you to maintain lower levels of mold, it makes it difficult to keep mold from proliferating. If a crawl space is unavoidable in the design of your home (existing or new), sealing it by using building-science methods (www.buildingscience.com) is recommended. Creating a climate-controlled basement instead — by following proper moisture-free construction methods — is also a direction you can take. (See *Builders Guide for Mixed Humid Climates* by EEBA (www.eeba.org).)

I consult with people daily (from all over the South and Northeast) who suffer from mold allergies and sensitivities. Yet I often hear that they "like to allow fresh air in by opening ...

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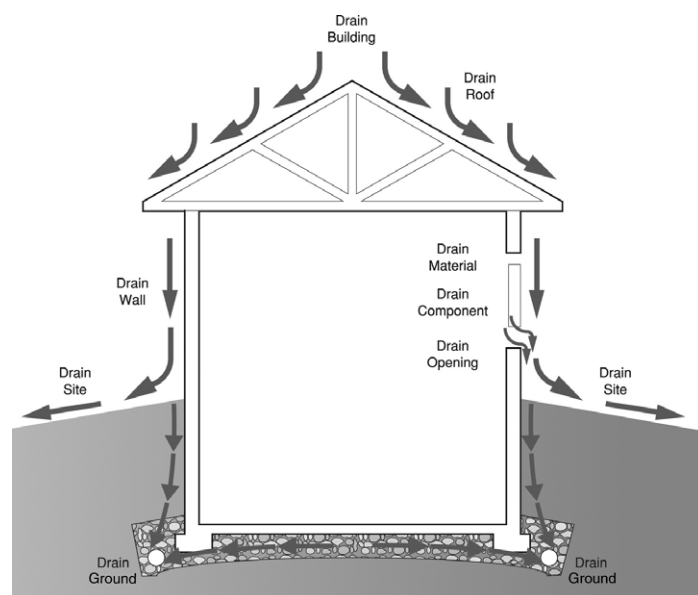


windows.” In a mixed humid/high-humid climate (extreme moisture area) like WNC, natural ventilation also allows high humidity in, thus allowing toxic mold in your home. Factually speaking, our outdoor-air quality ranks right up there with Los Angeles, one of the more polluted cities in the United States. Given these facts, it makes sense to create a home that is healthy by designing it to stay dry.

A few more facts

- Indoor-air-quality inquiries concerning toxic mold have increased from less than 2 percent in 2001 to more than 25 percent in 2002 (*Environmental Building News*, “Mold in Buildings and How to Keep it Out,” Volume 10, Number 6, June 2001).
- In 1991, The Business Council on Indoor Air (in a 10-year, 700-building survey) found microbial growth to be the No. 1 indoor-air-quality problem in the nation (*Environmental Building News*, “Mold in Buildings and How to Keep it Out,” Volume 10, Number 6, June 2001).
- A 1999 Mayo Clinic article states that 93 percent of all chronic sinusitis is caused by mold and fungus, *and* more than 37 million people in the United States suffer from chronic sinusitis (*Mayo Clinic Rochester News*, Sept. 9, 1999).
- A 300-percent increase in the asthma rate over the past 20 years has been linked to mold, *and* more than 50 percent of homes have mold problems (*USA Weekend*, Dec. 3-5, 1999).

Cindy Meehan-Patton is with Shelter Ecology, Inc. and serves as the WNC Green Building Council's secretary.



Any surfaces of the building envelope that might encounter liquid water must be designed to drain that water away. *Image courtesy of Building Science Corp.*



CHECKLIST: DESIGN STRATEGIES FOR MOISTURE CONTROL

Keeping water out

- **Provide proper flashing on all windows and doors:** All components should be layered so that water is shed down and outward. There are numerous ways to flash windows — flashing can be installed before or after housewrap or building felt. “Drainage plane” specialized formable flashing can be used at the sill, and special measures are required with masonry walls and when rigid foam provides the drainage plane.
- **Provide a rain screen behind siding:** To facilitate drying of siding and to provide a capillary break between the siding and the sheathing, most experts now recommend rain screen detailing in wetter climates (see map, page 13). This can be provided with vertical strapping (minimum 3/8 inch, 9.5 mm thick); a specialized rain screen product, such as Benjamin Obdykes Home Slicker; or, with brick siding, a bottom-draining air space behind the brick facing.
- **Seal wood and fiber-cement siding:** Porous siding materials should be sealed on all sides. Pre-priming is recommended prior to installation, with multiple coats as needed, especially on end-grain. Sealed siding will not absorb moisture, thereby reducing moisture migration driven by solar heat.
- **Provide a capillary break above footing:** Paint the top of the footing with a dampproofing coating or install an impermeable layer before installing the foundation wall to block the upward migration of soil moisture.
- **Provide drainage layer and poly vapor retarder under concrete slab:** Before pouring a concrete floor slab, install a minimum 4-inch (100 mm) layer of crushed stone (no fines) and a poly vapor retarder. The concrete should be poured right on top of the poly; without a layer of sand between the poly and slab.
- **Provide perimeter drainage at footing:** Install crushed stone (no fines) and perforated drain pipe around the footing. The drainage pipe should be slightly pitched but extend neither below the bottom of the footing nor above the top of the footing. Sections of plastic pipe should extend through the footing every 6 to 12 feet (2-4 m) to drain the space under the slab. Wrap the layer of crushed stone with geotextile filter fabric to keep fines out.
- **Paint outside of foundation wall with dampproofing layer:** A durable dampproofing should be painted on the outside of the foundation wall. Several layers are suggested, with the minimum thickness depending on the material (follow manufacturer's recommendations).
- **Install free-draining layer next to foundation wall:** Install a specialized drainage layer (free-draining insulation, kinked nylon mesh, corrugated plastic, etc.) against the foundation wall, or backfill against the wall with crushed stone, or do both. When using a layer of crushed stone, protect it with a geotextile filter fabric to keep fines out.

WNC GREEN BUILDING DIRECTORY

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On the cover: The Smail/Willoughby barn in Fairview incorporates natural ventilation, daylighting and local materials – including stone, and wood siding made from trees felled on site.

This Directory was designed by *Mountain Xpress* graphic designer Brannon Booth and copy edited by *Mountain Xpress* staffer Tracy Rose.

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- **Slope ground away from building and provide impermeable cap:** The ground should slope away from a building at a minimum pitch of 5 percent (6 inches per 10 feet, 5 cm per m). Provide a low-permeability (high-clay-content) soil cap extending 6 feet (1.8 m) from the building to reduce infiltration and direct surface runoff away from the structure.
- **Provide a roof overhang to keep rainwater away from building:** The longer the roof overhang, the greater the protection of the house. A minimum 24 inches (600 mm) overhang is recommended in most climates; 36 inches (900 mm) is preferable. Porch roofs and awnings also drain water away.
- **Provide self-sealing ice and water barrier on roof:** To protect against water penetration if ice dams occur in cold climates, install a self-sealing protective layer (e.g., Grace Ice & Water Shield) under roofing.
- **Install gutters and downspouts:** Install durable gutters and downspouts to direct rainwater away from the building. Use screening to keep leaves and other debris out of downspouts, and instruct building owners to keep gutters and downspouts clean. At the bottom of downspouts, water should be channeled as far from the building as possible. Do not connect downspouts to footing drains.

Designing building assemblies to dry out

- **In most climates, provide drying potential to both interior and exterior:** Building Science Corporation now recommends that in all but the coldest climates, above-ground walls should be designed to dry to both the exterior and interior. This means avoiding a poly air/vapor retarder and using

permeable or semipermeable layers in the wall system.

- **In the coldest climates, install poly vapor retarder on interior:** BSC recommends that polyethylene vapor retarders should be used only in the coldest climates. In such climates (over 8,000°F [3,400°C] heating degree days), install a poly-vapor retarder on the interior wall, under the drywall. The vapor retarder should be carefully sealed at all overlaps, edges, and penetrations. This arrangement will allow the wall cavity to dry to the exterior only.
- **Design basements to dry to interior:** In all climates, basement walls should be designed to dry to the interior. Insulation should be permeable or semipermeable, such as expanded polystyrene (EPS) or fiberglass with a moisture-resistant gypsum board product, such as Fiberock or HumiTech, and vapor-permeable latex paint on the interior.
- **Provide vented rain screen on exterior walls:** In climates with more than 40 inches (1 m) of rain per year, BSC recommends an exterior wall detail with a minimum 3/8 inches (9.5 mm) air space behind the siding, with screened vents at top and bottom. This rain screen detail both provides a capillary break and allows drying to the exterior. In climates with fewer than 40 inches (1 m) of rain per year, this vented rain screen may not be necessary.
- **Use plywood rather than OSB to aid in drying:** Recent research shows that while both plywood and OSB have low permeability when dry, plywood becomes significantly more permeable than OSB when moisture content rises; this will aid drying to the exterior. With a fully vented rain screen detail, using OSB should be satisfactory.
- **Consider perforating sheathing:** The June 2003 issue of Energy Design Update reported on Canadian research demonstrating the effectiveness of drilling 3 inches (75 mm) holes through the exterior sheathing at the top and bottom of stud bays. Some builders drill lots of smaller holes through the sheathing to aid in drying.
- **Provide a vented roof assembly:** In all climates, a vented roof assembly will assist in drying and is generally recommended. In cold climates, a vented roof also helps to prevent ice dams by keeping the roof surface cold. Full-length soffit and ridge vents are the preferred venting strategy. Keep roof geometry simple to aid in venting. Unvented (hot) roofs can be successful, but only with great care in the construction; avoid this approach unless working with an expert.

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"You can make more friends in two months by becoming more interested in other people than you can in two years by trying to get people interested in you."

— Dale Carnegie

"It is the nature of man to rise to greatness if greatness is expected of him."

— John Steinbeck

"I had rather do and not promise than promise and not do."

— Arthur Warwick



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Better Homes for a Better Life

WET BASEMENTS: COMMON CAUSES AND METHODS FOR REMEDIATION

by Paul Bobbitt

In Western North Carolina, many homes suffer from wet basements and crawlspaces due to high levels of rainfall and humidity. Each crawlspace/basement is different and remediation is site specific, but in each situation moisture does not just need to be removed, it needs to be prevented from entering.

Moisture movement into a crawlspace or basement

Understanding how to treat a wet basement requires an understanding of how it is getting wet. There are three main types of moisture: bulk, capillary and vapor. Bulk moisture enters the structure in unimpeded quantities, such as gutter runoff washing through holes in a foundation wall. Capillary moisture enters a house through porous spaces of surrounding materials, such as water that super-saturates the brick foundation walls and then seeps out of the wall into the basement. Vapor enters a structure from uncovered soil or through crawlspace and basement vents in the form of humidity. A home that has a partial crawlspace/partial basement may have moisture entering the structure via all three actions.

Water always moves from areas of high pressure to areas of low pressure and uphill to downhill. A basement is an area of very low pressure in relation to its surroundings. As water gets near the basement, this negative pressure draws it inside. Many homes are located on hillsides without proper site grading. Bulk moisture draining into the space is the most common cause of moisture introduction into a crawlspace/basement. Proper grading and site drainage will be addressed in the solutions section.

Problems created by moisture

As moisture problems increase in a basement or crawlspace, mold can become a serious health risk for the occupants of the house. This mold enters the conditioned living space (building envelope) through several paths but it is typically a result of a leaky building envelope.

As air moves upward through the house because of the stack effect, replacement air will be pulled through holes that are exposed to the crawlspace or basement. Any mold in these areas will hitchhike in the airflow and degrade the indoor air quality. Mold also enters the home through the ductwork if it is located in the crawlspace or basement. When the air handler turns on to either heat or cool, it inevitably has leaks that will pull crawlspace air into the ductwork. Once this happens, the mold is perfectly distributed throughout your house as it is blown out of every supply register. Excess moisture can also lead to serious building durability issues. When floor joists or sub-floor wood becomes excessively wet, wood rot begins. Soon thereafter, major flooring repairs will need to be made.

Remediation of wet crawlspaces and basements

Many crawlspaces and basements become wet by a combination of these methods. The steps to remediation are:

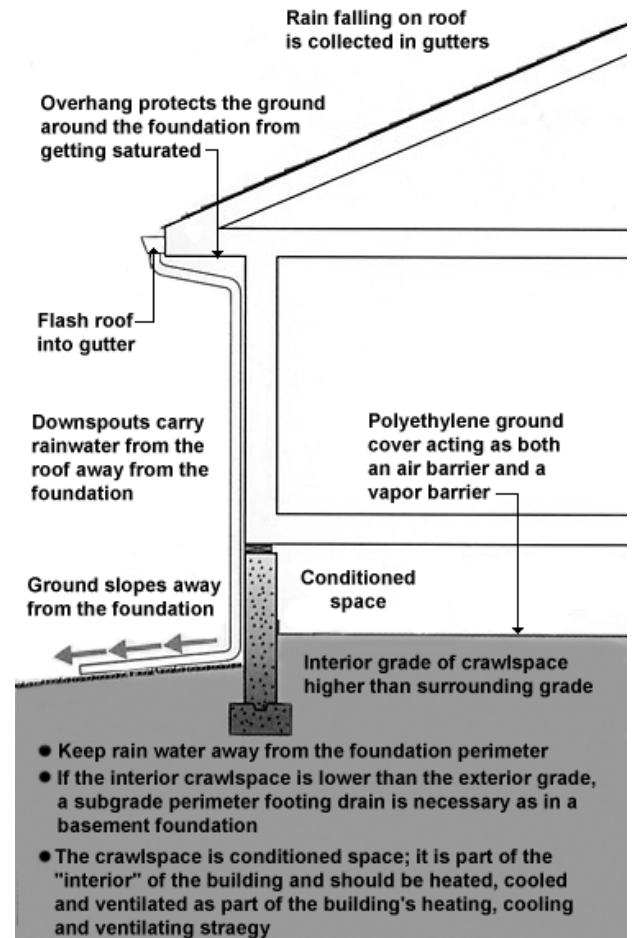


Figure 1. Source: EEBA Water Management Guide.

first, identifying the source(s) of moisture introduction to the basement or crawlspace; second, eliminating the source(s) of moisture; and third, drying the space.

Identifying all sources of moisture introduction is very important: bulk, capillary and vapor. Bulk moisture presents the largest problem to basements and crawlspaces, followed by vapor transmission. Poor foundation drainage, improperly graded sites and inconsistencies in the foundation walls (holes) lead to many bulk moisture problems. In order to fully control bulk moisture, the site should be properly drained away from the house.

A properly functioning foundation drain is another necessity to control moisture flow. Construction of a good foundation drain should include a bed of gravel surrounding the perforated drainpipe, which is located below the footer to ensure good drainage around the basement or crawlspace. While the trench is open it is a perfect time to dampproof the foundation walls. Figure 1 (above) is of a crawlspace. Once bulk moisture problems are taken care of, we must treat the vapor transmission into the crawlspace. This vapor originates from any uncovered soil in the basement. This uncovered soil must be covered continuously from wall to wall in order to properly

eliminate all vapor paths.

The first step to properly sealing a crawlspace is to remove all the old (if any) plastic and rake the soil. After all the rocks and sharp objects are removed, plastic is sealed to the crawlspace walls and lapped onto the floor of the crawlspace. A continuous floor covering of plastic is laid down from wall to wall and all seams in the plastic are then taped and sealed with mastic. Once all sources of moisture are eliminated by proper drainage and sealing, the space needs to be dried out. This can be accomplished by installing a dehumidifier in the crawlspace or basement. Ensure that the drain is installed properly to avoid risk of a back-up that could lead to other bulk water problems in the space.

Water is a necessity of life but it should not be found inside your home. Bulk water should have specific paths to follow, all leading away from the house. If it strays from these paths then it is bound to present problems including indoor-air-quality deterioration, mold and mildew growth, and building durability issues. When properly assessed, any moisture problem can be solved, and mold cannot grow without moisture.

It is critical to mitigate 100 percent of the moisture because it affects not only the health of the house, but the health of your family.

Paul Bobbitt is with Home Energy Partners and serves as a WNC Green Building Council board member.

"Loving thoughts are as precious as pearls strung together with caring actions, creating a network of dazzling beauty."

— Tom McClellan

"The future belongs to those who believe in the beauty of their dreams."

— Eleanor Roosevelt

"Deliberately seek the company of people who influence you to think and act on building the life you desire."

— Napoleon Hill

WHY BUILD GREEN?

by Boone Guyton

The world is a more populous and a wealthier place in this century. Increased population leads to increased resource consumption which has resulted in serious side effects: increased pollution, waste overwhelming our landfills, toxic waste build-up, global warming and deforestation. We must become more resource-efficient in order to meet the needs of humans while preserving natural resources for

future use. This concept of sustainability must be the bottom line for all of our development. We cannot continue our wasteful over-consumption. Buildings are a significant contributing factor to our current environmental predicament. Residential and commercial buildings account for 65 percent of U.S. electricity consumption (USGBC). Green-building techniques help minimize the impact of building on the environment. A green building will be more durable and healthy for the occupants, the environment, and the continued economic viability of the building industry.

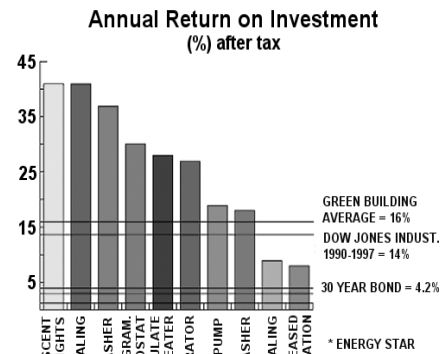
The goals of green building are to:

- Achieve sustainability through reduced energy and maintenance costs;
- Reduce resource use by increasing efficiency in design and through material choices;
- Improve land use strategies and transportation efficiency;
- Reduce waste generated in the construction process; and
- Improve health through better indoor environment.

Energy efficiency and economics

A home built to higher energy-efficient standards will also cost less to operate. An individual green-built home will be 30-60 percent more efficient than the standard home built to code. The return on investment in energy efficiency is higher than the stock market in general and usually greater than the increase in the mortgage due to increased up-front costs for the green upgrades. According to Southface Energy Institute (www.southface.org), increasing the energy efficiency of a newly constructed affordable home in Atlanta saved more than \$400 a year and added only \$500 in construction costs. An affordable-housing development in Texas cut household utility bills by \$450 a year by using efficient appliances and solar heating while adding only \$13 a month to mortgage payments (Roodman).

In commercial buildings the payback is more dramatic. "In the



Green-building strategies have a higher return on investment than average stocks and bonds.

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most comprehensive analysis of the financial cost and benefits of green building conducted to date, this report finds that a minimal upfront investment of about 2 percent of construction costs typically yields life cycle savings of over 10 times the initial investment. For example, an initial upfront investment of up to \$100,000 to incorporate green building features into a \$5 million project would result in a savings of at least \$1 million over the life of the building, assumed conservatively to be 20 years” (Katz).

Resource efficiency

Building represents 50 percent of our nation’s wealth, accounts for \$800 billion in economic activity and employs more than 10 million people as the largest manufacturing sector in the economy. It is a huge demand on our resources, which are diminishing. The building industry also produces 136 million tons of construction waste and 30 percent of greenhouse gas emissions in the United States per year. The building industry must account for its environmental costs if it is to become sustainable and remain profitable.

Green building incorporates strategies to increase the durability and energy efficiency of a building while at the same time reducing the use of virgin natural resources in the construction. Building with a systems approach integrates the various components so that they work to increase the resource efficiency and performance of the building.

A systems approach takes into account the building, building site, heating and cooling systems, building materials, interior furnishings and finishes, and appliances. This allows for cost savings in many areas. For example, increased insulation and air sealing reduces the size of the required heating and cooling equipment while providing a more comfortable home. Construction details are where many advantages will be realized, and it would require a complete book to cover them. A good resource for our area would be the *Builder’s Guide for Mixed-Humid Climates*, written by Joe Lstiburek of Building Science Corporation and published by the Energy and Environmental Building Association (www.eeba.org).

Resource-efficient building techniques include:

- Site-specific water management that will reduce mold and indoor air problems while increasing the life expectancy of the structure;
- Efficient framing decreases the amount of wood use, and therefore increases the overall insulation performance of the walls and ceilings;
- 2-foot overhangs protect walls from rain and shade the windows from the summer sun, which adds to the durability and the energy efficiency; and
- Reuse of valuable topsoil saves on material needs and reduces the cost and impact of trucking.

Healthier environment

Environmental building practices reduce pollution and conserve resources by decreasing the demand on our forests and our utilities. Using alternative materials will increase demand for recycled and reused products and sustainably harvested wood. Sustainable development includes “smart growth” to preserve green space and reduce transportation needs and pollution.

Here are a few ways to reduce environmental impact:

- Site planning to preserve the existing vegetation reduces landscaping costs and preserves the native ecology and sense of place;

- Buying locally produced products, especially sustainably harvested or recycled materials, reduces transportation and other environmental impacts;
- Building to a higher energy-efficient standard reduces demands on utilities and related pollutants. This improvement lasts for the duration of the building’s life, resulting in the reduction of environmental impacts and operating costs; and
- Using renewable energy for space heating, water heating and electricity (photovoltaic, solar hot water, wind, micro hydro).

Healthier indoor environment

Indoor air quality is often compromised in buildings. Green building improves the health of the people in the building by using low- and non-toxic materials, finishes and adhesives. It addresses humidity concerns and provides adequate ventilation of fresh, clean air. Building a tight house that improves the energy efficiency does not need to diminish the quality of the indoor environment. Controlled and filtered ventilation in a tight house assures that the air entering the living space is clean and maintains low humidity levels that inhibit mold growth.

Conclusion

Buildings are a major contributor to both environmental and human health problems. At the same time, there is a rapidly growing awareness of the problems and a growing market for the solutions. Environmental building practices and products have the potential to transform the market and dramatically reduce the ecological impact of the industry while providing more comfortable, durable and productive places to live and work. Energy efficiency is the most secure, reliable and largest domestic source for new energy in the U.S.

“Conserving energy through energy efficient improvements or upgrades produces an increase of available energy — (27 billion Quadrillion BTUs in 1999, more than natural gas),” according to David Nemetzow of the Alliance to Save Energy. Just the improved energy standards for appliances cut U.S. energy use by 2.5 percent and reduced carbon emissions by nearly 2 percent from 1997 to 2000. By 2010, the savings are projected to be 253 billion kWh/yr. or 6.5 percent of the projected total U.S. electricity use (Geller).

As well as the direct impact of improved building practices, there are a variety of secondary benefits to green building. The increased awareness in the environmental impact of buildings is as critical as the awareness of the impacts of cars, consumer products, manufacturing and mining on our environment. There is the possibility of an economic system that regards nature as the most important source of wealth and well-being. Human nature enjoys the creativity to apply knowledge to problems and find solutions that ensure a long lasting high quality of life.

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THE IMPACT OF BUILDINGS AND COMMUNITY STRUCTURE ON OUR ENVIRONMENT

by Ashley Featherstone

The way we plan and build our structures and our communities has far-reaching impacts on public health and our environment. Widespread use of the automobile after 1920 and a high demand for low-cost housing after World War II led to more urban sprawl and low-cost construction practices. Suburbs sprang up, houses were built on smaller lots and attached garages became popular, creating an opportunity for combustion products to enter the living space. Homes were constructed of less expensive building materials containing adhesives and other components that off-gas a wide range of pollutants. In conjunction, the demand for furnishings and products that make life easier resulted in carpet and other flooring material, air fresheners, personal care products, pesticides, easy-to-use cleaners, and other potentially toxic consumer and building products (Corsi).

Prior to 1920, traditional towns in America consisted of neighborhoods where residences, parks and schools were located within walking distance of stores, civic services, jobs and public transportation. The automobile seemingly eliminated the need for walkable communities. Our streets that were once pedestrian-friendly are now clogged with automobiles and their pollution; they now divide us rather than serve as a place where people come together. We have moved farther and farther away from sustainable communities and buildings, creating more pollution and new problems and associated challenges (Althouse).

Environmental impacts associated with today's buildings and communities

Approximately one-third of the environmental impacts in the United States are due to constructing, operating and demolishing buildings. The environmental impacts are caused by the indirect and direct consequences of land use, waste generation, air and water pollution, and natural resource depletion. Energy, water and material usage at building sites contribute to waste generation and pollution. Ecosystems are impacted by buildings through loss of habitat, introduction of invasive species, stormwater and erosion problems, and the contamination of water resources. (US EPA, 2001)

Three to 7 tons of waste are produced and more than 1 acre of forest land is lost during construction of an average wood-framed home. Typical construction practices in use today do not consider the common factors that influence the building

and its systems, surroundings and occupants. Consequently, common construction practices consume more resources, generate more waste than necessary and have a negative impact on the environment. As a result, we have inefficient structures that use excessive quantities of water and energy, and often have indoor air quality problems that are potential health hazards. (US DOE)

There are more than 76 million residential structures and nearly 5 million commercial buildings in the U.S. today. These buildings use one-third of all the energy and two-thirds of all electricity consumed. Buildings therefore are responsible for a significant amount of air pollution that contributes to bad air quality and climate change. Buildings cause 49 percent of sulfur dioxide, 25 percent of nitrogen oxide, 10 percent of particulate matter, and 35 percent of carbon dioxide (CO₂) emissions in the U.S. annually (US DOE).

Nitrogen oxide emissions from residential natural gas usage and volatile organic compounds (VOCs) from consumer products are significant sources of air pollution that are emitted directly from homes. Currently, California is attempting to reduce VOC levels in outdoor air by requiring manufacturers of consumer products to pay fees according to the amount of pollutants contained in their products. Most of these

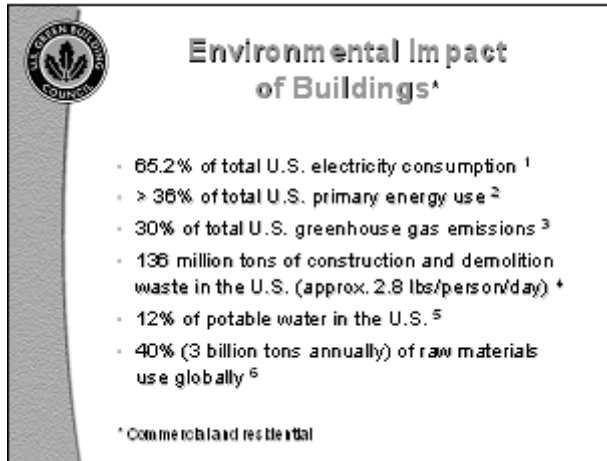
products are used indoors where the levels of VOCs are much higher compared to outdoors.

The structure of our communities is also related to air pollution. A three-year study — *Measuring Sprawl and Its Impact* — was conducted by Rutgers and Cornell universities. Researchers found that urban sprawl causes more traffic deaths, air pollution, driving and (contrary to one of the proposed benefits of sprawl) more traffic congestion (Smart Growth America).

Sustainable living practices for a healthier environment

The U.S. Department of Energy (US DOE) estimates that by 2010, an additional 38 million buildings will be constructed in the U.S. The challenge will be to build them sustainably to minimize demand on our resources and environment. Green-built structures are designed utilizing a systems approach that considers the interrelationships between a building site, a building and its components, and the needs of the occupants. Resource conservation, waste minimization, energy efficiency, renewable energy, water-conservation measures, and less-toxic interior products lead to structures that are comfortable, healthy, durable and efficient. Less air and water pollution and less waste benefit public health and our environment.

According to the N.C. State Energy Office, energy efficiency is "an important piece in the clean-air puzzle." Energy-



efficiency measures reduce the amount of fossil fuels that our power plants consume, and also lead to reductions in consumption of natural-gas- and petroleum-based heating and hot-water systems — reducing direct air-pollution emissions from residences, commercial buildings, industry and vehicles. From 2004 to 2010, the state energy office estimates that more efficient new homes that use an average of 30 percent less energy, together with energy-efficiency upgrades to existing homes, have the potential to decrease energy use and associated air pollution significantly in North Carolina: 50 tons of sulfur dioxide, 15 tons of nitrogen oxides and 8,000 tons of carbon dioxide could be reduced if these measures were taken. Other upgrades on existing homes include increasing insulation, installing double-pane windows, sealing air and duct leaks, conserving hot water, and installing programmable thermostats and more efficient lighting (NC State Energy Office).

Compared to typical new construction, green buildings use less than half the total amount of energy for heating and cooling, lighting and other purposes each year, resulting in substantial decreases in sulfur dioxide, nitrogen oxide and carbon dioxide emissions annually. A typical house is responsible for 23,406 pounds of CO₂ emissions per year, compared to 9,824 pounds of CO₂ for a green-built home (NC Solar Center). If solar hot-water heating systems were installed in 10 percent of homes in the U.S., 8.4 million metric tons of carbon emissions would be prevented annually (US DOE).

The Pennsylvania Department of Environmental Protection (PA DEP) provides a good example of measurable results in their pollution-prevention and energy-efficiency programs. From 1995 to 2002, PA DEP measured pollution reductions from 29 energy-efficiency projects. Energy use was reduced by 183 billion Btus, resulting in 55,978 tons of air-emissions reductions, 16,014 people educated and an economic benefit of \$2.8 million. During that same time period, PA DEP undertook six green building projects that resulted in an energy-use reduction of 1.36 billion Btu, 414 tons of air-pollution reductions and an economic benefit of \$21,064 in energy savings. The green-building projects also reduced water use by 593,040 gallons, diverted 153 tons of waste from landfills, preserved 13 acres, produced 18,000 kWh of renewable energy and educated 4,970 people (PA DEP).

ENERGY STAR®

ENERGY STAR is a program backed by the US EPA and the US DOE that seeks to encourage voluntary partnerships between consumers, manufacturers and others with the goal of reducing energy consumption and protecting the environment. Look for the ENERGY STAR label on consumer electronics, lighting, home-office equipment, appliances, heating-and-cooling systems, and new homes. ENERGY STAR products save energy without sacrificing quality. In 2001, Americans and ENERGY STAR reduced pollution equal to that of 10 million cars. New homes built to ENERGY STAR specifications feature airtight construction and ductwork, effective insulation, high-efficiency heating and cooling equipment, and high-performance windows. These homes are more comfortable, quiet and less drafty, and have more consistent temperatures, and better indoor-air quality. If one in

10 new homes were ENERGY STAR rated, air-pollution reductions would be equivalent to removing 600,000 cars from the road for a year (US EPA, 2002).

Smart-growth principles promote walkable, sustainable communities that lead to a reduction in vehicle miles traveled, and in associated air pollution. By using existing infrastructure and urban-infill strategies, existing transportation services can be better utilized and open space preserved. Comprehensive regional-planning strategies that promote mixed-use walking neighborhoods, increased public-transit opportunities and open-space corridors improve the community by protecting the environment and promoting more interaction among residents (Althouse).

Sustainability has been defined by the World Congress of Architects as a process that meets our needs today without sacrificing the ability of future generations to meet their own needs. By making smart choices when we plan our communities and buildings, we can improve our health and reduce unnecessary pollution. Smart growth and land-use planning, energy efficiency and conservation, building green and supporting renewable-energy projects are all smart choices we can begin making today.

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CHECKLIST FOR CREATING SMALL HOUSES THAT WORK

- **Consider alternatives to single-family homes.** Co-housing and attached houses can allow combining of functions to eliminate redundancies. This is especially true with co-housing, where a common house can provide for guest lodging, larger entertainment spaces, storage for little-used shared equipment such as lawnmowers, and shop space.
- **Evaluate space requirements very carefully.** Work with clients to carefully examine both current and projected requirements. How large is the family? Will it likely grow? Might it shrink? Is there — or might there be — a home office? How important is cooking? Do they entertain a lot?
- **Provide open-plan for kitchen/dining and living area.** Separate, formal dining rooms are rarely used today. The same is true for separate, formal living rooms. Family members and guests prefer to spend time in the kitchen — provide for that in the design. In many cases, it also makes sense to extend this open layout to the living area, so that one space serves all three functions.
- **Avoid single-use hallways.** Design houses so that circulation areas serve additional functions: circulation through the

living/dining area, or hallways that also serve other functions — as library space, for example, or (with adequate separation) for housing laundry equipment.

- **Combine functions in other spaces.** By combining functions in certain rooms, space can be optimized. For example: Combine a guest bedroom with a home office; provide for both television viewing and music functions in the living room; or put the laundry equipment in the mud room.
- **Provide built-in furnishings and storage.** Provide built-in furnishings and storage areas to better utilize space. For example: storage cabinets and drawers built into the triangular space beneath stairways; bench seats built into deep window sills; library shelves along stairway walls; and display cases built into wall cavities.
- **Provide adequate storage.** The desire for a big house may be driven by inadequate or poorly planned storage in the clients' existing house. Begin planning for built-in storage early in the design process, and try to utilize spaces that would otherwise be wasted. Small windows in walk-in closets can make those spaces more inviting and better used.
- **Make use of attic space.** A tremendous volume in most new houses is lost to unheated attic space. Instead, insulate the roof and turn attic spaces into a living area — making use of skylights and dormers to bring in light and extend the space. Scissor trusses permit high levels of insulation to be provided in the roof while avoiding the use of large-dimension lumber. Having some rooms extend right up to the roof (cathedral ceilings) often makes sense, because variation in ceiling height can make small spaces feel larger. Even if a standard uninsulated attic cannot be avoided, at least design easy access and provide convenient storage areas so that the space can be utilized.
- **Don't turn bedrooms into living rooms.** The “master-bedroom suite,” increasingly a given in upscale suburban “starter castles,” is actually little used. Even the wealthiest people use bedrooms primarily for sleeping and dressing. Keep them relatively small to avoid wasted space.
- **Provide acoustic separation between rooms.** A small house will be more acceptable if there are no common walls between bedrooms. Closets can help provide this separation. Also consider insulating interior walls and providing staggered wall studs for acoustic isolation.
- **Provide connections to the outdoors.** Providing linkages to outdoor and semi-outdoor spaces will both create a more pleasant house and make a compact house feel significantly larger. Careful placement of windows and glazed patio doors will increase the visual connection with the outdoors even during winter and inclement weather. Tall windows that extend down close to the floor help extend spaces to the outdoors.
- **Create outdoor living space through thoughtful landscaping.** Carefully landscaped patios, decks, woodland sitting areas, and small lawn areas encourage the outdoors to become additional living space during good weather.



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- **Provide a variety of ceiling heights.** Create spaces with varying ceiling height to make a house feel larger even if it reduces somewhat the actual usable floor area.
- **Provide natural daylighting and carefully placed artificial lighting.** Try to provide natural lighting on at least two sides of every room to provide a feeling of spaciousness. Incorporate some natural and artificial lighting where the light source is not readily visible to make compact spaces feel larger. Uplighting onto ceilings also makes a space feel larger.
- **Provide visual, spatial and textural contrasts.** Contrasting colors, orientations, degrees of privacy, ceiling heights, light intensities, detailing and surface textures can be an important design strategy for creating satisfying spaces that feel larger than they really are.
- **Use light colors for large areas.** Most walls and ceilings should be light in color to make spaces feel larger. Use dark colors only for contrast and accent.
- **Keep some structural elements exposed.** Structural beams, posts and timber joists should be left exposed, creating visual focal points and texture. Be careful not to let these elements overwhelm the space, however; too many exposed timbers can make a space feel smaller.
- **Make use of interior windows.** Transom windows above doorways and interior windows that allow natural light from skylights to be distributed into adjoining rooms can make those spaces feel larger.
- **Design spaces for visual flow.** Careful building design can make small spaces feel larger by causing the eye to wander through a space. A continuous molding line that extends throughout a house somewhat below the ceiling can assist with this visual flow. Continuity of flooring and wall coverings can also tie spaces together visually. With very small spaces, provide diagonal site lines that maximize the distance and the feeling of scale.
- **Provide a focal point for each room or space.** Each space should have one particularly attractive or interesting building element, feature, piece of furniture or work of art — a focal point for occupants.
- **Provide quality detailing and finishes.** By limiting the overall square footage of a house, more budget can be allocated to the detailing, materials and finish quality to make a house special. Minimizing house size may also be a way to include some of the “green” building materials and products that cost more (natural granite countertops, linoleum, certified wood flooring, top-efficiency appliances, etc.).
- **Design for flexibility and change.** A small house should be adaptable to change — changes in family size, changes in lifestyle, changes in health of the occupants, the addition of a home-based business. A flexible house design will permit future modifications with low impact, and it will obviate the need to build big “just because you don’t know what the future will hold.”

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ENERGY-EFFICIENT HOMES

by Maggie Leslie

Energy efficiency increases the quality and affordability of a home. But what makes a home more efficient? Efficient appliances are important to energy savings, but they only account for a fraction of the energy used in a typical home. The house itself is a system of individual components that interact just like the parts of a giant appliance. Heating-and-cooling equipment, site placement, design, lighting and appliances interact with lifestyle choices, all of which are sheltered by the building envelope. The building envelope keeps the weather outside and the comfort in.

Building an efficient home does not necessarily have to include costly materials and high-tech equipment. A systems approach to design and attention to detail during the construction process can be achieved without added cost. The first thing to consider when designing is site placement. Passive-solar design takes advantage of the patterns of the sun to increase solar-heat gain and to significantly reduce the amount of energy used to heat and cool a home. Proper design minimizes glass on the east and west walls while maximizing southern exposure; this prevents unwanted afternoon and morning glare, as well as the heat that comes with summer sun. When it is cold, the sun is low in the sky and enters the south-facing windows; this warms thermal mass and surrounding

surfaces throughout the day. As temperatures cool in the evening, the thermal mass radiates the heat back into the room. Summer-shading devices such as trees, screens or overhangs also minimize solar gain during the cooling season.

Upgrading to low-emissive windows also aids in passive-solar design without affecting the quality of the light. “Low-e” windows come in a variety of forms, but are typically coated in an invisible metallic oxide to hinder heat radiation and UV-light penetration. The thin metal glazing allows short-wave radiation to pass in, but blocks most of the long-wave thermal radiation attempting to escape. Low-e films are also available for retrofit. For added insulation, choose windows that are filled with argon or krypton gas. Argon and krypton are heavier than air and thus slow the movement of heat.

While choosing efficient windows is important, it is not a cost-effective upgrade if air can simply leak out through holes in the building envelope. There is a common misconception that a house should not be too “tight.” In reality, a home should be as tight as possible, but with controlled ventilation. This technique allows the homeowner to control where the air comes from and how much enters the home. In a typical home, heated or cooled air is exchanged for stale, moist air from attics and crawlspaces. A negative pressure, created by holes in the ductwork and building envelope, draws air through the cracks in the building envelope. Depending on the location of the holes, you are either using dirty air from the attic and crawlspace for heating and cooling, or actually paying to condition the uninsulated attic, crawlspace and neighboring yard. Properly sizing, insulating and sealing ducts with mastic may be the single-most important measure in ensuring the efficiency and health of a home. Holes in plumbing, electrical and HVAC penetrations, and in floor joists and ductwork, can also increase heating and cooling costs by 60 percent. Proper air sealing will increase a home’s performance dramatically with little to no additional cost during construction, and typically allows downsizing of the HVAC equipment. To determine the properly sized heating and cooling equipment necessary for your home, a Manual J calculation (a simple software program) should be performed before purchasing mechanical equipment. Never rely on “rule-of-thumb” sizing techniques, as all homes are not created equal.

Along with duct sealing, insulation choices and installation procedures have a significant affect on the heating-and-cooling costs of the home. R-value measures how resistant a material is to heat flow in the lab, but installation techniques can significantly decrease the insulation’s effectiveness. Fiberglass and other batt insulation is rarely installed to perform as intended. When installed without being misaligned or compressed, and without the voids and gaps though, it can save more than 25 percent in the efficiency of the building envelope.

An even better option is spray-applied insulation (typically foam or cellulose). The material expands to fill the entire wall cavity, thus eliminating air infiltration through convection loops within the wall cavities. Blown cellulose is manufactured from recycled newsprint; therefore, it’s a great renewable material. Spray foam creates a complete



Setting up a blower-door test.

air barrier, is very durable and inherently mold resistant, and now comes CFC and HCFC free.

When choosing a spray foam, it is important to note the difference between “closed cell” and “open cell” foam. Both systems offer significant advantages over batt insulation. Closed-cell foam is much more dense, has a higher R-value (R-6.5/inch) and is more expensive per R-value than open-cell foam. In addition, closed-cell foam increases the strength of the wall system (it’s approximately doubled) and is impervious to water and wicking, and therefore forms a vapor barrier. Open cell foam forms an air barrier, while allowing water vapor to pass through so that the wall can “breathe,” an important property in humid climates.

In a typical home, insulation is installed on the floor of the attic and the ceiling of the basement while HVAC equipment is often placed in those unconditioned spaces. Consider extending the building envelope to include the basement and attic. By adding a small amount of area to the conditioned space, many leak paths are prevented, reducing energy loss and improving air quality and comfort. Insulating along the basement walls and roofline can block air and moisture from entering the structure. Additionally, duct leakage becomes a less important energy issue because the ducts are located in a conditioned space. Finishing attics, basements and crawlspaces is a cost-effective option for retrofit. If this is not an option, consider applying at least an R-19 (an R-13 fiberglass batt and an inch of rigid foam board) to attic knee walls and doors. Knee walls are the short attic walls next to a conditioned space, a common source of heat loss and discomfort.

Investing in efficient equipment but not properly air-sealing sends your money, literally, out the window while simultaneously compromising indoor-air quality. Energy conservation is much cheaper and cleaner than burning natural resources. Properly air sealing just one electrically heated home could prevent 1,100 pounds of CO2 from entering the atmosphere (Seattle City Light). The Energy Star® Program, a federal certification for energy-efficient homes, requires third-party testing, verifying the new or existing home’s efficiency and qualifying the buyer/owner

for an energy-efficient mortgage. This helps ensure that the home is built well the first time. The financial savings can then be invested into upgrades of your choice or other energy-efficient measures, such as the low-e windows, spray-applied insulation, or high-efficiency lighting, appliances and mechanical equipment.

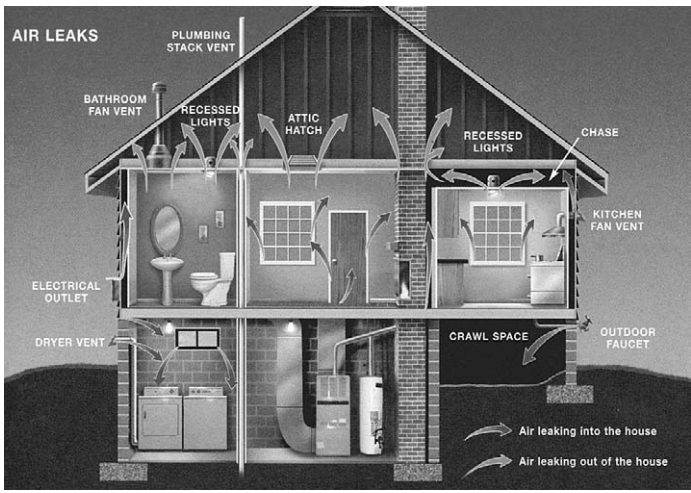
When choosing mechanical equipment, there are three main classifications to understand: AFUE, HSPF and SEER. The Annual Fuel Utilization Efficiency (AFUE) measures the efficiency of a furnace. A high-efficiency furnace has an AFUE of more than 92 percent. Keep in mind that the efficiency of the blower is not included in the AFUE determination, and should also be a consideration. The HSPF, or Heating Season Performance Factor, measures heat-pump efficiency: 8.0 or higher is considered high-efficiency. The Seasonal Energy Efficiency Ratio (SEER) measures cooling efficiency of an a/c unit or heat pump. Look for a 12 SEER or above (Wilson).

Water heating accounts for about 16 percent of heating and cooling costs in a home. Investing in an efficient water heater can offer a quick payback, ultimately saving several hundred dollars a year. There are many options: gas or electric, on-demand or storage, a stand-alone or integrated system, or solar thermal. Your choice depends on your needs and capabilities. Determining how much water you will use is very helpful in deciding what will be most effective. Obviously, solar-thermal systems will save the most energy, and are by far the most cost-effective based on life-cycle cost, but do have a higher first-cost and require an unshaded, south-facing location. Any hot-water heating system (new or existing) should have insulation around the heater and hot-water piping to be efficient. Installing heat traps on new or existing water heaters costs about \$30, and will save \$15-\$30 per year. Considerable savings are, of course, also incurred through conserving water by eliminating drips and using low-flow faucets and showerheads (Wilson).

Look for the Energy Star® label when purchasing refrigerators, dishwashers, laundry machines and other equipment. Typically, side-by-side refrigerators/freezers use more energy than models with the freezer on the bottom. Front-loading washing machines, while more expensive, have substantial water and energy savings over conventional top-loading models. Compact-fluorescent light bulbs have significantly improved in their lighting quality over recent years. Although they are more expensive, they last 10 times longer than incandescent bulbs, and use a quarter of the electricity. Bulbs are now available to fit most any ballast.

References:

Wilson, Alex; Thorne, Jennifer; Morill, John 1999. *Consumer Guide to Home Energy Savings*. American Council for an Energy-Efficient Economy and *Home Energy Magazine*.
Seattle City Light: www.ci.seattle.wa.us/light/conserve/.



Common sources of air leaks in a house. Source: Energy Star.

Maggie Leslie is with Home Energy Partners and serves as treasurer of the WNC Green Building Council.

INTRODUCTION

USING THIS DIRECTORY

Who can use the *WNC Green Building Directory*? Everyone can! It's that simple. Whether you're getting ready to design, renovate, add on, buy or build new, this directory is designed to be user friendly to homeowners, builders, architects, consultants, and anyone interested in green building. Regional suppliers and resources are the focus of this directory. However, due to limitations of production in this region, some national resources are occasionally listed as well. The directory is divided into five main sections:

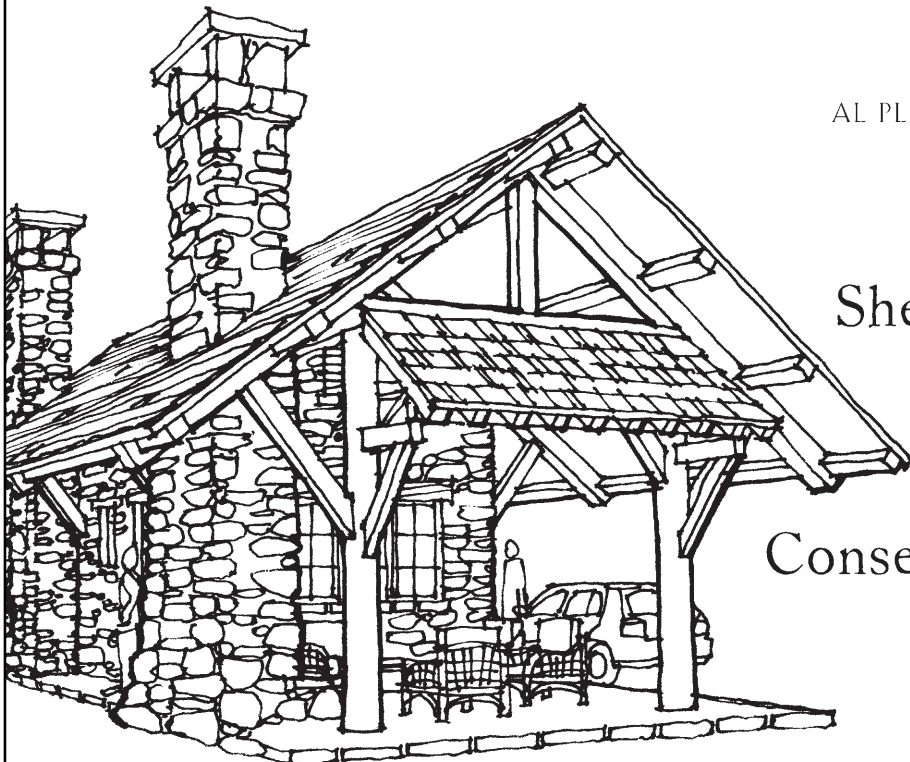
- **Introduction** — a general overview of the directory, green building, and the WNC Green Building Council to help you understand the basics.
- **Listings** — contact information and descriptions of regional green-building professionals, materials and suppliers to help you find the right people and products for your project.
- **Articles** — educational articles explaining green-building issues and techniques in more detail.
- **Case Studies** — local examples of "green" buildings.
- **Resources** — a concise list of publications and Web pages that can help expand your knowledge of sustainability and green building.

It's important to note that while all businesses listed in this

directory provide environmental building services and products, all their services or products might not be considered environmentally sound. Therefore we encourage readers to always specifically inquire about the *environmental* features a business provides. So, happy reading and building from all of us at the WNC Green Building Council.

DISCLAIMER

Though great attention has been made to ensure the accuracy of the *WNC Green Building Directory*, the publication assumes no responsibility and disclaims any injury, damage, or economic loss resulting in the use or effect of any product or information specified within this publication. Information in the *WNC Green Building Directory* does not necessarily reflect the endorsement of the advertising sponsors. The publication cannot be a substitute for product quality assurance by the manufacturers and providers of these products and services; it cannot be a replacement for preferences of individual consumers; and it cannot be an alternative to common sense employed by consumers who use the products and services discussed herein. It is recommended that consumers follow instructions in product and service manuals and on labels to ensure safe use.



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USING SCIENCE AND TECHNOLOGY TO MEASURE HOME PERFORMANCE

by Isaac Savage

How many miles per gallon does your home get? While it's relatively easy to obtain an efficiency rating for an automobile these days, it seems rather impossible to get a good grasp on exactly how efficient your house is. Just as there are guidelines to evaluating the mpg of a vehicle, there is an approved process for evaluating the efficiency of a building. This process has been labeled as the "Home Energy Rating System," or HERS rating. By taking into account all things that determine the efficiency of a building, a certified HERS rater can easily determine how well your home performs, as well as how your home will benefit from improvements.

Using high-tech software, proposed improvements are modeled to determine exactly how much energy will be saved. This quantitative method puts an end to guesstimating where one should spend home-improvement dollars. The system not only illustrates where a homeowner may get the most "bang-for-the-buck," but it is also recognized by the mortgage industry. The HERS rating is so accurate that the mortgage industry will actually loan you more money if it is used to make cost-effective improvements to your home — up to 15 percent of a home's appraised value is available for every home that is bought or refinanced!

Surprisingly enough, the things that have the greatest effect on a home's performance are most often invisible to the naked eye. Professional building-diagnostic tools are essential to the HERS rating. Without them, an accurate examination of a home is impossible. The blower door, duct blaster, manometer and infrared camera are the backbone of the rating system.

A blower door is a large fan that is used to depressurize the home by forcing air out. When combined with a manometer (a device that measures pressure differences), a blower door provides an accurate measurement of how "leaky" your house is. The leak factor is one of the main components of energy modeling, because the more leaky the home, the less efficient it is. The more "air-changes-per-hour" that your house undergoes, the more it costs you to reheat the new air that has replaced the old. If you could pay to heat your indoor air only once, and keep it inside the home, then you would undoubtedly be much happier when you receive your monthly utility bill.

The pathways that air takes within the walls of your home

are often the most overlooked. These interior chasesways and soffits typically contribute as much to inefficiency as would a door that was left open all winter long. These airways are easily documented with a blower door and proper use of pressure gauges.

The ductblaster is very similar to the blower door, yet smaller. This tool, as the name suggests, is used to measure the leakiness of ductwork. As with the leakiness of the walls, the more holes that are in your ductwork, the less efficient it is. Leaky ductwork is a bad scenario for a number of reasons. Let's begin with the efficiency side of the coin. Think of ductwork as a large vacuum that pulls air from one place and sends it to another. Air is either blown out of a supply duct or sucked into a return duct.

On the supply side, conditioned air is lost to the attic, crawlspace, or unfinished basement. This not only heats an unconditioned area, but it also depressurizes your living space. The depressurization causes air to enter the house to replace the air that was lost due to leakage. This replacement air is

not "fresh" air, as it is often considered, but originates from your crawlspace, basement or attic — or, the worst-case scenario, the flue pipe of a combustion appliance.

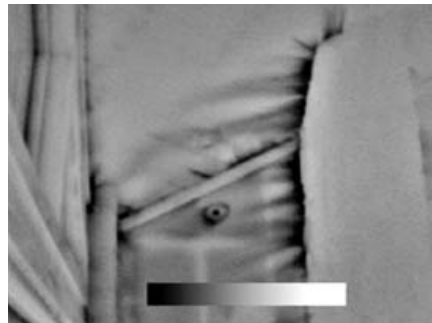
On the return-side of a system, the holes pull in air from the attic, crawlspace or basement (most of which are unconditioned) and distribute it to the rest of your home via your ductwork. This introduction of cold air (wintertime) not only makes for an inefficient system, but it can

create serious air-quality problems. Most of us would not want to breathe the air found within our crawlspace, but that's essentially what we're doing if the air handler is on and we have leaky ducts. As you can tell, duct leakage can certainly affect the efficiency and overall health of a home. Therefore, it is one of the main factors within the HERS rating.

With all of these thoughts about tightening a home, the question is often asked, "Is it possible to create a house that is too tight?" This is the most frequently asked question of a rater. As we have discovered, in order to have an efficient house, the house *must* be tight. But, shouldn't there be a little "fresh air?" yes, there should be fresh air. But there should be *fresh* air. Not air that originates from the dank, moldy crawlspaces ... not air that enters through the cracks in the wall where the critters live ... not air that comes from the attic that is filled with fiberglass insulation and old snake skins. The fresh air should truly be fresh. It should be introduced into the home through a mechanical system. This enables homeowners to control when they get fresh air (often on a timer), and how much fresh air



While under depressurization, cold air is pulled through holes in the envelope.



The infrared image indicates air leaks along the stone column (black as cold, and white as hot).

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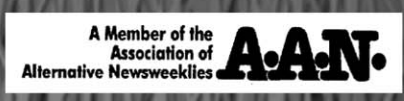
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they get (maybe a little more on poker night), and it enables the control of where the fresh air is delivered (to every room with a supply duct). By tightening the house and introducing fresh air mechanically, it is possible to create an efficient home that also has healthy indoor-air quality.

Perhaps the most fascinating tool used by HERS raters is the infrared camera. This high-tech device allows the viewer to see the relative temperature of surfaces, enabling one to see how well insulation is performing, or if it's even there to begin with! When combined with the use of a blower door (and a temperature differential between inside and outside), the infrared camera allows the rater to locate the holes in the building envelope. When the cold outside air comes in to replace the air being pulled out of the house by the blower door, the surfaces around the holes are cooled and therefore are easily identified. This allows homeowners to see exactly where their heating dollars are escaping their home!

As the cost of fuel rises and indoor environmental quality becomes more important to families across the nation, people are realizing the benefits of home performance. HERS raters have begun to fill the need for home inspections that reflect the principles of building-science. A typical home-performance evaluation includes an energy modeling of your home, a list of cost-effective improvements (focusing on efficiency, health and comfort), guidance through the Energy Efficient Mortgage process — and, most importantly, insight into how home performance actually works.

Isaac Savage is with Home Energy Partners and serves as a WNC Green Building Council board member.

"How far you go in life depends on you being tender with the young, compassionate with the aged, sympathetic with the striving, and tolerant of the weak and the strong. Because someday in life you will have been all of these."

— George Washington Carver

"The virtues which keep this world sweet and the faithfulness which keeps it steadfast are chiefly those of the average man."

— W. Russell Bowie

"Kindness in words creates confidence. Kindness in thinking creates profoundness. Kindness in giving creates love."

— Lao Tzu

"Watch your thoughts; they become words. Watch your words; they become actions. Watch your actions; they become habits. Watch your habits; they become character. Watch your character; it becomes your destiny."

— Frank Outlaw

"The issue is not that you need new stuff. The issue is to see what you already have in a new light...You did not come into this world lacking anything. Any appearance of lack is a place where you are not open to receiving what is already yours."

— Marianne Williamson

CLEANER ENERGY FOR ENVIRONMENTAL PROTECTION

North Carolinians now have an easy, low-cost way to help protect the environment and improve the state's air quality by contributing to NC GreenPower, a program to increase the use of renewable energy.

The goal is to improve the quality of the environment by encouraging the development of renewable-energy resources through consumers' voluntary contributions toward green power. The program supplements the state's existing power supply with more green energy. This type of electricity will be generated in North Carolina from renewable resources such as solar, wind and landfill gas.

Approved in January 2003 by the N.C. Utilities Commission, the program is administered by Advanced Energy, a nonprofit, Raleigh-based corporation with a 21-year history of working with renewable energy, energy efficiency and electric utilities. The program is the nation's first to receive support from the state's utility companies, environmental leaders, technology suppliers, consumers and state energy agencies for this independent, nonprofit organization.

NC GreenPower will use voluntary contributions from North Carolina citizens and businesses to help offset the cost of producing energy from renewable resources. A minimum contribution of just \$4 per month adds one block of 100 kilowatt-hours of green energy to North Carolina's power supply. That's less than 5 percent of the typical residential customer's monthly bill. Over the course of the year, sponsoring a single block of green energy is the environmental equivalent of not driving a car for 74 days, or of planting 150 full-grown trees.

For businesses that contribute at least 100 or more blocks of green power per month, the volume rate is \$250 per 100 blocks. There is a different energy mix for large-volume contributors. Companies or organizations contributing more than \$24,000 annually will be named NC GreenPower Founding Sponsors.

Contribution commitments from Lowe's Home Improvement Warehouses and the North Carolina division office of the Environmental Protection Agency far exceed that level.

All contributions are tax-deductible. To make payment easy, contributions will be added to the total amount of the contributor's electric bill. Electric companies have volunteered to collect those funds and pass the entire amount to NC GreenPower at no cost to the contributor or NC GreenPower. (Participating utilities include Dominion North Carolina Power, Duke Power, Progress Energy and members of North Carolina Electric Membership Corporation and North Carolina Electricities.) NC GreenPower will use contributions as incentives for producers of renewable energy.



For more information about the NC GreenPower program, visit www.ncgreenpower.org, or call (919) 857-9000.

A RESIDENTIAL GREEN-BUILDER PROGRAM FOR NORTH CAROLINA

by Dona Stankus



NC HealthyBuilt Homes Program

North Carolina is currently developing a green-builder program and the pilot project, supported by the North Carolina Solar Center (NCSC) and the Western North Carolina Green Building Council, is under way. So what is a green-builder program?

History

Past builder-oriented programs in North Carolina have centered on energy efficiency, such as the “E Seal” and the “Solar Spec” program focused on energy efficiency and passive-solar design. Currently, more than 20 residential green-builder programs have begun and are successful (or growing) on a national level. The “first” green-builder program to gain wide recognition and success is the Austin Green Building Program, begun in 1993 in Austin, Texas. This program provides guidance and marketing for concepts surrounding energy, water and site conservation; ecologically friendly material use; healthy indoor-air quality; and maintenance guidelines. The current effort for a North Carolina Green Builder Program began as an idea at the NCSC in 2000 for a solar hot-water program. As staff and funding shifted, it became prudent to develop a “whole-building” or “green-building” program for North Carolina that is similar to the Austin Green Building Program, Earthcraft in Atlanta (1,000 homes in 1999) and Built Green Colorado (10,000-plus homes in 1995), to name a few. By mid-2001, a small budget was in place to begin the development of a Green Builder Program in North Carolina.

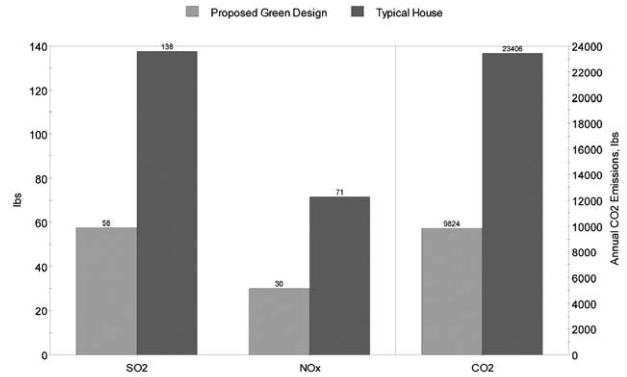
North Carolina’s green-builder program

The ultimate goal of a green-builder program is to transform residential construction to support clean air and water, and conservation of energy, land and material resources. Green building is interested in the intersection of conditions where people and the natural environment are healthy over an extremely long period of time. This intersection must provide meaningful work, a strong economy and continuation of human life in a healthy environment.

In order for this transformation to occur, support for those making the change must be paramount. Due to the potential economic burden of any change, builders will need assistance with marketing green homes, understanding the technology and building science of a green home, and with finding the financial incentives for both builder and owner that exist to make this shift away from the “that’s-how-we’ve-always-done-it” attitude. The primary focus of the program is to provide education, technical assistance, marketing and financial knowledge to builders, architects and homeowners.

The North Carolina Green Builder Program has statewide and community components. The statewide program will be administered by NCSC staff, who will solicit “community partners” throughout the state. Builders will be invited by the

Green Builder Program - ANNUAL EMISSIONS RESULTS



Green buildings can greatly reduce air pollution.

community partner to become certified green builders who construct homes according to the guidelines provided.

Builders benefits through the program will include: technical assistance, design reviews, site consultations, reduced workshop fees, marketing assistance, Web site publicity and a listing in a searchable directory. Additional benefits may be provided at the discretion of the statewide and community partners.

Throughout the process, many decisions have been reviewed and voted on by a statewide task force of builders, designers, real estate agents, building scientists and Home Building Association (HBA) members. Among those decisions are that the NCGBP will be voluntary and that HBC and non-profit groups within a community will be the primary target to become community partners. Typically, the most successful green-builder programs have been connected to the HBA.

The program will initially provide support to three target groups: builders, homeowners and financial providers. Information will be available to all three groups on a Web site, while educational workshops will initially focus on builders. Marketing and financial incentives for homeowners and builders will be researched and provided. Once financial institutions begin to understand the program and its economic benefits, additional financial products and incentives can be developed. Over time, other groups that will be supported in the program include designers and architects, real estate agents, inspectors and home-energy raters.

The pilot program

The NC Green Builder Program started an 18-home pilot program in 2003 at Prospect Terrace — a residential development in downtown Asheville — in conjunction with the

developer, Mountain Housing Opportunities, and with Mathews Architecture. Included are single-family homes, several low-income homes, a six-unit multifamily building and one historical duplex renovation. The diversity of the project allows for putting the guidelines to a real test. The project is expected to begin construction in early 2004 and include solar orientation, increased insulation, design for reduction of air infiltration, an efficient but downsized HVAC system, a solar hot-water system and Energy Star-rated appliances.

The Western North Carolina Green Building Council and Land of Sky Waste Reduction Partners have been the driving community force on this pilot program. They have worked closely with the NCSC to develop the NC Green Builder Program. The NCSC, WNCGBC and the Asheville Home Builders Association are looking at developing a statewide/community partnership to bring a permanent NC Green Builder Program to the Asheville area. In the meantime, the NCSC is working with other communities across the state to develop potential pilot programs.

Builder benefits

Builders will receive many benefits for a yearly program-enrollment fee. In addition to the ability to distinguish their company in the marketplace, increase their profitability and reduce callbacks, benefits for the homebuilders include:

- Market-development materials: marketing assistance including brochures, fact sheets, certificates for framing and yard signs. The community partner will distribute other marketing materials.
- Web site: Builders will receive publicity via listing on a Web site.
- General assistance: Community partners will provide information about benefits and answer or will direct questions as necessary.
- Technical assistance: Community partners will be the first point of contact for technical questions, or direct builders to Web sites or to the "statewide partner" for technical questions and referrals.
- Training for builders in the NC Green Builder Program: The statewide partner will provide content and materials for the training session. The community partner will also be present and available for questions, especially relating to local issues.
- Consultations: One field

review will be included in the registration fee for each home. All projects will be required to include a blower-door test to establish minimum air infiltration.

- Workshops: Builders will be given reduced rates to workshops held by the statewide partner.
- Design reviews: The statewide partner will provide one no-cost design review per year to each builder who is a member of the program; additional reviews will be available for an hourly fee.
- Sustainable demonstration house: The statewide partner will maintain a demonstration house, and a library with computer station(s) will be maintained for builders. The statewide partner will work with community partners to fund the building of demonstration homes in their area.
- The North Carolina Green Builder Program will provide designers with a pool of builders who are familiar with and knowledgeable about green building, and who are willing to provide healthy, energy- and resource-efficient homes.

Homeowner benefits

Homeowners will receive benefits from the program as well. Below is a list of expected benefits:

- Encourage homeowner to use available tax credits.
- A Web site and searchable directory of quality builders who are part of this program.
- Reduced utility bills, which continue to provide saving for the life of the building.
- Financing options that take advantage of the decreased energy use through a larger initial mortgage or reduced up-front costs.
- Additional quality assurance in the form of a field review provided by the community partner.

Conclusion

The future is bright in the North Carolina building market for green building. National trends, energy cost concerns, clean air and the need for water conservation will be driving the market. The building industry accounts for 36 percent of our energy use (IEA) and 40 percent of our natural resource use (EPA). Through the cooperative efforts of state-wide building industry representatives, a green building program will support the sustainable use of our resources and help reduce the industry's impact on the environment. The NC Green Builder Program will promote a healthy industry and assist builders in implementing these new techniques and ensure the continued economic growth of their business.

For more info

For more information, please visit the program's Web page: www.ncsc.ncsu.edu/programs/North_Carolina_HealthyBuilt_Homes_Program.cfm.

Dona Stankus, AIA, is with the North Carolina Solar Center and a member of the WNC Green Building Council. Stankus can be reached at dona_stankus@ncsu.edu. For more info on the N.C. Solar Center, see www.ncsc.ncsu.edu.

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THE GREENGUARD CERTIFICATION PROGRAM: A TOOL FOR MINIMIZING INDOOR-AIR POLLUTION

INDOOR-AIR QUALITY AND EMISSIONS FROM BUILDING MATERIALS

by Ashley Featherstone

Indoor-air pollution has been ranked by the U.S. Environmental Protection Agency, the American Lung Association, and the World Health Organization as one of the greatest threats to public health. Studies show that indoor-air pollution can cause allergies, asthma, reproductive and developmental problems, and cancer.



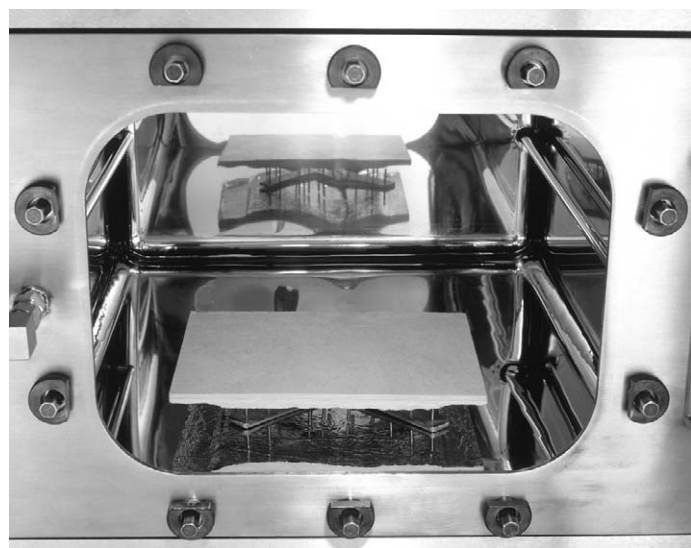
The monetary costs associated with poor indoor-air quality (IAQ) in the United States are estimated to be in the tens of billions of dollars per year due to increased worker absenteeism and health-care costs, and decreased productivity and morale.

The most effective way to maintain indoor air quality is through the implementation of an indoor-air-quality-management plan. Controlling pollution at the source has typically been one of the most difficult aspects of an IAQ-management plan. Source control includes minimizing emissions from building materials, indoor furnishings and processes such as the cleaning and operation of office equipment.

In the past, the only way to obtain air-emissions information for building and consumer products was to ask the manufacturer. A lack of standards and uniform-testing requirements and specifications resulted in unreliable information.

Currently, there are no federal, state or local regulations that control product emissions. The state of Washington and the U.S. EPA have set standards that address purchasing requirements for their facilities, but neither has attempted to set standards that can be applied universally. The carpet industry was required to establish an indoor-air-quality labeling program as a result of the carpet-policy dialogue in the early 1990s. This initiative was effective at reducing volatile-organic-compound (VOC) emissions from carpet and its associated materials, but the program lacks third-party oversight and verification procedures.

The US Green Building Council's Leadership for Energy and Environmental Design program (LEED) does address indoor environmental quality (IEQ); 23 percent of all credits in the program are IEQ related. However, when the LEED program was established, the lack of an independent third-party-certification process for product emissions resulted in indoor environmental standards that were based on chemical content and not actual emissions testing or verification. In 2002, the US GBC introduced a pilot of LEED for commercial interiors that required furniture and furnishings to be tested for volatile organic-compound emissions, including formaldehyde.



A piece of fiberglass in a small environmental testing chamber is being prepared for emissions testing for compliance with the GREENGUARD Certification Standard for Chemical Emissions. *Image courtesy of Air Quality Sciences Inc.*

The GREENGUARD Certification Program

The goal of the GREENGUARD Certification Program is to improve public health and quality of life by encouraging and helping manufacturers to produce better and safer products, while providing the public a free indoor-air-quality resource and guide to low-emitting products. The program was created to provide an independent-third-party verification process based on proven standardized emissions testing and verification procedures. The program provides a free resource to managers and procurement officials for low-emitting products.

GREENGUARD grew out of the AQSpec list program developed by Marilyn Black, Ph.D., and Air Quality Sciences, Inc. in 1996. The AQSpec list program started out as a registry or list of manufacturers and products that had been shown to meet the specifications for low emissions that were established by the state of Washington for a wide range of products, and by the U.S. EPA's furniture-emissions standards that were utilized to select products for their new headquarters building.

In June of 2000, the GREENGUARD Registry Program replaced the AQSpec List. In June 2001, the GREENGUARD Environmental Institute was founded to oversee the GREENGUARD Certification and Labeling Program. The GEI is a nonprofit organization with a scientific, third-party board responsible for establishing environmental standards for indoor products and building materials. The certification-advisory board includes individuals who are world-renowned for their expertise in green building, indoor-air quality, chemical-emissions testing and public health.

The GREENGUARD Certification Program is a resource for identifying products and materials that have been tested regularly and found to meet VOC and particulate-emissions standards. This resource is an essential tool for architects,



An office chair in an environmental testing chamber is being prepared for emissions testing for compliance with the GREENGUARD Certification Standard for Chemical Emissions. *Image courtesy of Air Quality Sciences Inc.*

interior designers, product specifiers and purchasing organizations that seek to identify, select and purchase low-emitting products for indoor environments. The voluntary program is open to all manufacturers and suppliers.

Product categories and testing

The GREENGUARD Certification Program includes all construction materials, furniture, furnishings, office equipment, cleaning and maintenance materials, and processes that are used indoors. General product categories include: wall coverings, flooring, insulations, textiles, office furniture, paints and coatings, construction materials, adhesives and sealants, ceiling materials, appliances, office equipment, consumer products and carpet-cleaning systems. General categories contain subgroups. For example, subgroups in the office-furniture category include workstations, desks, acoustical panels, tables, file and storage cabinets, chairs and bookcases. Additional subgroups will be added as the program expands.

Maximum-allowable emission levels were based on the most stringent levels for each pollutant as set by Washington's IAQ

program for new construction, EPA's procurement specifications, World Health Organization recommendations and Germany's Blue Angel program for electronic equipment. Products must meet emission-level standards within one week of installation.

Necessary testing procedures and protocols for each product are determined on a case-by-case basis utilizing on-site reviews of the manufacturing process and environmental-chamber testing of product samples. Certification testing includes quarterly sample analyses and annual recertification-testing requirements. The manufacturer must report changes in production methods for certified products.

Environmental-chamber testing takes place in a dynamic environment, allowing for real-world scenarios. Test data can be mathematically modeled to estimate exposure rates in different environments, allowing evaluation of health, irritation and odor concerns. Since products are tested at the same loading ratio of exposed surface area to room volume — as found in a typical environment — results of chamber testing are scalable to any size room.

Program benefits

In addition to being a free online resource to those considering IAQ while selecting products for use inside buildings, the program helps promote awareness of IAQ issues and best practices. The program also offers manufacturers verified IAQ information about their products and provides a valuable marketing tool while promoting safer products. As IAQ awareness grows, the program provides an opportunity for companies to demonstrate their commitment to public health and indoor environments by producing better, safer products.

Source: Bloech, Henning. Improving IAQ at the Source — GREENGUARD Program Certifying Products for Low Emissions. *Indoor Environment Connections*. Volume 4, Issue 6, April 2003.

For more information about the GREENGUARD Program, please see: www.greenguard.org

For more information about indoor air: www.epa.gov/iaq

EPA's I-BEAM software for indoor-air-quality management in commercial buildings can be found at this Web site: www.epa.gov/iaq/largebldgs/ibeam_page.htm

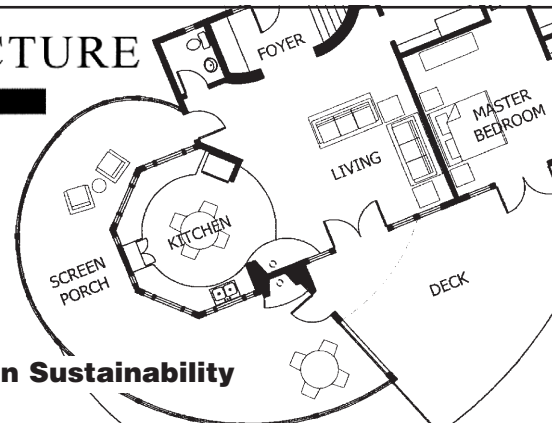
Ashley Featherstone is with the Regional Air Quality Agency and serves as a WNC Green Building Council board member.



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WNC MILLION SOLAR ROOFS INITIATIVE



The WNC Million Solar Roofs Initiative has a goal of installing 500 solar systems in the region by the year 2010. Our local efforts have included solar public education, solar-home tours and solar-installation tracking. Long term, our focus is to increase public awareness about the benefits of solar energy and act as a liaison for local solar professionals.

Our 2004 initiatives include a WNC MSR Web site, creating an educational display for local events and networking for a solar-demonstration project. Look for our upcoming educational forums investigating solar applications in affordable housing, government buildings and high-profile projects.

Absorbing the heat from the sun is the most direct way to use solar energy — ask any cat. Solar thermal can be just as enjoyable for humans, and gives the greatest return on investment of any renewable-energy application.

Techniques fall into two general categories — passive and active. Passive techniques include letting the sun in to warm a building in winter and blocking it out in summer (passive design), or allowing the sun to heat water in an insulated, glazed tank (passive water heating). Once such a system is built, it requires no intervention or outside power to do its basic work.

Active systems use pumps, blowers or dampers as control devices, which sometimes boost the efficiency of heat absorption. In these, air or another fluid is moved through collectors to absorb heat and move it into a storage device. The simplest form is a transpired collector — essentially a dark, metal, south-facing wall with holes punched in it. Fresh air is drawn through and behind the wall and into the building. Most active systems, though, use a glazed, insulated collector to achieve higher temperatures, and some even use mirrors to concentrate the sunlight. This heat may be used for space or water heating, for process heat in industry, or to run an engine to generate electricity.

Pros and cons

Passive design offers the best return on investment of any solar technology. Some design considerations add no cost while others pay for themselves quickly in reduced heating and air-conditioning costs.

Solar water heating offers the second-best return on investment, and is more easily added to an existing structure, according to the N.C. Sustainable Energy Association. Passive water heaters are inexpensive (\$2,000-\$3,000 for a residence) but have potential freezing problems if they use water in the collector and are not drained in winter. Active water heaters (\$3,000-\$5,000) provide freeze protection and can be either self-powered (the pump is run by a small photovoltaic panel) or use low-wattage AC pumps.

Research shows that an average household with an electric water heater spends about 25 percent of its home-energy costs on heating water. Solar-water heaters offered the largest potential savings, with solar water-heater owners saving as much as 50 percent to 85 percent annually on their utility bills over the cost of electric water heating.

Courtesy of the N.C. Sustainable Energy Association.

PHOTOVOLTAICS

Photovoltaic (PV) power is the process of converting sunlight into electricity with solar cells, which are semiconductor materials that generate a flow of electricity when sunlight shines on them. A PV system consists of all the equipment and materials needed to generate solar energy, including solar modules, a support structure, wiring, an inverter, a meter and other equipment as required by a specific application.

Although the production of solar panels incorporates a high-tech manufacturing process, it is really very easy to use a photovoltaic system. Solar panels have no moving parts to wear out; they can be used alone or in combination with other energy sources; and they are silent, reliable and long lasting. A properly designed photovoltaic system can supply electricity for many applications — from small remote lighting needs to megawatts of power for large utility companies. An advantage of photovoltaic power is that it can do anything a traditional power generator can do without ongoing fuel requirements, pollution or noisy motors.

A 1-kilowatt PV system* each month:

- prevents 150 pounds of coal from being mined;
- prevents 300 pounds of CO₂ from entering the atmosphere;
- keeps 105 gallons of water from being consumed; and
- keeps NO and SO₂ from being released into the environment.

* in Colorado, or an equivalent system that produces 150 kWh per month.

— *Solar Energy International*

North Carolina renewable-energy tax credits

North Carolina's renewable-energy tax credits were revised in 1999. The new statute provides for an expanded tax credit of 35 percent of the cost of renewable-energy properly constructed, purchased or leased by a taxpayer and placed into service in North Carolina during the taxable year. The credit is subject to various ceilings depending on sector and the type of renewable-energy technology implemented.

Credit limits for the various technologies and sectors are as follows: up to \$10,500 for residential photovoltaic or solar electric systems; up to \$3,500 for residential passive and active solar space heating systems; up to \$1,400 for solar-water-heating systems; and up to \$250,000 for all solar, wind, hydro and biomass applications on commercial and industrial facilities, including photovoltaic, daylighting, solar-hot-water and space-heating technologies.

Renewable-energy-equipment costs eligible for the tax credit include the cost of the equipment and associated design, construction and installation costs — less any discounts, rebates, advertising, installation assistance credits, name-referral allowances or other similar reductions.

For more information on solar applications — or if you have an existing solar system — please visit the MSRI link at www.wncgbc.org.

BRIDGING THE GAP BETWEEN SOLAR AND HEALTHY-HOME DESIGN METHODS

by Cindy Meehan-Patton

Answering the question “Why am I choosing to build green?” is an important detail to consider in the conceptual design or renovation plan of your home. This seems to be an easier question to ask than it is to answer; it involves prioritizing the needs of you and your family, which can be difficult when it comes to implementing as many green-building methods as possible.

Not all green-building methods are compatible, so prioritizing at the beginning of the process is essential. The focus of this article is the potential incompatibility of solar and healthy home methods. While solar design usually requires the most energy-efficient strategies possible, this is only part of the focus for a healthy-home design.

For an allergy-sensitive individual, the priority for building green is usually healthy-home methods. For a less sensitive and more energy-conscious individual, the priority is usually solar-design methods. What about the individual who wants to address both issues? Can the differences between these two building strategies be bridged?

Let's compare a couple of ways that they conflict:

- A successful solar design requires the use of gas appliances and mechanical systems instead of electric, to maximize efficiency and keep the kilowatt load down (especially for photovoltaic systems.) Gas use is discouraged for a couple of reasons. The first is exhaust from combustion-related problems; the second is the smell of the gas or propane. These two fuels in their raw form (prior to resale) do not have the peculiar odor you smell when they are used in your home. The odor comes from a pesticide additive, which is supposed to warn you if there is a leak.

I am currently investigating the possibility of using a natural, nontoxic alternative, such as eucalyptus, as a warning smell. If possible, the use of gas appliances would be less hazardous to your health.

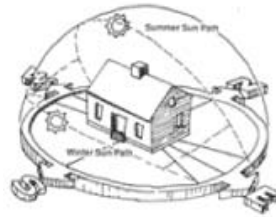
To minimize any negative effects, combustion appliances (including gas stoves) should be properly and directly vented to the outdoors, and inspected annually by a professional.

- Solar design often relies on natural ventilation (opening of windows) rather than air conditioning (controlled temperature and humidity) for the same reasons as stated above — air-conditioning systems create a large kilowatt load. Western North Carolina is a temperate rain forest. We are located in the extreme moisture belt, where high-humidity days are just as common as low-humidity days.

High-humidity air travels differently than low-humidity (dry) air. Humid air, when traveling through a wall or window, is heavy and slow flowing. It travels to the nearest porous material and nestles in there like a sponge, due to its high moisture content. Using a whole-house fan, which circulates outside air throughout the house, is not the most viable strategy for ventilation in high-humidity climates.

If your windows are open on a typical spring, summer or

early fall day when the outdoor humidity is above 60 percent, then the air in your home will also be above 60 percent. As that slow air travels to the nearest building material (drywall, fabric and carpet, just to name a few), mold spores can be created. For the allergy-sensitive person, this is a serious health hazard.



Solar orientation.

Mechanical ventilation, used in healthy-home design, is the lungs of your home. It “breathes in” the “fresh” outdoor air needed to keep oxygen and CO₂ levels balanced in a tightly constructed design. It begins by filtering the air — and in more advanced systems, dehumidifying the air before it is sent into the indoor environment. It also creates a comfortable indoor environment without your

having to open the windows (to let in the not-so-fresh air). This system, along with air conditioning, is a vital component to creating a mold-, moisture- and toxin-free home in Western North Carolina. The use of natural ventilation in this area creates a breeding ground for mold and moisture.

These two conflicts do not prohibit a healthy-home design from being energy efficient in any way. There are “super-efficient” mechanical ventilation systems on the market (www.thermastor.com, and www.venmar-ventilation.com) to bridge this gap. As a matter of fact, there are super-efficient electric appliances for almost every need in the home. One air-conditioning system used in solar-home design is a ductless system known as Mr. Slim (www.mini-split.com) by Mitsubishi. This system could also be applicable to healthy-home design if you are choosing to use radiant floor heat rather than ducted HVAC systems. Radiant heat can be energy efficient, is used in solar design, and is a healthy alternative to forced air, which has a tendency to aggravate upper respiratory conditions when ductwork is not properly installed or maintained.

In conclusion, bridging the differences between these two green-building methods can be done if the following steps are taken:

- Prioritize you and your family's needs.
- Work with a “green team,” with experts who specialize in both methods.
- Be willing to compromise — choose methods and materials that are energy efficient, but that do not negatively affect the indoor-air quality.

Resources

Some resources on energy-efficient appliances, solar design and healthy-home design are as follows (please refer to the Listings and Resources sections of the Directory for more):

- www.shelterecology.com (local business offering healthy home design consultations and products).
- www.advancedenergy.com (regional business offering educational and consultation services on healthy home-design and energy-efficient design (and renovations)).



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GREEN BUILDING OVERVIEW

The growth and development of our cities and communities have a major impact on our environment. How and where we build is one of the most important factors in our future health and happiness. The manufacturing, design, construction and operation of the buildings we live and work in are largely responsible for the consumption of many of our resources. Certain design and construction techniques can be used to considerably reduce these effects of development. Green building is a broad term for the design and construction of energy-and-resource efficient, durable, and healthy buildings that minimize their impact on the environment.

Green buildings include:

- Least-toxic, renewable, recycled building materials
- Energy efficiency, renewable energy and lower operational costs
- Resource efficiency, reduced construction waste and water conservation
- Durability, quality construction and low maintenance
- Healthy indoor environment
- Sustainable landscape, protection of ecosystems, native plants and drought-resistant landscaping.

The Council estimates that the building industry consumes more than 60 percent of the natural resources and is responsible for more than half of the waste produced in the United States each year. The operations of residential and commercial buildings consume one-third of all energy used in the United States. A properly designed and constructed green-built home will use 30 to 60 percent less energy to operate than the conventional home and requires fewer resources in the building process. Green-building techniques must be an integral part of the overall design and construction process. Varying factors that influence the process should be taken into consideration including local, regional and global environmental issues; functional requirements; existing site conditions; and availability of resources. Priorities should be established to help determine which strategies will be most effective in reducing the building's overall environmental impact. A systematic approach that incorporates these factors into the entire decision-making process not only allows for a more environmentally conscious building and landscape, but also a more environmentally conscious way of living.

What is sustainability?

The term "sustainable" is used with great enthusiasm these days. A general definition of sustainability is: a process that can be continued indefinitely without degrading the environment. Sustainability encompasses a broad range of factors including cultural, environmental and economic issues.



CHECKLIST FOR ENVIRONMENTALLY RESPONSIBLE DESIGN AND CONSTRUCTION

Design

- **Smaller is better:** Optimize use of interior space through careful design so that the overall building size —and resource use in constructing and operating it — are kept to a minimum.
- **Design an energy-efficient building:** Use high levels of insulation, high-performance windows and tight construction. In Southern climates, choose glazings with low solar heat gain.
- **Design buildings to use renewable energy:** Passive solar heating, daylighting and natural cooling can be incorporated cost-effectively into most buildings. Also consider solar water heating and photovoltaics —or design buildings for future solar installations.
- **Optimize material use:** Minimize waste by designing for standard ceiling heights and building dimensions. Avoid waste from structural over-design (use optimum-value engineering/advanced framing). Simplify building geometry.
- **Design water-efficient, low-maintenance landscaping:** Conventional lawns have a high impact because of water use, pesticide use, and pollution generated from mowing. Landscape with drought-resistant native plants and perennial groundcovers.
- **Make it easy for occupants to recycle waste:** Make provisions for storage and processing of recyclables — recycling bins near the kitchen, undersink compost receptacles, and the like.
- **Look into the feasibility of graywater:** Water from sinks, showers, or clothes washers (graywater) can be recycled for irrigation in some areas. If current codes prevent graywater recycling, consider designing the plumbing for easy future adaptation.
- **Design for durability:** To spread the environmental impacts of building over as long a period as possible, the structure must be durable. A building with a durable style ("timeless architecture") will be more likely to realize a long life.
- **Design for future reuse and adaptability:** Make the structure adaptable to other uses, and choose materials and components that can be reused or recycled.
- **Avoid potential health hazards — radon, mold, pesticides:** Follow recommended practices to minimize radon entry into the building and provide for future mitigation if necessary. Provide detailing to avoid moisture problems, which could cause mold and mildew growth. Design insect-resistant detailing to minimize pesticide use.

Land use and site issues

- **Renovate older buildings:** Conscientiously renovating existing buildings is the most sustainable construction.

- www.homeenergypartners.com (local service offering healthy-home renovation services and HERS energy ratings).
- www.hhinst.com (healthy-home books by John and Lynn Marie Bower).
- www.cmhc.schl.gc.ca (Healthy Housing Renovation Planner)
- www.epa.gov (US EPA indoor air division).
- www.press.jhu.edu (*My House Is Killing Me!* by Jeffrey C. May).
- www.newsociety.com (*The Sick House Survival Guide*, by Angela Hobbs).
- www.chelseagreen.com (*Consumer Guide to Home Energy Savings*, 7th Edition, by Alex Wilson, Jennifer Thorne and John Morrill).
- www.dsireusa.org (DSIRE — Database of State Incentives for Renewable Energy).
- www.eeba.org (EEBA Builder's Guide Series).
- www.aspenpublishers.com (*Energy Design Update*, magazine on residential, energy-efficient design and construction).
- www.fsec.ucf.edu (Florida Solar Energy Center, with some of the leading research on energy conservation and comfort in hot, humid climates).
- www.jxj.com (*Solar Energy House*, 2nd edition, by International Energy Association. Book outlines 15 experimental houses in a variety of climates).

Cindy Meehan-Patton is with Shelter Ecology, Inc. and serves as the WNC Green Building Council's secretary.

WNC FORESTS AND CERTIFICATION

by Katie Goslee

One of the greatest challenges facing forest conservation in the Southeast is private forest stewardship. In this region that is home to the greatest diversity of trees and aquatic species in the United States, nearly all of the forestland is privately owned. Individuals and families, rather than corporations, own well over half of these private holdings, and the vast majority of these landowners hold tracts smaller than 50 acres. These family forests offer tremendous opportunity for safeguarding one of the world's centers of biodiversity, while also producing natural resources and building the economic capacity of communities closest to the forest.

The communities of Western North Carolina have long relied on their forests for a host of reasons: timber and other valuable products, recreation, cultural heritage, wildlife habitat and many others. Throughout the mountains there are numerous local logging operations, sawmills and craftspeople that depend on the local wood supply and wood-products industry. In addition to these, there are many foresters and natural-resource professionals who depend on forests for their livelihood, while at the same time working to promote responsible management practices for forested ecosystems.

However, sustainable management of forests has to compete with large-scale industrial forest-management practices, which often trade sustainability for short-term-profit gain. Many landowners, resource managers and wood processors in Western North Carolina are already making an effort to



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conserve forests and communities in the area — supporting these people and businesses and encouraging others to join them are critical to the long-term health of the forests.

One method of support and encouragement that has great possibility in this area is a regional forest-certification system. Forest certification is similar in principle to organic agriculture. Standards are set that identify sound forest-management practices, including ecological, economic and social aspects. Forests and/or forest managers are assessed based on these standards, and are certified if all standards are met. Comprehensive certification systems also track forest products after timber is harvested, and as it is processed into an end product such as lumber or flooring. Such a system creates incentives for sound forest management, and provides consumers with the knowledge that they are supporting good management and, ultimately, forest conservation.

In supporting a healthy rural economy that can afford to conserve its resources, it is critical to support the region's resources and products. Therefore, a regional forest-certification system also incorporates the geographic origin of forest products. The most straightforward method of achieving regional recognition is by creating a label or brand that companies can join, indicating the regional origin of products. Promotion of such a label builds name recognition and leads to a greater understanding of the value of local products. The most valuable regional programs combine such a regional label with accepted standards for sustainable forest management.

Many systems of forest certification currently exist. The best-known and most stringent of these standards are those created by the Forest Stewardship Council (FSC). Because FSC's standards are already established and well-recognized, they can be endorsed immediately for use in a regional effort, and they can provide legitimacy to the monitoring of forest management. For individual landowners with small holdings, however, FSC certification can be costly. An alternate possibility is group certification, which allows many landowners to operate under one certificate, which is held by a resource manager or overseeing organization. This can increase the affordability of certification and expand the amount of land that is certified.

There are a number of communities throughout the United States that have discovered a similar need to support regional and sustainable forest management and responded with a similar solution of regional certification. These efforts have had varying levels of success and provide a wonderful source of



Forest certification can reward sound management and provide "green" forest products to consumers. *Courtesy of Chris Schnepf, Forestry Images.*

information and ideas. Because of the current widespread interest in such efforts both locally and nationally, this is a good time for WNC to make a strong, concerted effort to realize certification in this region; regional group certification offers a good way to coordinate existing, but somewhat disjointed efforts, in WNC. The primary focus of such an idea must be to provide incentives for improved forest management, to reward existing good management, to tap into new markets and to support the local economy through the creation of value-added products. Forest certification can recognize and reward sound management and provide green forest products to consumers.

Both the regional label and the certification process must include the appropriate links in the value-chain in order to be fully successful. There must be participants representing the land base, as well as an end market, plus every component involved in the process of moving wood products from the land base to the end market. This includes foresters, loggers, transporters, processors and distributors. It is also critical that each participant from every step in this value-chain must support the concepts of sound management and regional wood production, and must be willing to convey the importance of these objectives.

Examples of regional efforts

As mentioned earlier, there are many other organizations that have undertaken similar efforts throughout the United States and in Canada. These can serve as case studies to help determine what might and might not work for certification and a regional label in Western

North Carolina. The efforts include: the Sustainable Woods Cooperative in Wisconsin; Vermont Family Forests; the Resident's Committee to Protect the Adirondacks; the Community Forestry Resource Center in Minnesota; Value Missouri; Sustainable Northwest's Healthy Forests Healthy Communities in Oregon; and the Eastern Ontario Model Forest. All of these operate in different ways, although all are certified under the Forest Stewardship Council.

Below is a brief description of some of these organizations' certification programs:

- **Vermont Family Forests** provides educational materials and events to a network of landowners with an interest in ecological forest management. In addition, those members of the network that wish to sell forest products can be certified under the FSC-certified Family Forests® brand.
- **Resident's Committee to Protect the Adirondacks** is accredited as a Smartwood Resource Manager. RCPA has a forester who oversees the certification program, recommends



A hickory forest. Image courtesy of David Moorhead, Forestry Images.

private consultants to landowners, and works with landowners and their consulting foresters to ensure FSC compliance on participating lands.

- **The Community Forestry Resource Center** has developed and piloted an “umbrella certification system” as a way to help private landowners overcome some of the barriers of FSC certification. The umbrella certification allows the program to hold an FSC certificate and certify individual private-woodland owners who utilize responsible forestry-management practices.

- **Value Missouri** involves a certified-landowner-management program and chain-of-custody certification that includes loggers known to do good work in the woods, and processing plants that are willing to do the record keeping, and who want to market certified products. One of the major landowners in the program, Pioneer Forest, has also been certified through FSC, and Value Missouri is now working towards FSC chain-of-custody certification, and certification for individual landowners.

Nearly every house that is built contains wood as at least part of its structure. In fact, nearly 90 percent of houses are built on wood frames. This means that any building has an impact on forests, and usually on Southern forests, because 60 percent of timber harvests in the United States occur in the Southeast. Combined with the growing rate at which new houses are built in WNC, this provides a unique opportunity for green-building methods to help improve the management and condition of Southeastern forests.

For more info

For more information about FSC certification, visit www.smartwood.org, or www.fscus.org. For more information about WNC regional certification, call Appalachian Voices at (828) 262-1500.

Katie Goslee is with Appalachian Voices.

WATER EFFICIENCY IN THE HOME

by Terry Albrecht

The average American uses 69 gallons of water per day. Typical water consumption in the home comes from: toilets, clothes washers, showers, faucets (kitchen and bathroom), leaks, baths and dishwashers. Outdoor-water use can account for a sizable percentage of overall water use, depending on landscaping practices and lot size.

Almost all of the plumbing fixtures that one finds on the market today are already water efficient. The Energy Policy Act of 1992 established water-efficiency standards for a number of plumbing devices.

These standards have been in full effect since 1997. The American Waste Works Association estimates that the nationwide saving of 6.5 billion gallons of water per day will be achieved by the year 2025 through the application of these standards.

Going “beyond the code”

For new construction and renovations, these plumbing standards offer substantial water- and utility-cost savings over pre-1994 plumbing standards.

Additional “beyond-the-code” savings can be made via lower-flow faucets, showerhead, dishwashers and clothes washers, and through improved landscaping practices. Bathroom lavatory faucets can perform well in the 1.0-1.5 gallon per minute (gpm) range, which is well below the current 2.5 gpm standard. Faucet aerators can be installed simply and very inexpensively — for less than \$5-\$10.

Showerheads are available in flow rates down to 1.5 gpm, but should be tested for performance satisfaction. Appliances can consume approximately one quarter of your entire home-water use. Carefully review water-use information when buying new clothes washers and dishwashers. New high-efficiency clothes washers will use an average of 30 percent less water and 40-50 percent less energy than others on the market.

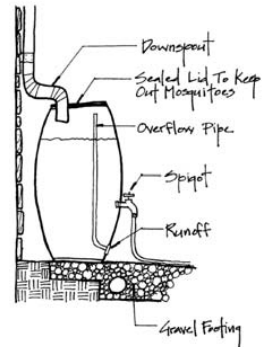
Much water savings can be achieved through behavioral changes — “the way we use water,” and maintenance. Consider the water-saving tips listed below:

Check for leaks

Studies show that dripping faucets and leaking toilets account for as much as 14 percent of all indoor-water use, equivalent to 10 gallons per person of water lost per day. Use your water meter to check for leaks in your home. Start by turning off all faucets and water-using appliances and make sure no one uses water during the testing period. Take a reading on your water meter, wait for about 30 minutes, then take a second reading. If the dial has moved, you have a leak.

Toilets

Older toilets (installed prior to 1994) use 3.5 to 7 gallons of



Rain barrels or cisterns can be used to collect rainwater from the roof and then irrigate the landscape using a drip-irrigation system.

water per flush, and as much as 20 gallons per person per day. Replacing an old toilet with a new model can save the typical household 7,900 to 21,700 gallons of water per year, cutting both your water and wastewater bills.

- Install an ultra-low-flow toilet that requires only 1.6 gallons per flush.
- To ensure optimal performance, when installing a low-flow toilet in areas with a low-drainage gradient (such as basements), consider a pressurized model.
- Check toilets periodically for leaks and repair them promptly. Check toilets for leaks by placing a few drops of food coloring in the tank. If after 15 minutes the dye shows up in the bowl, the toilet has a leak. Leaky toilets can usually be repaired inexpensively by replacing the flapper.
- Reduce the amount of water used by an older toilet by placing a 1-gallon plastic jug of water, or two 1-quart bottles, in the tank to displace toilet flows. Or you can install a “dam” that partitions off a section of the tank so it can’t fill with water. These methods can save more than 1,000 gallons of water per person per year.
- Don’t use the toilet as a trash can.

Showers and faucets

- Take a quick shower rather than a bath and save an average of 20 gallons of water.
- Install a water-efficient showerhead with a flow rate of less than 2.5 gallons per minute. (Replace an existing showerhead if a 1-gallon bucket placed under the flow takes less than 20 seconds to fill.)
- Install aerators on your kitchen and bathroom faucets to reduce indoor-water use by as much as 4 percent.
- Turn off the water when brushing your teeth or shaving and save more than 5 gallons per day.
- Clean vegetables in a sink or pan partially filled with water, rather than running water from the tap.
- Re-use the water that vegetables are washed in for watering houseplants, or for cleaning.
- If you wash dishes by hand, rinse them in a sink partially filled with clean water instead of under running water.
- Instead of waiting for tap water to get cold enough for drinking, keep a bottle of water in the refrigerator.
- Whenever possible, compost food scraps or dispose of them in the garbage, rather than in a garbage disposal.

Major appliances

Clothes washers can use as much as 30-35 gallons of water per cycle and dishwashers as much as 25 gallons per cycle. A full dishwasher is more water-efficient than washing the same load by hand. Energy-efficient appliances are usually water-efficient too.

- Only run your dishwasher when it is full, to make the best use of water, energy and detergent.
- Cut down on the amount of rinsing you do before loading the dishwasher. Most modern dishwashers do an excellent job of cleaning dishes, pots and pans all by themselves.
- When purchasing a new appliance, look for one offering several different cycles. This will allow you to select more energy- and water-efficient cycles when heavy-duty cleaning is not required.
- Wait till you have a full load of laundry before running the

clothes washer to save both water and energy. If you can’t wait for a full load, use the right water level to match the size of the load.

Other opportunities

- Insulate your hot-water pipes and your electric water heater. Insulation will reduce the amount of time it takes for hot water to reach the tap, saving water and energy.
- If in the market for a new water softener, consider one with a “hardness sensor” that will automatically trigger regeneration as needed. This type of softener will make the most efficient use of both water and salt.

Landscaping

Landscaping accounts for 20-50 percent of all residential water use, and provides the best opportunity for water conservation at home. (See article “Creating a Sustainable Residential Landscape” for xeriscaping and rainwater-harvesting ideas that can reduce water use.)

Graywater reuse

“Graywater” is the term for bathing, dishwashing and laundry water than that goes down the drain. More than half of your indoor water use is “graywater,” and this water can be reused for outdoor landscaping purposes where allowed by local building codes. Graywater systems can help reduce water and sewer costs while helping you to “drought-proof” your landscape during times of water-use restrictions. Graywater systems are designed in conjunction with landscaping watering installations such as subsurface leach fields or subsurface drip irrigation. Typical system components include: plumbing (dedicated pipes and valves that bring graywater out of the house); a surge tank (to temporarily hold large drain flow for bathtubs and washing machines); a filter (to remove particles that could clog the irrigation system); a pump (to move water from surge tank to the irrigation field); and the irrigation system (to deliver the water to plants).

Sources:

- Residential Water Use Summary*, WaterWiser/AWWA, 1999.
- A Consumer’s Guide to Water Conservation*, AWWA, 1993
- A Consumer’s Guide to Water Conservation — Video*, AWWA, 1999.
- Layperson’s Guide to Water Conservation*, Water Education Foundation, 1990.
- California Water Service Group, 1998-99.
- Residential End Uses of Water*, AWWA Research Foundation/AWWA, 1999.
- Water Efficiency Manual for Commercial, Industrial, and Institutional Facility*, 1998, NCDENR.
- Graywater Guide*, 1994, Dept of Water Resources, Calif.
- Texas Guide to Rainwater Harvesting*, 1997 Texas Water Development Board, www.twdb.state.tx.us/assistance/conservation/Rain.htm.

For more info

For more information, see: www.dpla.water.ca.gov/urban/land/graywater_guide_book.pdf
For more Internet resources, see: www.waterwiser.org and www.p2pays.org

Terry Albrecht is with Waste Reduction Partners and serves as a WNC Green Building Council board member.



CHECKLIST

WATER-CONSERVATION CHECKLIST

Indoors

- **Repair leaks.** Carefully examine plumbing for dripping faucets, toilets that continue running, and leaky pipes. The building's water meter (if there is one) can be used to identify leaks — take readings before and after a two-hour period when no water is being used (there should be no change). On well-water systems, a frequently running pump is a sign that there may be a leak in the system. Repair any leaks or faulty fixtures.
- **Replace toilets.** Replace older toilets with new, 1.6 gpf (6-liter) models. Highest priority should be those toilets that are used the most, or that leak. Less effective, but better than nothing, is installing toilet dams or displacement devices (usually plastic jugs filled with water) in the tank to reduce the flush volume.
- **Install low-flow showerheads.** Replace existing showerheads with low-flow models. Models that permit the users to reduce the flow without changing the hot-cold mix allow even greater savings.
- **Add low-flow faucet aerators.** Flow-restricting faucet aerators providing 2.5 gpm (9.5 lpm) are appropriate for kitchens; models providing 1.0 gpm (3.8 lpm) usually suffice in bathrooms.
- **Install water-conserving clothes washers and dishwashers.** Purchase state-of-the-art clothes washers and dishwashers. The best clothes washers are front-loading (horizontal-axis). Water-conserving dishwashers have advanced circuitry that determines the water use based on how soiled the dishes are.
- **Avoid in-sink garbage disposals.** Kitchen-sink garbage disposals require a lot of water to operate, and they overload sewage-treatment plants or in-ground septic systems with organic matter.
- **Insulate water pipes.** By insulating hot water pipes, water in the pipes will stay warm longer between uses; the user won't have to run water as long to get hot water, and waste will be reduced. A device to cycle water back to the water heater during warm-up will even more effectively reduce this waste (see EBN Vol. 4, No. 2). Avoid systems that circulate water continuously to keep hot water at the tap — these waste a lot of energy.
- **Reduce water pressure.** If a building has water pressure in excess of 60 psi (414 kPa), it may make sense to reduce that pressure to 40-50 psi (276-345 kPa) to lessen the likelihood of leaks. Pressure-reducing valves can be installed on individual buildings, or the municipality can be approached about lowering the pressure over a larger area.
- **Plumb buildings for graywater separation.** Even if local building codes do not yet permit graywater separation and use, it makes sense to plumb wastewater lines so that a graywater system can later be added easily (see EBN Vol. 4, No. 2).
- **Consider rainwater harvesting.** Rainwater-collection systems for potable water make sense in some locations and situations. Careful roof-wash, filtration and purification sys-

tems are required to ensure safe drinking water (see EBN Vol. 6, No. 5).

- **Consider dual plumbing for water reuse.** In certain buildings, it may make sense to provide dual plumbing so that recovered water can be used for toilet flushing. California now promotes this practice.
- **Design more efficient evaporative-cooling systems.** In commercial and industrial buildings, evaporative-cooling towers can use significant amounts of water through evaporation and blowdown (in which some of the recirculating water is flushed to get rid of dissolved solids). More water-efficient systems are available.
- **Educate building occupants.** Provide homeowners or commercial-building occupants with information about water conservation. Include specific information on how to use appliances and plumbing fixtures for maximum water savings. Behavioral changes can dramatically reduce water use in buildings.

Outdoors

- **Minimize lawn area.** Lawns are not only excessive water consumers, but they also often require significant use of fertilizers and pesticides, and mowing generates air pollution.
- **Plant climate-appropriate turf grass.** For areas that are planted to lawn, choose a variety of grass that is well adapted to your climate. In hot, arid areas, the native buffalo grass (*Buchloë dactyloides*) is a good choice. Avoid overfertilizing.
- **Use xeriscaping practices.** Xeriscaping (use of drought-tolerant, low-water-demand plants; mulching; and other practices to reduce water use) can dramatically reduce irrigation needs outdoors.
- **Avoid watering pavement.** Make sure that sprinkler systems (if used) are designed and positioned properly to put the water only where it is needed.
- **Install water-efficient watering systems.** When landscape irrigation is needed, install the most water-efficient systems possible. Micro-irrigation, drip-irrigation and soaker hoses are examples of more efficient systems. Sprinklers should be timed for early morning and evening operation, when evaporation rates will be the lowest.
- **Ensure that automated-irrigation systems will be checked regularly.** If installing timers, or a more sophisticated automatic irrigation system, install a rain-sensor device or switch that will override the watering system when there is adequate rainfall. Check automated-irrigation controls regularly.
- **With pools, install water-conserving filters.** Backflushing with a conventional swimming-pool filter can consume 180 to 250 gallons (680-950 l) of water. Some newer filters require much less water.
- **Use graywater for landscape irrigation.** If local building codes allow it, use graywater for below-ground landscape irrigation (see EBN Vol. 4, No. 2). This will reduce the amount of potable water used for irrigation.
- **Use collected rainwater for landscape irrigation.** Very simple rainwater-harvesting systems work very well for landscape irrigation. This application can be cost effective even if a full-scale rainwater system for potable water is not.

WATER CONSERVATION IS IMPORTANT BECAUSE ...

It preserves and protects our natural resources.

Conserving water can help preserve our natural resources. Conserving water means more water is available to serve additional water needs, as well as for wildlife and recreation. Water-conservation practices can result in lower wastewater discharges, which can mean an improvement in overall water quality. Conserving water diminishes our need to find or build new water sources, leaving them in reserve for our possible later use.

It saves money for you and your community.

Conserving water reduces the amount of money you spend each month for household water use. Your community saves the money spent pumping and treating water before and after use, plus conservation can delay expenditures for additional water sources and treatment facilities.

It ensures the reliability of your water supply.

Water conservation can positively affect the reliability of your water supplies during periods of high demand (such as the summer months) and during droughts. Communities should implement a water-conservation program that discourages wasteful water use at all times, and that restricts nonessential water uses during droughts, when such a program can enable a community to respond to water shortages early, thus avoiding the need for more extreme measures later.

CREATING A SUSTAINABLE RESIDENTIAL LANDSCAPE

by David Tuch

It's relatively easy to create an environmentally friendly landscape. By following all — or even a few — of the following five steps of sustainable design, the homeowner can make a difference by creating a landscape that improves water quality, lowers energy and resource consumption, reduces waste, provides wildlife habitat and produces food.

Step 1: Use native plants

Native plants are those that naturally occur in an area and have not been introduced through human actions since settlement. The Southern Appalachian Mountains region contains a diversity of native-plant species, which are some of the most beautiful native plants found throughout the entire country.

The benefits of landscaping with native plants are as follows:

- Provides habitat for wildlife.
- Requires less water usage once established.
- Helps lower maintenance costs.
- Does not require application of fertilizers once established.
- Provides a "sense of place" and inspires a sense of pride in the Southern Appalachian Mountains community.

Step 2: Reduce the amount of lawn

There are many alternatives to using or reducing the amount of lawn in the home landscape, such as creating a wildflower

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meadow for a sunny location, or a woodland garden for a shady location. As desirable as some lawns may appear, they tend to be very resource- and energy-consuming.

The benefits of shrinking the amount of lawn are in reducing:

- Air pollution — due to the reduced use of power mowers for maintenance.
- Runoff from pesticides and fertilizers that are typically used to keep the lawn clean and green.
- Water usage (lawns often require supplemental watering).
- Yard waste (lawn clippings).

Step 3: Provide wildlife habitat

By reducing the amount of lawn and using native plants, the landscape is already more hospitable to wildlife. Keep in mind that wildlife has four basic needs: food, water, shelter, and places to reproduce and rear young.

To attract wildlife into your landscape:

- Provide a water feature, such as a pond or bog garden.
- Plant native plants with wildlife value (such as plants with berries, nectar-producing flowers or plants that provide materials for nesting and shelter).
- Provide protective cover (include trees to create overlapping canopies, densely branched shrubs, fallen trees, brush piles, evergreens and/or a wildflower meadow).
- Plant in masses and create “shrub islands” and/or “tree thickets.”

Step 4: Provide for the three “Rs”

The three “Rs” — reduce, reuse and recycle — is a basic concept of sustainable residential design. Water harvesting and recycling can provide drinking water and water for irrigation. “Graywater” from washing machines, dishwashers and kitchen sinks can be collected to use in the garden while rainwater collected from the roof can provide additional sources of water for irrigation, as well as drinking water (if properly filtered). Any residential landscape striving to become a sustainable landscape should include:

- A compost bin to compost plant residuals and leaves.
- Recycling bins to recycle household waste.
- Rain barrels or cisterns to collect rainwater.

Step 5: Site plants to help conserve energy

Energy-conscious design can reduce the consumption of potentially limited natural resources, reduce heating and

cooling costs, and create comfortable environments that are buffered against harsh weather. Plants can be placed so as to allow the maximum amount of sunlight to reach the house in the winter and screen the house from the sun during the summer. Plants can also be used to block winter winds or funnel cool summer breezes toward the house.

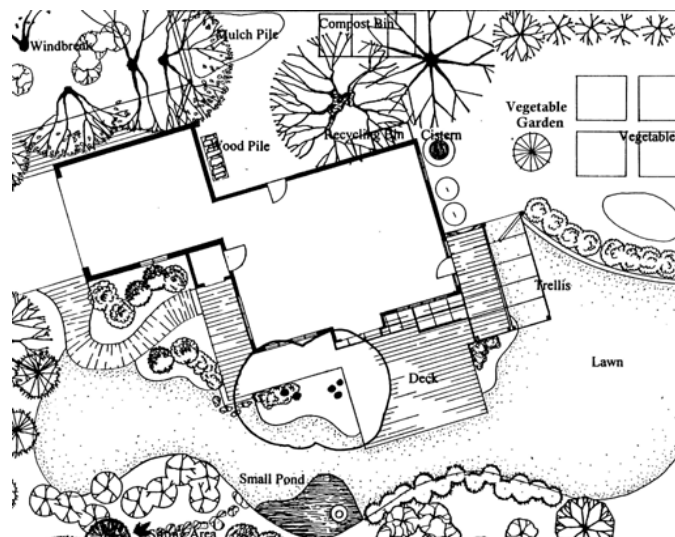
Solar use:

- Placing large deciduous trees close to the south- and southwest-facing sides of the house can block up to 96 percent of the hot summer sun’s direct rays.
- During winter, the same deciduous trees lose their leaves, allowing approximately 50 percent of the sun’s rays through to heat the house.

Controlling airflow:

- A dense mix of evergreen and deciduous trees and shrubs placed on the north-northwest side of the house can cut winter winds roughly in half.
- Trees planted on the southwest portion of the property can be located to collect and funnel summer breezes toward the house.

David Tuch is with Equinox Environmental Consultation and Design and a member of the WNC Green Building Council.



Note the massing of trees and shrubs to improve wildlife shelter. The meadow serves as a food source — and the pond, a water source.



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RECYCLING

by Aaron Johnstone



Reducing waste is a fundamental aspect of green building — approaching construction with the intention to create buildings that are integrated with the environment. Our ability to reduce the scale of our ecological footprint when we create our habitation is dramatically improved by making a concerted effort to eliminate wastefulness. By changing our attitudes about what constitutes waste and including resourcefulness and resource efficiency as criteria in the valuation of our building projects, it is possible to alter the conventional approach to construction that can be so wasteful. In this new context — where our impact on our environment and resources is a main consideration — recycling becomes a highly valuable approach to both reducing waste and increasing resource efficiency.

According to the North Carolina Co-Op Extension Service Web site, it is estimated that North Carolina produces nearly twice the national average of daily waste. While members of state government have shown a concern for reducing state waste production, legislation has yet to be passed that adequately addresses the issue by providing incentives and mandating certain practices for reducing and recycling what otherwise ends up in landfills within the state and further afield. While resistance to recycling is often the result of fears of incurring heavy expenses and reaping little economic benefit, there are, in fact, many economic advantages to reducing waste, and to recycling.

As landfills across the country are reaching maximum capacity and the siting of new landfills becomes a thornier issue, tipping fees for disposing of waste have increased rapidly. The ability to dramatically reduce the waste going into landfills is one of the first ways to see an economic benefit to recycling, in the form of lower waste disposal costs. As the recycling industry becomes stronger and more extensive, costs associated with recycling will also be reduced, and the means to recycle will be more widely available, resulting also in more access to recycled products. (And buying recycled products provides further demand for recycled materials, further reducing costs of recycling.) According to the N.C. Co-Op Service, 33 jobs are created for every 10,000 tons of materials recycled, as opposed to only seven jobs for the same quantity of material that goes into landfills. Obviously, this suggests that the economic impact of recycling can be far ranging, and can carry over into many sectors of the larger economy.

It is no secret that the construction industry is one of the biggest producers of waste that ends up in landfills. Yet some experts predict that nearly 90 percent of construction waste could be eliminated by reducing waste produced, and by recycling (N.C. Co-Op Ext. Web site). There are several recommendations for reducing waste and recycling in construction, as provided by the Extension Service. These include:

- Design dimensions to accommodate standard material sizes (like 4x8 sheathing) to reduce time and labor and waste in making cut-downs.
- Ask subcontractors to include cost of waste-removal in their bids, providing incentives to reduce waste.
- Leftover masonry and rubble can be crushed for use as fill, as bedding material in driveways or as an aggregate in non-structural applications.
- Gypsum drywall can be ground up for soil amendments, and for use as a lime substitute.
- Asphalt shingles can be used in paving and pothole repair.
- Glass can be recycled as fiberglass, or as a substitute for sand in paving materials.
- Scrap lumber and sawdust can be converted into mulch and compost for landscaping, animal bedding, boiler fuel, or engineered building products.

Approaching design and building with the efficient use or reuse of materials in mind is an important first step to reducing waste. Simply understanding the process of a building project from start to finish can help to create awareness of what scraps and leftovers can be reused later, and of mistakes that are caused by not realizing the next step of the project can be eliminated. This means good communication and careful planning.

By enacting a recycling program, contractors can also influence the subcontractors they do business with by encouraging — or even requiring — some joint efforts in recycling and reducing waste. Local salvage companies can be contacted to reclaim leftover materials; old doors and fixtures from demolition and remodeling (and often other usable building materials) can be salvaged, too.

Currently, there are at least three construction byproducts that can be recycled easily in Western North Carolina: cardboard, scrap metals and waste wood — all of which can be collected on-site and removed to the recycling sites for fees comparable to waste-removal charges. Concrete, drywall, and shingle recycling is being done in other parts of the state, but apparently has not yet been adopted by any businesses in Western North Carolina. Hopefully, with increased interest and action by local construction companies, these services will soon become available and economically viable here.

Aaron Johnstone is with Rare Earth Builders and serves as a WNC Green Building Council board member.

A few recycling stats ...

- Energy saved in producing from recycling: aluminum cans, 90 percent; newspaper, 40 percent; and steel, 60 percent.
- In 1999, North Carolina recycled 967,000 tons of materials, saving 5.2 trillion BTUs of energy — enough to provide the electrical needs of 113,000 households.
- Recycling steel reduces energy use by 74 percent; air pollution, 86 percent; water use, 40 percent; and mining wastes, 97 percent.
- Recycling aluminum reduces water and energy use and air pollution by 95 percent.
- The amount of waste disposed of in North Carolina increased from 6.8 million tons in 1991 to 9.2 million tons in 1999, but recycling jobs did increase 12 percent in the last 5 years.
- Without recycling, the U.S. timber harvest would have to increase 80 percent to meet demand. Paper is about 40 percent of the total waste stream in the United States.

Source: Office of Waste Reduction Web site.

RECYCLING CONTACTS

GENERAL

- **N.C. Office of Waste Reduction** - (919) 715-6522. www.p2pays.org. Markets directory for recycling construction waste. Information on recycling and grants for recycling projects also available.
- **City of Asheville** Recycling Hotline - 259-5547.
- **Buncombe County** Recycling Info - 250-5460.
- **N.C. Cooperative Extension** Service (local office) - 255-5522.
- **Asheville FreeCycle** - http://groups.yahoo.com/group/Asheville_freecycle/
e-mail: asheville_freecycle@yahoo.com. E-mail-based way to trade things you don't need for those you do, or to pass along unused items to those who will use them.

CARDBOARD

- **Curbside Management Inc.**, Asheville - 252-2532. Provides curbside recycling (residential and commercial) for the Asheville and Hendersonville area. Recycling Dumpsters will soon be available.
- **Asheville Waste Paper Co.**, Inc. - 252-6963. Paper and cardboard recycling.
- **GDS Inc.**, Asheville - 253-3929. Recycling Dumpster rental and removal, including scrap metals.
- **Waste Management**, Asheville - 253-5364. Recycling Dumpsters and removal, including waste wood or brush.
- **Wyatt Waste Container**, Asheville - 250-0996. Recycling Dumpster rental and removal.

METALS

- **Asheville Metal Recycling** - 350-1002. Scrap-metal recycling.
- **Biltmore Iron and Metal Co.**, Inc., Asheville - 253-9317. Recycler of scrap metals: light copper, copper, brass, aluminum, insulated copper, steel and insulated electrical wire. Scrap-metal removal available.
- **Blue Ridge Metal Recycling Inc.**, Asheville - 254-2840.
- **Western Carolina Recycling**, 1430 Riverside Dr., Woodfin - 252-1689. Scrap-metal recycling.

WOOD

- **Henson's Mulch and More, Inc.**, Asheville - 665-0200. Any size scrap, plus pallets and brush.
- **WNC Pallet and Forest Products Co., Inc.** - 667-5426. Pallet recycling.
- For more info on wood recycling, check the **N.C. Office of Waste Reduction** (www.p2pays.org).

SALVAGE

- **Asheville Architectural Salvage and Antiques** - 281-2600.
- **Greene's Building Supply and Salvage**, Asheville - 255-0325. New materials that are leftover — mainly doors, windows, cabinets.
- **Preservation Hall**, Weaverville - 645-1047. Architectural salvage: doors, windows, lighting and plumbing fixtures.

Source: Office of Waste Reduction Web site.



JOB-SITE WASTE CHECKLIST

Lumber

- Optimize building dimensions (e.g., wall height) to correspond to standard lumber sizes.
- Modify framing details to optimize lumber use and thus reduce waste (e.g., 3-stud corners).
- Develop detailed framing layouts to avoid waste when ordering lumber.
- Store lumber on level blocking under some type of cover to minimize warping, twisting and waste.
- Set aside lumber and plywood/OSB cutoffs that can be used later as fire blocking, spacers in header construction, etc.
- In remodeling, evaluate whether salvaging used lumber might be worthwhile — either for reuse, delivery to salvage operations or for recycling.
- Save small wood scraps to use as kindling — either for the clients, or your crew members — or for recycling if available in your area.
- Save clean sawdust for use in compost piles or around gardens. Avoid sawdust that might have been painted or treated — it should be bagged separately for disposal.

Drywall

- Order drywall in optimal dimensions to minimize cutoff waste. Take advantage of the fact that drywall sheets are available in different lengths.
- When hanging drywall, set aside larger drywall scraps for use where filler pieces are needed, e.g. in closets. Note: With drywall subcontractors, this strategy may not be feasible.
- Seal leftover drywall scraps into interior wall cavities. Be sure that this strategy will not interfere with future wiring or plumbing modifications.
- If drywall recycling is available in your area, separate drywall scraps into a separate pile or waste bin. Only new, unpainted, drywall can be recycled. Uses for recycled drywall include agricultural gypsum and absorbent material for oil-spill cleanup, as well as remanufacturing scraps into new drywall.
- Joint compound buckets can often be reused for tool or material storage, or given to clients for various around-the-house uses.

Masonry

- Clean concrete chunks, old brick, broken blocks and other masonry rubble can be buried on-site during foundation backfilling. If dumping material along the foundation, be careful not to damage exterior insulation or foundation coatings.
- Salvage usable bricks, blocks, slate shingles, tile and other masonry materials from demolition and large remodeling jobs. Either store this material for a future project, or take it to a salvage operation.

- Concrete and unusable masonry rubble can be taken to companies that crush and process it for roadbed aggregate and other uses. If this type of disposal option exists, follow the company's requirements for separation.
- Estimate masonry-material needs carefully to avoid waste.
- During construction, collect and stack bricks or other masonry materials scattered around the job-site to keep them from getting soiled or lost. Save leftover masonry materials for a future job, or return them to your supplier.

Metals and appliances

- During remodeling or demolition, separate out metal radiators, grates, piping, aluminum siding and old appliances for salvage and/or recycling.
- Talk to the clients about the idea of a tag sale or giveaway, in which old appliances and other still-usable materials are displayed on the front lawn for a period of time. Called a "stripper sale" in Canada, this can be time consuming for the building or remodeling contractor; try to have the client take responsibility for it.
- Recycle. In new construction, separate metals for delivery to, or pickup by, scrap metal dealers. Metals that can be recycled include: copper (water pipes, gas pipes or tubing, wire, flashing); aluminum (siding, flashing, gutter sections, broken ladders); iron and steel (banding from wood bundles, nails and other fasteners, galvanized flashing and roofing, rebar); and lead (chimney flashing). Recycling lead is especially important to keep it out of landfills, where it can pollute groundwater.

Cardboard and Paper

- Avoid excess packaging of building materials and supplies. At the same time, however, products and materials should be adequately protected to prevent damage and waste.
- Separate out cardboard waste on the job-site. Bundle the cardboard to permit easier storage, and deliver it to a recycling facility that accepts cardboard. On jobs where large quantities of cardboard waste are generated, some recycling facilities will make pickups.
- Recycle paper in your office, and purchase paper supplies made from recycled paper.
- Try to generate less paper waste by streamlining your plans, or reducing the quantity of information supplied to subcontractors. A study of waste generated by the construction of 1,500 new homes in the Oakland Hills following the fire there found that an average of 890 pounds of paper was produced in blueprints and documentation for each house.

Insulation

- Install leftover insulation in interior wall cavities or on top of installed attic insulation. In wall cavities, either batt or rigid insulation will provide sound control. In attics, extra insulation will further reduce heat loss.
- Expanded polystyrene insulation can be recycled in some areas for remanufacturing into new styrene products. The Association of Foam Packaging Recyclers (800-944-8448)

has member plants in more than 100 locations, though not all of these will accept EPS insulation (because of flame retardants). You can also ask at the plant where the EPS was produced.

Asphalt roofing

- Asphalt roofing materials and aggregates can be recycled into road-paving or patching material. Where they exist, asphalt-roofing-material recycling centers provide a lower-cost disposal option than landfilling.
- Leftover shingles can often be donated to nonprofit local-housing organizations, such as Habitat for Humanity — saving you the disposal cost, and helping out a good cause.

Plastic and vinyl

- Reduce plastic-packaging waste by specifying materials with less packaging. Let your supplier know your concerns about excess packaging — a few calls from volume users can make a big difference.
- With vinyl siding, flooring and countertop materials, minimize waste by ordering only as much as you need.
- Certain plastics around the job site (e.g., plastic-wrap and poly-vapor barrier) can be recycled in many communities. Check with your municipal-solid-waste office to find out what your recycling options are. Separate and store these materials separately, where they will stay relatively clean.

Paints, stains, solvents and sealants

- Find out if unused or partially empty cans of paint can be donated to local theater groups or local low-income housing agencies.
- Save leftover partial cans of paint to use as primer on the next job.
- Some municipal-solid-waste facilities accept paint and mix like types into low-cost basic-gray primer. The City of Seattle, for example, mixes its own "Seattle Gray" paint from paints dropped off for recycling.
- Those paints, stains, finishes and solvents that you cannot drop off for re-use or recycling should be taken to a hazardous-waste facility.

Miscellaneous

- Branches from trees and shrubs cleared from a building site can be chipped and the chips piled for use in landscaping. The appropriate use of woodchip walkways can reduce the area of lawn needed.
- Save worn-out NiCad (nickel-cadmium) batteries from portable power tools for delivery to a specialized battery-pickup site. The heavy metals in NiCad batteries are extremely hazardous to the environment. If there is no place in your area to take these batteries at present, hang onto them until such facilities become available.

- **Create community:** Development patterns can either inhibit or contribute to the establishment of strong communities and neighborhoods. Creation of cohesive communities should be a high priority.
- **Encourage in-fill and mixed-use development:** In-fill development that increases density is inherently better than building on undeveloped (greenfield) sites. Mixed-use development, in which residential and commercial uses are intermingled, can reduce automobile use and help to create healthy communities.
- **Minimize automobile dependence:** Locate buildings to provide access to public transportation, bicycle paths, and walking access to basic services. Commuting can also be reduced by working at home — consider home-office needs with layout and wiring.
- **Value site resources:** Early in the siting process, carry out a careful site evaluation: solar access, soils, vegetation, water resources, important natural areas, etc., and let this information guide the design.
- **Locate buildings to minimize impact:** Cluster buildings to preserve open space and wildlife corridors. Avoid especially sensitive areas including wetlands, and keep roads and service lines short. Leave the most pristine areas untouched, and build on areas that have been previously degraded. Seek to restore damaged ecosystems.
- **Provide responsible on-site water management:** Design landscapes to absorb stormwater instead of putting in storm sewers to carry it off-site. Consider rooftop water-catchment systems so that rainwater can be used for potable needs and landscape irrigation.
- **Situate buildings to benefit from existing vegetation:** Trees on the east and west sides of a building can dramatically reduce cooling loads. Hedge rows and shrubbery can block cold winter winds or help channel cool summer breezes into buildings.
- **Protect trees and topsoil during sitework:** Protect trees from construction damage by fencing off the “drip line” around them and avoiding major changes to surface grade.
- **Avoid use of pesticides and other chemicals that may leach into the groundwater:** Look into less toxic termite treatments, and keep exposed frost walls free from obstructions to discourage insects. When backfilling a foundation or grading around a house, do not bury any construction debris.
- **Buy locally produced building materials:** Transportation is costly in both energy use and pollution generation. Look for locally produced materials. Local hardwoods, for example, are preferable to tropical woods.
- **Use building products made from recycled materials:** Building products made from recycled materials reduce solid waste problems, cut energy consumption in manufacturing, and save on natural resource use. A few examples of materials with recycled content are cellulose insulation, Homasote®, Thermo-ply®, floor tile made from ground glass, and recycled plastic lumber.
- **Use salvaged building materials when possible:** Reduce landfill pressure and save natural resources by using salvaged materials: lumber, millwork, certain plumbing fixtures, and hardware, for example. Make sure these materials are safe (test for lead paint and asbestos), and don’t sacrifice energy efficiency or water efficiency by reusing old windows or toilets.
- **Seek responsible wood supplies:** Use lumber from independently certified well-managed forests. Avoid lumber products produced from old-growth timber unless they are certified. Engineered wood can be substituted for old-growth Douglas fir, for example. Don’t buy tropical hardwoods unless the seller can document that the wood comes from well-managed forests.
- **Avoid materials that will offgas pollutants:** Solvent-based finishes, adhesives, carpeting, particleboard, and many other building products release formaldehyde and volatile organic compounds (VOCs) into the air; these chemicals can affect workers’ and occupants’ health as well as contribute to smog and ground-level ozone pollution outside. Avoid materials that offgas HCFCs, such as extruded polystyrene and polyisocyanurate foam insulation.
- **Minimize use of pressure-treated lumber:** Use detailing that will prevent soil contact and rot. Where possible, use alternatives such as recycled plastic lumber. Take measures to protect workers when cutting and handling pressure-treated wood. Scraps should never be incinerated.
- **Minimize packaging waste:** Avoid excessive packaging, such as plastic-wrapped plumbing fixtures or fasteners unavailable in bulk. Tell suppliers why you are avoiding over-packaged products. (Some products must be carefully packaged to prevent damage — and resulting waste.)

Materials

- **Use durable products and materials:** Because manufacturing is very energy-intensive, a product that lasts longer or requires less maintenance usually saves energy. Durable products also contribute less to our solid waste problems.
- **Choose low-maintenance building materials:** Where possible, select building materials that require little maintenance (painting, retreatment, waterproofing, etc.), or whose maintenance will have minimal environmental impact.
- **Choose building materials with low embodied energy:** Heavily processed or manufactured products and materials are usually more energy intensive. As long as durability and performance will not be sacrificed, choose low-embodied-energy materials.

Equipment

- **Install high-efficiency heating and cooling equipment:** Well-designed high-efficiency furnaces, boilers, and air conditioners (and distribution systems) not only save building occupants money, but also produce less pollution. Install equipment with minimal risk of combustion gas spillage, such as sealed-combustion appliances.
- **Avoid ozone-depleting chemicals in mechanical equipment and insulation:** CFCs have been phased out, but their primary replacements — HCFCs — also damage the ozone layer and should be avoided where possible. Reclaim CFCs when servicing or disposing of equipment.
- **Install high-efficiency lights and appliances:** Fluorescent lighting has improved dramatically in recent years and is now suitable for homes. High-efficiency appliances offer

IS YOUR HOME A GOOD, "GREEN" INVESTMENT?

by Jerome Chambliss

New-home construction is at an all-time high. Owning a home is the single-largest investment of a person's life. But are our homes worth the investment? Are they built to last? Requiring little maintenance? Safe? Healthy? Energy efficient? Resource efficient?

These are the criteria for a "green" house, and also for a good investment. To answer these questions and to get the best home for our money, we must look at how houses are built, and what materials are used. You don't have to be an engineer or contractor to build a "green" house, but you must know your options so you can make a "green" investment, which is a good investment.

The first option is stick built. Most homes today are stick-built, either on-site or modular, but usually with wood-frame construction using wooden 2 x 4 or 2 x 6 studs. Layers of insulation and plastic vapor barriers are used to slow down the movement of hot and cold air and moisture. Layers of wooden composites like plywood, particleboard and OSB give added strength to the wooden skeleton. Finish layers of drywall, siding or brick provide protection and decoration.

The potential for small cracks and voids in walls — which can trap moisture just like layers of clothing on a cold, winter morning — is a problem with layered construction. These warm, dark, moist places provide good conditions for mold and

mildew growth. Conventional building materials can contain toxic glues, resins and pesticides that give off vapors and fumes, making people ill. Air sealing makes the house very energy efficient, but without proper ventilation, it can also trap these harmful chemicals inside, along with radon gas. Also, higher maintenance is required to prevent rot and termites from consuming a stick-built house.

One alternative is to use steel studs instead of wood. Steel is stronger than wood and resists rot and termites. While this sounds like a good idea, the problem is that the rest of the house is built the same way, with the same layers of insulation and finish materials as a wood-frame house. This means that a steel-frame house has the same potential to be as toxic and as sick as a wood-frame house and requires greater maintenance as well.

Another option is to build out of concrete cinder blocks, as is done with most commercial buildings. But, as most people know, many commercial buildings are also toxic and sick with poor indoor air quality. This is because you have to use the same layers of insulation and finish materials as with a wood-frame home. So, even though a cinder-block home would be very strong and more fire-resistant than a wood-frame home, it could still be moldy like a damp basement. Again, the potential for problems arises with the use of layers of insulation and finish materials that must cover the concrete blocks.

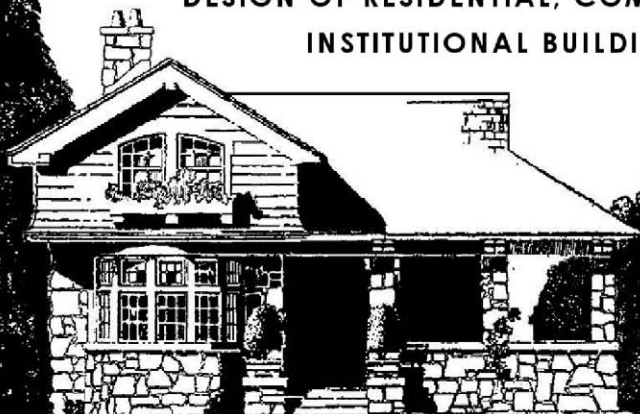
Since concrete is such a strong building material, an alternative product called insulating concrete forms (ICFs) has been developed. ICFs are large building blocks made out of foamed plastic, which is usually polystyrene. These Styrofoam blocks are stacked up, glued together, and then filled with steel rebar

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and concrete. The ICFs insulate the concrete from heat and cold. But the outside and inside surfaces must be covered to protect the insulation. The plastic foam won't rot, but termites do eat through the foam to get to the rest of the house. The concrete walls are very strong, but the foam can burn and is very toxic. ICF homes are very energy efficient, but they use layers of foam, which can have drawbacks.

A monolithic or one-piece wall without the composite layers provides a good alternative. An example would be a log home. Large-diameter wooden logs are very strong and provide good insulation without additional layers. Many people like the look of log homes, but a log home is a high-maintenance option because rot, termites and fire are a concern. Log homes, ICFs, cinder-block and steel-frame constructions can cost more than a conventional wood-frame home.

One more option is an insulated-concrete-block home. These blocks are similar to ICFs, but use foamed concrete instead of foamed plastic. Insulated concrete is produced by aerating concrete with millions of tiny air bubbles that are encapsulated inside the concrete. Insulated concrete blocks are called aerated autoclaved concrete (AAC), or cellular concrete. This means that the insulation is an integral part of the concrete, not added on as a layer. The result is a monolithic concrete wall with the insulation being part of the concrete. There are no layers to trap moisture and grow mold or mildew. This means it is easier to create a safe, healthy home with excellent indoor-air quality.

Many homes in Europe and other parts of the world use insulated concrete instead of wood stick-built. Typical new American homes are considered a waste of resources and money because they do not last long, do not take advantage of passive-solar design, and require high maintenance. The American model is built with lightweight materials that are easy to transport and quick to assemble. New American homes are considered disposable. On the other hand, insulated-concrete homes have 12-inch thick walls that will last more than a lifetime.

AAC block creates thermal mass and insulation, making it possible to design passive-solar homes that are very energy-efficient. The thick, massive walls also make for a very safe home in tornado- and hurricane-prone areas. Insulated concrete blocks covered with plaster and stucco create a very durable and low-maintenance home. Of course, concrete will not burn or be consumed by rot or termites, so insulated concrete is definitely a long-lasting material. An insulated-concrete-block home is a quality investment that does not necessarily cost more.

Since these homes are not built layer upon layer like stick-built houses, there are fewer pieces to handle during construction. This means lower transport and labor costs. The lightweight blocks are twice as large as cinder blocks, but not much heavier. Using fewer layers typically means quicker construction with lower costs. So, with the labor savings, a new home does not have to cost more even though the materials are of the highest quality. The result is a durable, low-maintenance home that is safe and healthy as well as being energy-efficient and affordable. This sounds like the recipe for a "green" home that is a good investment for a lifetime.

SUSTAINABLE DESIGN — 25 YEARS AGO AND TODAY

by William Langdon

In 1976, while I was an architect intern, The First Passive Solar Conference occurred in Albuquerque, N.M., with about 450 attendees. The Second National Passive Solar Conference was held at the University of Pennsylvania, in Philadelphia in March 1978. Those who planned the conference were astounded. The pre-registration — of mostly of young architects, researchers and builders — had filled the 2,000 slots well before the conference. Another 2,000 had been turned away by mail and told not to come, but outside the halls, there were close to 2,000 people (some from overseas) who sadly had to be turned away at the gate, because there was standing room only inside. Working independently, most of us had been on a quest for a sustainable future that had seemed to be sought by so few. There in Philadelphia in 1976, we discovered that there were thousands of others on the same journey, with the same values, and the same vision.

The fervor with which energy, buildings and the environment were examined during the 1980s has not been matched since. For the very first time, computer-modeling-and-simulation methods were developed for heat collection, storage and utilization in buildings. The modeling was derived from test data in experimental buildings with temperature probes throughout. The earlier, simple, heat-loss calculations through a building envelope were driven by how cold it is outside (temperature difference), and by wall or ceiling R-values. The new computer modeling was dynamic and studied hourly how heat would circulate in the building, and thus how it could be collected, stored and dissipated. Computer modeling and simulation allowed building energy strategies to be compared in buildings still in the design stage and fine-tuned before construction. It also allowed the development of Building Energy Performance Standards (BEPS), a performance-based energy-code standard, instead of a prescriptive code.

Today, sustainable design generates a new wave of interest and effort. The planet is in worse shape ecologically than it was 25 years ago, thus the need for sustainable design is now even greater. There are some positive signs: Some renewable-energy strategies such as photovoltaic panels have come down considerably in cost over the past 25 years. Electric-hybrid cars — though a small percentage of the total vehicles on our highways — are now a common sight. However, the total energy use per capita for this country, which dropped 14 percent between the years 1978 and 1983 (during the energy crises), has risen back to the 1978 levels.

In many of the passive-solar homes we designed between 1978 and 1983, the south facade consists partly of direct-gain windows and partly of heat-storage walls behind glass. These heat-storage walls performed very well thermally, but when it

came to detailing them, they were somewhat experimental in that there were lingering, long-term maintenance questions and concerns.

Passive-solar-heating design has many elements, and to some extent has been marginalized today, because many designs only include south-facing windows. Without heat-storage components (thermal mass), passive-solar heating can provide, at most, 30-35 percent of a home's heating requirements. With carefully designed thermal mass, passive-solar heating can provide 75 percent or more of a home's heating needs. It would be helpful to revisit some of the lessons learned from the passive-solar homes built during the early '80s.

Sustainable design promotes resource conservation in several areas, including energy efficiency, recycled building materials, embodied energy in materials, and healthy indoor-air quality. The past decade has seen great advancement in building science with regard to understanding moisture in buildings and its relationship to indoor-air quality. Beginning with the use of wall insulation in the '50s and the widespread use of mechanical cooling for homes and buildings in the South during the '60s and '70s, moisture movement through wall sections became a more climate-specific design issue. Moisture barriers with a low-to-no perm-rating (and placed in the wrong places), plus poorly located insulation or cooling ducts can cause condensation and moisture/mold problems. The moisture appearing in insulated and mechanically cooled buildings was exacerbated by tighter construction for energy-conservation in the '70s and '80s.

WNC is in the colder fringe of a "wet-mixed" climate zone. Indoor and outdoor pressure and temperature differences cause moisture movement through walls. In the winter, heat-driven moisture moves into walls from the interior; in the summer, AC dehumidification and cooling draws moisture from the exterior. To control this moisture, walls need to be detailed to prevent air infiltration, while also allowing water vapor to escape to the interior and exterior. This allows for drying, thus preventing trapped moisture from causing mold, mildew and rot. A drainage plane or surface under your siding is very beneficial on the outside — and even the type of paint or wallpaper applied to the interior surface of exterior walls can be important.

Sustainable design is continuously developing new levels of complexity. From passive-solar design in the '70s to mold and moisture control today, it is critical that the performance of previous designs is studied and improved upon. Balancing energy needs with health and environmental concerns is an ongoing challenge that sustainable design must address.

William Langdon is with Wm Langdon Architecture PA, and is a WNC Green Building Council member.

"THIS ONE IS JUUUUST RIGHT"

by David Hill

Green building: admit it, we all think of things like photovoltaic panels or trombe walls or recycled rubber flooring first — the sexy "gee whiz" stuff. Sure, that's green building, but so are the more pedestrian elements of the industry, like good flashing or caulking details.

Or right-sized mechanical equipment - which is just exactly what it sounds like - as opposed to over-sizing, which often occurs with the installation of heating, venting and air-conditioning (HVAC) equipment. Look, we specialize in green building, so a lot of our work is geared toward reducing heating and cooling demands — even eliminating the need for air-conditioning via passive-cooling techniques in the building and site design. And we also work with high-efficiency alternative systems. That's easier here in Western North Carolina than on the coast, where heat and humidity are more of an issue, but the large majority of the market just about everywhere wants (and even demands) air conditioning. If we are truly committed to making a difference with green building, we must also improve upon the existing market and consumer needs from the ground up.

Luckily, that's not as difficult as it sounds. For example, it is common to install oversized a/c units, because they provide cooling more quickly, thus avoiding any possibility of not meeting the cooling demand. It's probably our collective push as consumers that has driven some of this: Think about that beer commercial a few years ago where everyone from lingerie models to sweat-stained cabbies was cooling off in front of an



Passive cooling techniques can eliminate the need for air-conditioning.

open freezer (beer in hand, of course) during a heat wave.

However, over-sized a/c units “short cycle,” which means they run for shorter periods of time than they were engineered to do for optimum operation. The efficiency of a/c units is low when they first start and increases gradually to peak efficiency in about 10 minutes: if operating time increases from 5 minutes (a typical short cycle) to only 9 minutes, efficiency improves by 17 percent. Since a/c accounts for 15 percent of home-energy use on average, and as much as 40 percent in hot/humid regions, that adds up quickly. Utility savings is one of the ways we “sell” green building. But there are other benefits here as well, including:

- **Lower installation costs:** Right-sizing can save one-third or more on up-front costs.
- **Fewer maintenance problems:** Short cycling increases unit wear and tear.
- **Better humidity control:** Short cycling does not allow the system to effectively remove humidity.
- **Improved comfort:** Air is supplied at a lower volume over more time, providing a more gradual mix.

So how do you right-size a system? It’s not rocket science, although I suppose NASA engineers do work with right-sizing on a much grander scale. In simple terms, a qualified designer runs a load analysis on a building design to determine exact heating and cooling needs, taking into consideration the size, location, number and quality of doors and windows; the insulation in the walls, floor and roof, and the “tightness” of the construction; the building shape, configuration and N-E-S-W exposures; and finally, the activities, equipment and lighting proposed for use in the building.

You may be asking yourself another question here — why is an architect writing this? I mean, it’s our job just to make things look “pretty,” right? While I’m tempted to trot out the old “pocket-protector envy” engineer jokes, or even poke fun at my own profession with a “hey, if an architect can understand this stuff” slant, my real motivation is based in several key factors.

First, our clients appreciate the innovation, organization and aesthetic presentation we bring to a building. But the two things most users notice most immediately (and over the long term) is whether the roof leaks, and whether they are warm when they want to be and cool when they don’t. Second, our

firm’s “mission” is to bring green to the market, but we cannot do that without overcoming typical consumer misconceptions about higher cost and lower quality. Right-sizing provides the best quality possible, and even saves money up front, and in every month of operation. And third, the larger issue is the integration of all facets of design from the very beginning to achieve the greatest green return. But even larger — with right-sizing as one of our green strategies for every market — we reduce the impact on our public infrastructure and on the environment.

David Hill is with Verdi Architecture and is a WNC Green Building Council member (and does not, in fact, know how to use a slide rule). Contact him at www.verdi-se.com.

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An open freezer: Not the way to beat the heat.

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CASE STUDIES

DROVERS ROAD PRESERVE: A SUSTAINABLE CONSERVATION-BASED DEVELOPMENT

by David Tuch

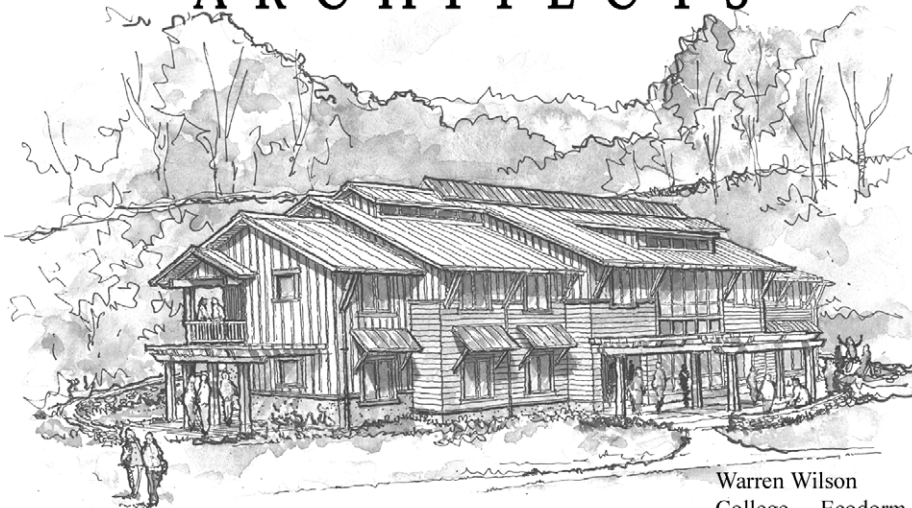
Introduction

Drovers Road Preserve is a 186-acre conservation-based, residential development in Buncombe County that is planned and designed to protect and celebrate the property's unique ecological features and historic past. A total of 23 lots have been sensitively located within the landscape in order to protect the site's resources, while also providing lots that offer meadow, woodland or mountain views. A conservation easement, which is held by Southern Appalachian Highlands Conservancy encompasses 110 acres, permanently protecting a majority of the forested, mountainous terrain from future development. This conservation easement is referred to as the Nature Preserve, and adjoins each lot, providing easy access to miles of hiking and equestrian trails.



Aerial view of the Drovers Road site.

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Planning process

Prior to the location of a single lot or the layout of any roads, a detailed site assessment and analysis was performed to identify the site's significant cultural and natural resources. The findings of the inventory provided the basis for the lands to be protected through the conservation easement. The permanently protected areas include the habitat for the rare Eastern woodrat, the Carolina hemlock bluff-plant community, four rare plants, seeps, springs, mountain streams and the ridgeline, which contains old-growth forest with 150-year-old trees. These resources were classified as the "conservation areas" that could not be developed.

The conservation areas also included buffers, which were located around all bodies of water, and the significant ecological landscape patterns found on the property. Once these areas were defined, the "buildable areas" were then located. The buildable areas include slopes of less than 20 percent, soils that would support septic systems, and portions of the property that had experienced past disturbances. Once the conservation and buildable areas were mapped, then the homesite areas, roads, trails and lots were designed.

Design elements

After the overall plan for the property was crafted, the more detailed design elements were developed. The design focuses on: (1) responding and integrating the site's ecological and cultural resources into the overall design; (2) minimizing construction impact through appropriate road design; (3) utilizing innovative stormwater management techniques; (4) recycling tree lumber and debris resulting from construction; (5) providing a blend and diversity of lot types; and (6) providing amenities designed to celebrate the property's cultural history and rustic natural beauty. The design elements and natural features at Drovers Road Preserve include:

- The Nature Preserve.
- Mountain streams and rock outcroppings.
- Nature trails.
- Treetop viewing platform.
- Picnic shelter with springhouse and restored



Chimney ruins were restored, which adds to the character of the site.

- turn-of-the-century chimney.
- Stone bridge crossings.
- Rustic pedestrian and equestrian bridge crossings.
- Landscape enhancements and restoration.
- Trailhead signs and kiosk.
- Historic markers.
- Wildflower meadow.
- Rain gardens and water quality swale.
- Horse pasture.

Design guidelines

Once the planning and design were complete, the final step was the development of design guidelines in order to convey to the public and homeowners the philosophy of the Drovers Road Preserve. The design guidelines are used to

add homeowners in maintaining the ecological integrity of the property by: (1) encouraging homesite development that creates environmental and visual harmony with the surrounding landscape and (2) incorporating time-tested, regional architectural design concepts.

The guidelines illustrate appropriate architectural styles and materials, appropriate landscape materials and design, and site-design issues, which include severe restrictions on tree removal and disturbance to each individual lot. Finally, the guidelines recommend to all homeowners the integration of green-building techniques and sustainable landscape-design principles, which promote the use of native plants, edible landscaping, solar access, and water and energy conservation.

Summary

Drovers Road Preserve is the first conservation subdivision of its kind in Buncombe County that carefully integrates and protects the natural and cultural resources of the landscape with homesite development. Through proper planning and design, it is possible to create ecologically sensitive developments that connect people with the natural environment while, at the same time, responding to the resources of an existing landscape.

David Tuch is with Equinox Environmental Consultation and Design, and is a member of the WNC Green Building Council.

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THE BONDURANT RESIDENCE

by Mark Bondurant

The modus operandi in building the Bondurant home in Canton was superior energy performance and an aesthetic leaning heavily on the beauty of minimally refined materials. The result, as always, was the sum of trade-offs.

The 2,500-square-foot home employs a passive-solar design, facing due south at the top of a mountain cove. It sits on a 45-degree westward-facing slope and steps up the slope in four levels: a root cellar, a basement bermed on the east, a main floor and a loft.

The foundation of the house below grade is Durisol, an insulating concrete form (ICF) made of chipped wastewood, mineralized and bonded with portland cement. Like the foam ICFs, the 12-inch thick Durisol block is drystacked (without mortar). Steel reinforcement is added where needed, and the cells are grouted with concrete, creating a very strong, insulated wall ready for interior and exterior finishes. Unlike the foam ICFs, Durisol cannot be tunneled by termites and doesn't burn and emit nasty gases the way expanded polystyrene does.

Above grade, 12-inch-thick, aerated, autoclaved concrete-block forms the exterior walls. The AAC block has the look of pumice — full of holes and lighter than concrete block. Like the Durisol, the insulation is built in — by virtue of the trapped air bubbles — and is interior- and exterior-finish ready.

The static R-values (insulation value) of Durisol and AAC respectively are R-21 and R-12. The substantial mass of the walls helps boost the effective R-value depending on daytime and nighttime temperatures.

In building the house, we took special care to maintain the integrity of its exterior walls or “envelope,” which is the barrier between exterior temperature and desired indoor temperature, outdoor humidity and desired indoor humidity, and outdoor noise and desired indoor calm. We ledgered floors to the exterior walls rather than setting them on top to create a more continuous envelope. Plus, we kept plumbing out of exterior walls and minimized penetrations through the envelope.

One technique that minimized penetrations was to use one fan to exhaust humid air from all bathrooms and the mechanical room. We used 4-inch thinwall PVC to duct all the rooms to the fan. When we did have to penetrate the house envelope — for windows and doors, and for plumbing and mechanical vents — we “sealed with zeal” around the penetration to minimize the entry of outdoor air and the loss of conditioned air.

The other key element of the house's envelope is the roof, which from inside out is 2 x 6 tongue-and-groove pine (which serves as the cathedral ceiling), 30-pound roofing felt, R-40 insulative panels (like an open-face sandwich of foam and a sheet of OSB plywood), 30-pound roof felt and, finally, roofing metal.



The residence takes full advantage of its sunny southern exposure.

Other features of the house's passive-solar design are an acid-stained concrete slab in the basement (which stores and slowly releases the sun's heat), and specially made windows that have a high insulating value, but still allow much of the sun's heat to pass through.

In addition to solar heating, the basement is heated with radiant tubing in the slab. The water is heated by solar collectors mounted on the roof, and by a propane boiler. The upstairs is heated with a high-efficiency wood stove.

To reduce potential toxins in the home, we installed a passive-radon mitigation system, used only non-arsenic ACQ-treated wood and ran ductwork for a whole-house air-filtering-and-dehumidification system. We're taking measurements now to see whether such a system is warranted, or whether the current passive air-exchange system is enough.

As much as possible, we tried to keep to the “sticks-and-stones” aesthetic: peeled locust logs for deck and roof-support posts, Travertine limestone flooring and window sills, granite counters and hearth, and plastered walls — some pigmented, some painted with a faux finish, and some left simply white. An exception to the natural elements is the outdoor deck, where we used plastic to minimize maintenance.

The house was designed by Alice Dodson of Weaverville and built by Rare Earth Builders, Inc.

As we live in the house, we continue to tweak. We're currently looking for the best solution to slow the heat loss out windows at night — perhaps a quilted curtain with a radiant barrier built in.

Come see us.

Mark Bondurant is the owner of Rare Earth Builders and is a member of the WNC Green Building Council.

PROSPECT TERRACE

by Shane Elliott

Mountain Housing Opportunities, a local nonprofit organization, is continuing to prove that affordable housing can be built. When hammers start pounding at Prospect Terrace in Asheville's West End/Clingman Avenue (WECAN) neighborhood, MHO may prove that affordable housing can also be built "green".

Thanks to a diverse project team — including the project developers, architects, civil engineers and contractors, plus a handful of local nonprofits such as the Western North Carolina Green Building Council and the North Carolina Solar Center — Prospect Terrace is slated to be the pilot project of the new North Carolina HealthyBuilt Homes green-building program. This program, developed by the N.C. Solar Center and a state-wide Green Building Task Force, including key contributions from the WNC Green Building Council, will provide a rating system for building green homes in North Carolina. This rating system — similar to existing green-building programs around the country — will help to provide technical and marketing assistance to builders who have an interest in reducing the negative environmental impacts of construction.

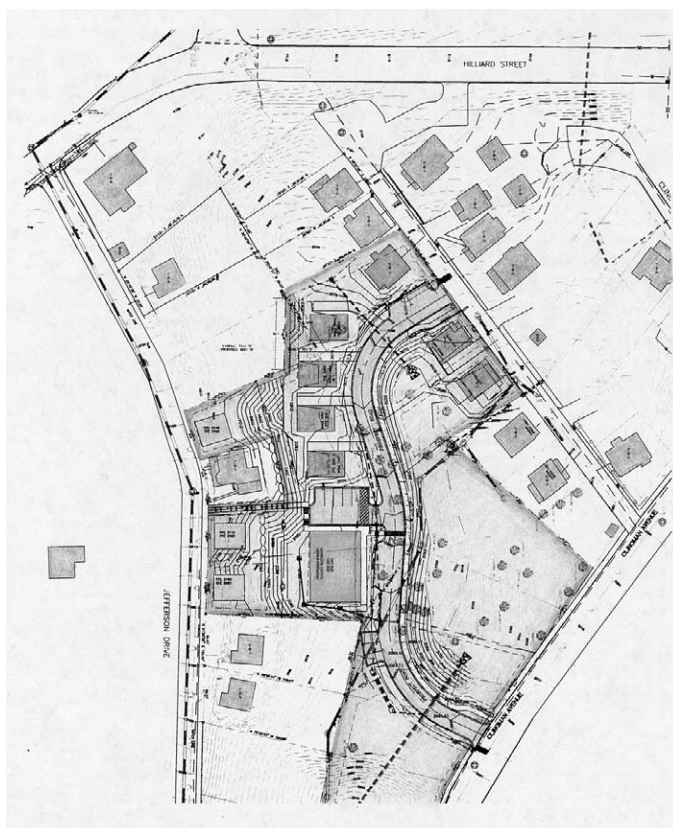
The Prospect Terrace site, on Jefferson and Rector streets, and the proposed Prospect Lane, are located in the heart of the WECAN neighborhood. In 2000, MHO, in conjunction with other local non-profits, held a series of design charrettes to help envision the future of their neighborhood. The site planning and architectural treatment of the project has shown sensitivity to the neighborhood vision by providing a mixed-use infill development with relationships to existing historic structures, as well as a public-park area with community space and natural landscape. An existing creek bed is slated for restoration, and the neighborhood vision of a walkable city has also been met by placing importance on sidewalks for pedestrian access.

The proposed green-built housing units include a six-unit, multi-story condominium; nine single-family homes ranging from 900 to 1,500 square feet; and one existing historic house that will be renovated as a two-unit duplex. The HealthyBuilt Homes program is broken into categories that provide each project with specific opportunities to lessen its environmental impact. These categories include site issues, water conservation, energy conservation, indoor-air quality and material-resource conservation. For example, Prospect Terrace will employ alternate-framing techniques to minimize material use, provide on-site construction-material recycling, and potentially work with the neighborhood to relocate heirloom plantings located in the construction zone. It will meet Advanced Energy's SystemVision program for energy efficiency, as well as provide Energy Star appliances that meet the EPA's energy-savings guidelines. The program, designed for maximum flexibility, also includes bonuses for innovations in conservation, as well as a community checklist to ensure that a project can become a conscientious community neighbor.

While there are some prerequisites required for compliance with HealthyBuilt Homes, the flexibility of the program has been largely responsible for providing an opportunity to introduce green construction into the affordable-housing sector. The majority of the criteria listed under the various program areas can be addressed with solutions that cost little or no more than typical construction. The countless options and differing methods of compliance to meet conservation goals encourage creativity and resourcefulness on the part of the project team, and help to ensure that no project can adopt a "one-size-fits-all" approach to green construction.

With good planning and determination, Prospect Terrace will help to set a new standard in the constantly changing world of construction. Hopefully, with a collective vision for affordable and environmentally sound housing, our community will realize that we are limited only by our willingness to evolve, and by our imaginations.

Shane Elliott is with Mathews Architecture and is a member of the WNC Green Building Council.



The site plan of Prospect Terrace shows Clingman Avenue in the bottom-right corner.

EPA'S RESEARCH TRIANGLE PARK CAMPUS — A MODEL FOR THE FUTURE

by Ashley Featherstone

Pollution from buildings is well-documented. Energy, water, and material usage at building sites contribute to waste generation and pollution. In the United States, 42 percent of energy use, 30 percent of raw materials, and 25 percent of water use are building related. Approximately one-third of the environmental impacts in the U.S is due to constructing, operating and demolishing buildings. The environmental impacts are caused by the indirect and direct consequences of land use, waste generation, air and water pollution, and natural-resource depletion. Ecosystems are impacted by buildings through loss of habitat, introduction of invasive species, stormwater and erosion problems, and the contamination of water resources.

When the EPA began planning the largest construction project in its history in the early 1990s, officials decided to make every effort to construct a model of "green building." The goal was to build an efficient building and campus that would save the taxpayers money in the future, and show that the environmental and health considerations that define green building can be incorporated in the building and site-design process without costing more money.

The Research Triangle Park Campus is EPA's major center for air-pollution research and regulation, and the home of their national computer center. The 1.2-million-square-foot building complex is located on a 133-acre site in Durham, N.C. The building, which overlooks a woodland lake, sits below a knoll of the site's oldest trees. The building accommodates 2,200 employees and contains 600 laboratory modules in five laboratory wings, three office wings and a six-story office tower with a cafeteria and conference center. The buildings are organized around a series of atria that act as a "main street" to enhance communication among professional staff. Laboratories include biology and chemistry labs, building-material-emissions testing labs, electronics labs, automobile-testing facilities, and large-scale combustion-research labs.

Below is a very brief listing of just a few of the green-building design features incorporated by EPA in the design and construction of the new RTP campus, completed in 2001.

Site design

- Buildings were placed along the natural contours of the land, reducing grading and limiting disruption to existing woodlands and wetlands.
- One acre of new wetlands was added, seven times the amount disturbed by construction.
- Native grasses, wildflowers, wetlands and forests allow 100 percent of stormwater runoff to be treated naturally before flowing into streams. Native grasses and wildflowers along 15 acres of campus roadways reduce the need for watering, fertilizing and mowing.
- Land clearing was minimized and a rescue effort was undertaken in which volunteers transplanted more than 3,500



The atrium connects the labs, offices, conference center and café along an interactive "main street." The energy-efficient design provides daylighting and improved thermal insulation.

native plants to nearby locations.

- Roads, parking lots and other impervious surfaces were minimized to preserve green space, reduce stormwater runoff and increase groundwater recharge.
- The campus has the largest stretch of solar-lighted roadway in the world. 90 percent of roadway lighting is solar powered.

Building design

- The main building uses 40 percent less energy compared to standard buildings of equal size, cutting annual operating expenses by approximately \$1 million while reducing environmental impacts. Lighting is 70 percent more energy-efficient; features include natural daylight, automatic sensor controls, and high-efficiency fixtures.
- The atrium uses natural light while connecting different sections of the building, conserving energy, reducing the amount of materials that would otherwise be needed for exterior walls, and creating more opportunities for interaction among staff.
- A building-automation system consists of 25,000 sensors and controls to respond to changing heat, cooling and ventilation needs. Outdoor temperature and humidity are monitored, optimizing introduction of fresh air. Variable-speed pumps, fans and motors, along with variable air-volume units are utilized to meet energy needs without using excess energy.
- The National Computer Center has a 100-kilowatt (photovoltaic) solar roof, the largest in the eastern United States.
- The National Computer Center was designed to achieve a silver rating under the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) system.

Construction features

- 80 percent of construction waste was recycled, diverting 8,000 tons of material from local landfills. Open burning of land-clearing waste was prohibited to reduce air pollution.
- Building materials were selected with careful consideration of durability and environmental impact, including specifications for recycled and chemical content, and sustainable sourcing for all wood products used. Durable materials and flexible-design features extend the life of the building, minimizing impacts from renovation and reducing lifetime waste.
- On-site concrete production diverted 75,000 miles of truck traffic from local roads, saving 10,000 gallons of fuel, reducing air pollution and project costs.

Operations

- Recycling bins and receptacles are located in individual offices and all common areas to maximize employee recycling. Compost from the café is reused as natural fertilizer on the grounds.
- All furnishings for the interior of the building (including carpeting, furniture and cabinets) were selected with environmental and human-health considerations in mind. Chemical emissions, recycled content, biodegradability and manufacturers that had a “take back” program were all considered.
- A 25 percent reduction in parking area was achieved by providing incentives for public transit, carpooling and other alternatives to single-occupant vehicles. In-house services — including a restaurant, a dry cleaner, and a convenience store — also reduce driving and air pollution.

“EPA’s campus has shattered the notion that environmental enhancements are too expensive to be practical. Costs can be kept in balance with environmental ideals when builders are willing to sacrifice traditional methods for new, environmentally friendly ones” (*Our Green Campus - A Model for the Future*, EPA, 2001).

For more info

For more information, including lessons learned in the development of this project, please see the EPA’s RTP Web site at:

www.epa.gov/rtp/new-bldg/environmental/environmental.htm

Ashley Featherstone is with the Regional Air Quality Agency and serves as a WNC Green Building Council board member.



The EPA’s National Computer Center has a 100-kilowatt (photovoltaic) solar roof, the largest in the Eastern U.S.



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both economic and environmental advantages over their conventional counterparts.

- **Install water-efficient equipment:** Water-conserving toilets, showerheads and faucet aerators reduce water use as well as the demand on septic systems or sewage-treatment plants. Reducing hot water use also saves energy.
- **Install mechanical ventilation equipment:** Mechanical ventilation is usually required to ensure healthy indoor air. Heat-recovery ventilators should be considered in cold climates for energy savings, but simpler, less expensive exhaust-only ventilation systems are also adequate.

Business practices

- **Minimize job-site waste:** Centralize cutting operations to reduce waste and simplify sorting. Set up clearly marked bins for different types of usable waste (wood scraps for kindling, sawdust for compost, etc.). Find out where various materials can be taken for recycling, and educate your crew about recycling procedures. Donate salvaged materials to low-income housing projects, theater groups, etc.
- **Make your business operations more environmentally responsible:** Plan transportation to be as efficient as possible — purchase energy-efficient vehicles, arrange carpools to job sites, and schedule site visits and errands to minimize driving. In your office, purchase recycled paper and supplies, recycle office paper, use mugs instead of disposable cups. On the job, recycle beverage containers.
- **Make education a part of your daily practice:** Use the design and construction process to educate clients, employees, subcontractors, and the general public about environmental impacts of buildings and how these impacts can be minimized.

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“Your dreams of reaching your goal should be so vivid that when you actually come close to that goal in life, you will feel like you’ve done it before.”

— Author unknown

“Teaching is a way to love others. Learning is a way to love yourself.”

— Author unknown

“A friend is one who sees through you and still enjoys the view.”

— Wilma Askinas

“Fail to honor people, They fail to honor you; But of a good leader, who talks little, when his work is done, his aim fulfilled, they will say, ‘We did this ourselves.’”

— Lao-tze

“We are told never to cross a bridge until we come to it, but this world is owned by men who have ‘crossed bridges’ in their imagination far ahead of the crowd.”

— Author unknown



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www.ci.austin.tx.us/greenbuilder/

Energy Star Program

www.energystar.gov/

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www.sbicouncil.org

US Green Building Council

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Fax: (202) 828-5110
www.usgbc.org

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North Carolina Green Building Program
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Fax: (919) 545-9060
www.cra-recycle.org/index.htm

North Carolina Solar Energy Association

P.O. Box 6465
Raleigh, NC 27628
(919) 832-7601
ncsea@mindspring.com
www.ncsolar.org

N.C. Solar Center

Box 7401
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Raleigh, NC 27695-7401
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Toll-free in North Carolina:
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www.smartgrowth-wnc.org

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info@cleanenergy.org
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241 Pine St.
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www.southface.org

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70 Woodfin Place, Suite 326
Asheville, NC 28801
(828) 258-8737
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asheville@wnca.org
www.main.nc.us/wnca

Western North Carolina Green Building Council

PO Box 8427
Asheville, NC 28814
(828) 232-5080
info@wncgbc.org
www.wncgbc.org

WNC Regional Air Quality Agency

49 Mount Carmel Road
Asheville, NC 28806
(828) 255-5655
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www.wncair.org

For more info

For additional resources — including books, videos and periodicals — see the WNC Green Building Council's Web page: www.wncgbc.org



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WNC GREEN BUILDING COUNCIL

The Western North Carolina Green Building Council, formed in August 2000, is a non-profit organization whose mission is to promote environmentally sustainable and healthy building practices through community education.

The term sustainability can be defined as a process that can be continued indefinitely without degrading the environment. This ultimate goal of environmental and economic sustainability provides a framework for making decisions during the research, design and construction phases of the building process.

Members of the Council include architects, builders, homeowners, consultants, product distributors, and governmental organizations. The members are well versed in the issues of sustainable design. It is the Council's goal to share this knowledge with the community in order to raise awareness of green buildings and how they can benefit the community by using less energy, providing healthier environments, and creating less waste.

There is a need to educate the public and other building professionals about the options of creating healthier, more efficient buildings that have less impact on the natural environment. The Council and this directory aim to protect the natural environment by promoting green building.



Goals

The WNC Green Building Council's goals are to:

- Develop educational programs and opportunities for professionals and the public;
- Develop and implement a "Green Building Program" for Western North Carolina;
- Enhance networking among homeowners, professionals, governments and organizations; and
- Help the region become a model of successful green building and sustainable development.

WNCGBC projects

The WNC Green Building Council has several projects, including:

- **Green Building Hotline** — (828) 232-5080 — A FREE service providing information and referrals for homeowners, businesses, architects, builders and non-profits. Call us with any green building questions. SPONSORED BY: Land-of-Sky Regional Council, Waste Reduction Partners NC, and the Division of Pollution Prevention and Environmental Assistance.
- **Public forums** — The Council sponsors four educational public forums a year (free to members) which address current green-building issues. Past forum topics include: energy-efficient mortgages, sustainable landscapes, and indoor air quality. Professional continuing education credits are usually available. EarthFare has been sponsoring refreshments for the forums. (For more info, send e-mail to: forum@wncgbc.org.)
- **Field trips and tours** — The council has hosted several green-building tours including the annual SEE Expo Green

Building Tour, and the statewide Solar Tour. More casual field trips to local green-building examples are also organized.

- **Newsletter** — A quarterly newsletter is published for members with educational articles and calendar of events.
- **Events** — The council participates in several local events a year including the SEE Expo, The Asheville Home Show, Rolling Thunder, and Earth Day. In addition to a booth to provide educational material and answer questions, we often present workshops. Let us know if your organization would like us to give a presentation.
- **MSRI - Million Solar Roofs Initiative** — A national program that promotes and documents existing and future solar installations (passive and active). The WNCGBC is a regional representative in our state, working with the N.C. State Energy Office, which administers the program statewide. (For more info, send e-mail to: msri@wncgbc.org.)
- **N.C. Green Building Program** — The council has worked with the N.C. Solar Center and statewide task force on developing a residential green-building program for North Carolina. Checklist guidelines have been developed and planning for an Asheville pilot program has begun. See the article "A Green Builder Program for North Carolina" on page 43 and the Prospect Terrace case study on page 67 of this directory. (For more info, send e-mail to: healthybuiltomes@wncgbc.org.)

The WNC Green Building Council Hotline is (828) 232-5080. You can also reach the council via P.O. Box 8427, Asheville, N.C. 28814 or through info@wncgbc.org. For more info, check out www.wncgbc.org.



The WNC Green Building Council maps out strategies for the coming year at its 2004 planning meeting and potluck.

ABOUT THIS DIRECTORY

The WNC Green Building Directory — the second of its kind — was produced by the WNC Green Building Council with assistance from *Mountain Xpress*, which helped with the publication's design, editing, ad sales and distribution. *Mountain Xpress* is a weekly Asheville newspaper celebrating its 10th year of independent news, arts and events for Western North Carolina. Reach *Xpress* at (828) 251-1333, xpress@mountainx.com or check out www.mountainx.com.



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