A Guide to Product Selection and Specifications

GREEN BUILDING MATERIALS

third edition

ROSS SPIEGEL AND DRU MEADOWS

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The authors advocate the use of environmentally friendly (green) building products, systems and materials; and believe that green products and innovative technology can enhance the outdoor and indoor environment, improve the quality of life of the user, and in general, perform as well and even outperform their baseline competition. This book is intended to be a guide for researching environmental issues relative to building products. No warranty is made as to completeness or accuracy of information contained herein. References to manufacturers do not represent a guaranty, warranty, or endorsement thereof.



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PREFACE TO THE THIRD EDITION

As we write this, the Third Edition of what has become a leading technical primer on green building materials, we see the landscape shifting in a most dramatic manner. Green building has achieved a critical mass—and is becoming just "building." What many of us have dreamed for decades now seems to be materializing. Green building is mainstream.

We are witnessing a fundamental transformation in the market. All levels of government are embracing green building in meaningful, enforceable ways. Major institutional purchasers and large corporations are scrambling over each other to get greener faster. Consumers are starting to embrace the New Green Economy.

Within this context, guidance on specification of green building materials is more important than ever. We are grateful that our editor at John Wiley & Sons recognizes the continuing need and has assisted us in expanding and updating this edition.

This edition includes:

- A new chapter on eco-labels, green standards, and product certification
- A new appendix providing reference information for sustainability standards and standards development organizations
- New sample specifications, including: Green Power Requirements, Vegetated Green Roof System, Rainwater Harvesting, and Water Reuse Systems
- A revised and updated review of trends affecting the future of green building materials
- An updated approach and reference information for the Product Selection Process
- Updated reference information for information sources

We hope that readers will find this Third Edition even more helpful than the previous editions and will continue to use it as a "toolkit" in their daily practice and learning.

Ross Spiegel
Shelton, Connecticut

Dru Meadows
Tulsa, Oklahoma

ACKNOWLEDGMENTS

It is hard to believe that just 10 years ago the first edition of the book that you are now holding in your hands was published. In that short time span much has changed in the arena of green buildings and materials. This third edition contains updated information and expands the subject matter to keep pace with the current state of the industry. It is the result of much hard work and the product of encouragement and input from many people. Although limited space does not permit me to thank them individually, I would like to recognize the following groups: my "green" friends and fellow members in The Construction Specifications Institute; my friends in the U.S. Green Building Council; and the special people who believed in this project from the start . . . to the finish: my coauthor Dru Meadows, my wife and daughter, Dorine Shirinian Spiegel and Erica Shirin Spiegel; thank you all.

Please take the information contained in this edition to heart as I have, and when you finish reading this edition, sit back and remember that "a greener future is in your hands." Make good use of the time you have.

Ross Spiegel
Shelton, Connecticut

* * * * *

For my colleagues, clients, family, and friends—all of whom have inspired me to find more sustainable solutions. And especially for the readers who care enough to act on their convictions. Thank you.

Dru Meadows
Tulsa, Oklahoma

PREFACE TO THE SECOND EDITION

When we set out over seven years ago to write "a guide to product selection and specification" for green building materials, the extent of design and construction professionals' knowledge of green or environmentally friendly buildings was fairly limited. The variety of green building materials was similarly limited. In these few short years, the industry has expanded exponentially. Today, there are hundreds (if not thousands) of green building products. There are green journals, green conferences, and green committees in nearly all building trade and professional organizations. There are numerous green building rating programs, not least of which is the U.S. Green Building Council's LEED® (Leadership in Energy and Environmental Design). There are now well over 100 ASTM standards related to sustainability in buildings. Spurred by the mounting public interest in green buildings, municipalities, states, and national governmental agencies are implementing green initiatives and adopting one rating system or another with increasing rapidity.

The years between the publication of the original edition and the second edition have seen an explosion in the knowledge base supporting green buildings, green building materials, and sustainability. The science informing environmental decision making continues to grow. Manufacturers are researching and developing new green product lines as well as improvements to existing products. With the increasing number of completed green, sustainable or high-performance buildings, real-life statistics about cost and energy usage are becoming available. Not only is it possible to find a definition of "sustainability" in your dictionary today, but also it is difficult to pick up a newspaper or magazine or read an electronic newsletter that does not mention "sustainability."

In light of the progress at all levels in the green building industry, it became clear to us that an updated edition was overdue. We are grateful that our editor at John Wiley & Sons agreed. We hope that readers will find this second edition even more helpful than the first edition and will continue to use it as a "toolkit" in their daily practice and learning.

Ross Spiegel
Shelton, Connecticut

Dru Meadows
Tulsa, Oklahoma

PREFACE TO THE FIRST EDITION

Much has been written in the last 25 years about the philosophical and moral impetus to design and construct green or environmentally friendly buildings. Although more and more building owners are demanding that their design professionals take environmental concerns into account for new buildings, knowledge about the process of selecting and specifying green building materials has remained sketchy.

In this book, the reader will find not only a discussion of why one should use green building materials and what green building materials are but a guide to their selection and specification as well. The reader will also find information about the construction process and how to guard against the substitution of non-green building materials. The information contained in the appendices and glossary serve to round out the package, providing the reader with valuable reference material, sample specifications, and a kit of tools to use on green building projects.

This book was a labor of love for the authors, and its creation and birth were made possible by the encouragement and understanding of their families, friends, professional colleagues, and members of the green building movement. Our thanks also go out to the editors and staff at John Wiley & Sons, who made the birthing process as painless as possible.

Ross Spiegel
Fort Lauderdale, Florida

Dru Meadows
Tulsa, Oklahoma

CHAPTER 1

Introduction

> *No man is an Island, entire of itself; every man is a piece of the Continent, a part of the Main; if a clod be washed away by the sea, Europe is the less, as well as if a promontory were, as well as if a manor of thy friends or of thine own were; any man's death diminishes me, because I am involved in Mankind; And therefore never send to know for whom the bell tolls; It tolls for thee.*
>
> —*Devotions upon Emergent Occasions*, "Meditation 17"
> John Donne

In *Devotions upon Emergent Occasions,* the seventeenth-century English metaphysical poet John Donne wrote, "No man is an Island, entire of itself." Through this statement, Donne asserted that we all share a common humanity. In today's increasingly complex and interrelated world, not only is no man an island but, similarly, no building stands alone. Every building exists within an environmental context upon which it not only acts but which also has an impact upon the building. Because of today's increased complexity and interrelatedness, no building can be constructed as a microcosm. The people in charge of every building project must consider the impact it will have on the environment into which it will be placed, locally and globally.

Donne's assertion that no man is an island is also an affirmation of sustainability. *Sustainability* is commonly interpreted to mean living in such a way as to meet the needs of the present without compromising the ability of future generations to meet the needs of the future.[1] It is frequently compared to the Native American concept of consultation with the as yet unborn future generations for their input on significant decisions—decisions that might affect them. Sustainability is a social concept in that it considers the needs of the unborn. It is an environmental concept in that it addresses the effect of pollution and resource management (or lack thereof) on Earth's ecological systems. Further, it is an economic concept in that it seeks to quantify the tolerable limits for consumption such that we can live on Earth's interest instead of depleting the principal. It is a perspective that focuses on systems and relationships instead of objects.

The term *sustainability*, once rare to find in a dictionary, now appears regularly. Whereas the spell checker on your personal computer used to stumble over the word, it is common now to find it included in your computer's spell checking library. Online dictionaries such as yourdictionary.com and OneLook.com include the term. *Sustainability*

can also be found in online encyclopedias such as Wikipedia. Use of the term has quickly become widespread. Another term that has come into common usage is *high-performance building*. A high-performance building is one whose energy, economic, and environmental performance is substantially better than one designed by standard practice. It is a building that is healthy to live and work in and that has a relatively low impact on the environment.[2] The term *green* has also become part of our working vocabulary. It is now used not only as a name for a particular color but also as an adjective meaning "environmentally friendly." It refers to the color of lush, healthy, unpolluted vegetation. Some local and regional programs use *blue* in a similar manner to indicate the idea of cool, clean, unpolluted water or air. *Brown* is indicative of dirty, barren, polluted areas, and has entered the industry vocabulary as a term referring to contaminated sites, *brownfields*. Like the terms *sustainability, green,* and *high-performance building, integrated design* is now in common usage. Integrated design describes a process used to design and construct a building in such a manner so as to promote sustainability. The integrated design process encourages all members of the building team to work together from the earliest stages of project development to achieve high performance and sustainability in the design. *Green,* like the other terms, has entered the vernacular. Thus, *a green building* does not refer to the shade of paint, but signifies the impact the building has on the environment. Simply stated, a green building is one that is located and constructed in a sustainable manner and that is designed to allow its occupants to live, work, and play in a sustainable manner.

The growth of interest in green buildings has led to the development of rating systems such as the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED®) Green Building Rating System and in green building material rating systems such as the National Institute of Standards and Technology's (NIST) BEES (Building for Environmental and Economic Sustainability) program.

Over the last decade, interest in green issues among those in both the building industry and the general public has grown considerably. Today, the proliferation of green articles, conferences, publications, websites, electronic newsletters, and projects attest to an increasing consciousness. We have been made aware, in no uncertain terms, that we are a dirty and wasteful species. Each of us has had to accept responsibility for our part.

The United States generates more waste than any other nation. In 2008, U.S. residents, businesses, and institutions produced about 250 million tons of Municipal Solid Waste, which is approximately 4.5 pounds of waste per person per day.[3] For many American schools, the amount of money spent on trash disposal is at least equal to that spent on textbooks.[4] The construction industry dumps between 25 and 40 percent of the total into America's solid waste stream.[5] "The U.S. Environmental Protection Agency (EPA) estimates that approximately 170 million tons of building-related [Construction & Demolition (C&D)] debris were generated in 2003—the majority from demolition (49 percent) and renovation (42 percent). New construction generated only 9 percent of building-related C&D debris."[6] "The United States Geological Survey has estimated that in 2006 construction accounted for 77 percent of all materials used in the United States for purposes other than food and fuel."[7]

We waste energy. The U.S. Department of Energy has estimated that improvements in the energy efficiency of buildings, utilizing existing and readily available technologies, could save $20 billion annually in the United States and create 100,000 new jobs.[8] A significant percentage—40 percent—of the world's energy usage is dedicated to the construction and operation of buildings.[9] Even more is indirectly mandated by the thoughtless siting of

buildings relative to each other. Urban sprawl has been denigrated for its negative impact on quality of life. People regularly complain about the time devoted to traveling across town or the unfortunate aesthetics of their surroundings. However, as environmentalists will quickly tell you, urban sprawl is guilty of damaging the environment both directly and indirectly. It directly damages the environment as inexpensive fringe property is hastily and wastefully paved over, and indirectly as the hundreds of thousands of energy-burning vehicles drive past to conquer the next bit of fringe real estate.

We also waste our natural resources. Over 50 percent of the wetlands of the contiguous United States have been destroyed—filled, contaminated, or otherwise "reclaimed."[10] The destruction of wetlands and other natural resources has become much more efficient with technological advances. In recent decades, "... the average annual rate of deforestation worldwide was approximately equivalent to an area the size of the state of Georgia."[11] James Lovelock, creator of the GAIA theory,[12] has predicted that, at current rates of deforestation, we will have lost 65 percent of all the forest of the tropics by the end of this century. This is a critical threshold. "When more than 70 percent of an ecosystem is lost, the remainder may be unable to sustain the environment needed for its own survival."[13] The building industry commandeers 3 billion tons of raw materials annually—40 percent of total global use.[14] It uses almost half of all the mined, harvested, and dredged raw materials each year! It also diverts 16 percent of global fresh water annually.[15] Most of the earth's water is located in our oceans and is too salty for residential, commercial, or industrial use. Only 3 percent of the water on the planet is fresh, and most of that is located in polar ice. Of all the water on the planet, only about 0.003 percent is readily available as fresh water for human use.[16] The 16 percent annual usage estimate accounts for the quantity of water required to manufacture building materials and to construct and operate buildings. It does not reflect the impact of the building industry on the quality of water. It is entirely possible that future estimates of the percentage of available fresh water will decrease as we continue to contaminate our limited supply.

At some point, with continued unlimited growth, demand will exceed our resources. But at what point? There is a great deal of debate over the exact numbers. How much fossil fuel do we have left? Enough for 10 years? 100 years? Determining the exact limit causes genuine concern because we want to know how much we can use—and, of course, how much is it going to cost.

According to the United Nations Population Fund reports, from the beginning of time until 1950, the world population grew to almost 2.5 billion people; from 1950 to 1990, that population doubled; and by 2050, the world will add almost 2.5 billion people, an amount equal to the world's total population in 1950.[17] The same resources we are now using will have to support nearly 9 billion people. Each additional person requires food, clothing, shelter, and assorted amenities. Most of this growth is anticipated in Asia and in developing countries. Currently, these areas do not have the same standard of living that developed nations do, but they are actively attempting to acquire it. Also, these areas produce the majority of the raw materials, the renewable and nonrenewable resources that developed nations use to achieve their higher standard of living. As available resources per capita decrease, the costs will increase; there is even a question as to whether or not the developing nations, as they industrialize and acquire not only the need for but also the capacity to process their raw materials, will continue to supply raw materials to the previously developed nations.

A simple objective comparison of available resources to increasing human demands indicates that the system, as currently functioning, cannot continue indefinitely. Use of

nonrenewable resources must stop, either voluntarily or involuntarily. Proponents of sustainability opt for the voluntary method.

Sustainable approaches focus on two questions:

1. What are we using?
2. How well are we using it?

What we are using may be perpetual resources, resources that are "virtually inexhaustible on a human time scale,"[18] such as solar, wind, or tidal energy; renewable resources, resources that can be replenished through natural processes in a relatively short time, such as trees and water; or nonrenewable resources, resources that require millions or billions of years to be replenished through geological, physical, and chemical processes, such as aluminum, coal, and oil.

The law of conservation of matter states that matter can be neither created nor destroyed. What we have inherited—perpetual (exclusive of the solar input), renewable, or nonrenewable—is, ultimately, all we've got. We can take some from here and move it there, reshape it, burn it, bury it—but it's all we are going to get. What existed at the beginning of time is what we have now.

A significant ecological aspect of the law of conservation of matter is that matter goes through cyclical transformations. Matter cycles from physical reservoirs into biological reservoirs and back again. Water, for example, regularly travels through rivers, lakes, oceans, and the atmosphere, making detours through plants and animals (e.g., human beings). Through transpiration, plants transfer water from the soil to vapor in the air. The rising vapor condenses to form clouds; rain falls, trees grow. Water vapor also condenses over the ocean. Algae in seawater produce dimethyl sulfide, which provides cloud-condensing nuclei, the particles that water condenses around to form clouds. The cloud cover lowers the temperature, causing differentials in temperature and air movement. The cloud collides with a land mass—rain.

There are some interesting environmental corollaries to the law of conservation of matter. If matter cannot be created, we never really get anything new, and we never really throw anything away. We just move it around and combine it with different materials. Therefore, we are drinking the same water that has traveled through the cycle over and over and over since day one. And, if we deposit chemicals into a stream, they are likely to travel with the water to the next location in the cycle, and the next. Ultimately, everything is in your own backyard. The time a water molecule stays at any one point in the cycle is as follows:[19]

Location	*Residence Time*
Atmosphere	9 days
Rivers	2 weeks
Soil moisture	2 weeks to 1 year
Large lakes	10 years
Underground water at slight depth	10s to 100s of years
Ocean mixed layer to a depth of 55 yards	120 years
Seas and oceans	3,000 years
Underground water at depth	up to 10,000 years
Antarctic ice cap	10,000 years

The question of how well we use our perpetual, renewable, and nonrenewable resources must be answered in terms of our effect on the quality of the resource and our impact on the cycle of the resource (rate of flow, diversion, etc.). According to the EPA, "In 2004, states, tribes, territories, and interstate commissions report that about 44% of assessed stream miles, 64% of assessed lake acres, and 30% of assessed bay and estuarine square miles were not clean enough to support uses such as fishing and swimming."[20] That survey included only 16 percent of the nation's 3.5 million miles of rivers and streams, and only 39 percent of the nation's 41.7 million acres of lakes, reservoirs, and ponds. According to the Index of Watershed Indicators for 2002, only 15 percent of the nation's watersheds had relatively good water quality.[21] Hose down your driveway and you have diverted a portion of the daily one-third of flowing water in the country and added to it an assortment of petroleum products, pesticides, herbicides, and debris that will flow down the street into the stormwater system. Thermoelectric power generation is responsible for nearly half of the annual water withdrawals in the United States, amounting to approximately 195 billion gallons per day in 2000.[22] A significant pollutant that power plants add to the water is waste heat.

The options for greener use of a resource are often complicated by political and economic factors. Water quite visibly travels across borders and is subjected to a variety of social, economic, and political values along the way. Of the 200 largest river systems in the world, 120 flow through two or more countries. Access to shared resources has triggered numerous conflicts over the centuries. Witness the tension in the Middle East. The 1967 Arab-Israeli war was fought, in part, over water rights to the Jordan River. The conflicting demands of agricultural, industrial, and urban uses are felt not only between countries but also between and within states. The Los Angeles aqueduct project infuriates Northern California. The mighty Colorado River has so many users that it is virtually dry at its end.

While sustainable approaches could benefit from political advances and new technologies, many simple and innovative options are currently available. Many not only improve the manner in which we use our resources but also have financial benefits. For example, a water recirculation system reduced the amount of water the Gillette Company used to make razor blades from 730 million gallons to *156 gallons* per year, saving approximately $1.5 million a year in water and sewage bills.[23]

Harrah's Hotel and Casino in Las Vegas asked its customers whether they wanted their sheets changed every day. Most said no. Harrah's reduced "its energy and water costs for cleaning sheets by $70,000 per year."[24] By utilizing a landscaping technique called *xeriscaping*, which relies on native plants instead of water-intensive imported plants, Valley Bank in Tucson, Arizona, realized a $20,000 per year savings.[25]

The Earth has evolved thousands of intricate, delicately balanced cycles, each of which is woven into increasingly more complex systems to create the overall single system that is our world. The prospect of living sustainably in the midst of such complexity can be overwhelming. Some respond with a deus ex machina confidence that technology will "solve" the problems, whatever they are, or that nature will adjust as necessary. Others, overwhelmed by the enormity of the challenge, reassure themselves by asserting that the impact one individual can make is negligible. Technology may solve *some* problems, but only if we focus our attention on those problems and seriously endeavor to understand them. Nature *will* undoubtedly adjust; the question is whether or not that adjustment will involve the eradication of our species. And individual impact *does* add up, regardless of whether or not you choose to see the aggregate. Furthermore, history books are full of individuals who had tremendous cultural, economic, political, and environmental impact.

As the anthropologist Margaret Mead pointed out, "Never doubt that a small group of thoughtful, committed citizens can change the world. Indeed, it is the only thing that ever has." Solving all the problems simultaneously is as unrealistic as avoiding them. A more constructive approach is to do what you can and continue improving. Maintain the deep dark green goal, but don't let the fact that you are a few shades lighter stop you from achieving even that much.

Can you, as a designer or building owner, envision a building that neither imports nor exports material or energy during construction? During operation? If not, can you envision a trade for the imported or exported material that will balance in a larger picture? To determine how closely you come to this goal, ask these questions: What am I using? How well am I using it?

With a basic appreciation of the law of conservation of matter, the answer to the first question will have implications for the impact of your choice on our natural resources and on the relative healthfulness of our environment. These two topics—resource management and toxicity—are valuable tools for evaluating materials. The answer to the second question will have implications for the performance of the material. Performance issues include durability, energy efficiency, amount of waste generated, and potential for reuse or recycling. Performance is also a valuable tool for evaluating the greenness of a material.

Life Cycle Assessment (LCA) is the formal methodology for answering these questions. LCA is a process that investigates the impact of a product at every stage in its life, from preliminary development through obsolescence. At each stage, you look at the materials and energy consumed and the pollution and waste produced. Life stages include extraction of raw materials, processing and fabrication, transportation, installation, use and maintenance, and reuse/recycling/disposal. To date, there is no single accepted LCA methodology. Groups as diverse as the EPA, ASTM International, the Society of Environmental Toxicology and Chemistry (SETAC), the National Institute of Standards and Technology (NIST), and the International Organization for Standardization (ISO) each have worked on creating an outline of the process. Nevertheless, there is general consensus regarding the concept of LCA and its usefulness in quantifying sustainability. And, in 2001, an organization dedicated to increasing the capacity and knowledge of LCA was formed: The American Center for Life Cycle Assessment (ACLCA). The ACLCA developed and manages the Life Cycle Assessment Certified Professional (LCACP) Certification, which was offered for the first time at the end of 2009.

Selection of materials is only one part (albeit an important one) of making a green building. The LCA methodology helps us visualize the link between the big picture and the details, while bringing us that much closer to the goal of living sustainably. This point is emphasized by inclusion of the LCA approach specified in ISO 14000 standards in the BEES software. A future version of the LEED Green Building Rating System is scheduled to include LCA methodology as well.

Every human endeavor has as its basis a condition or state of being we wish to attain. Call it an ideal of perfection for which we strive. In order to make our struggle more manageable, we break our efforts into smaller pieces, called *goals*. Goals are the steps we can take on the path toward our ideal. Within the context of the subject of this book, our ideal can be described as a world of buildings that are located, constructed, and designed in a sustainable manner and that allow their occupants to live, work, and play in a sustainable manner.

An inherent quality of an ideal, of perfection, is that it is unattainable. This should not discourage us from making changes in the status quo. With a limited investment of time, money, and research, it is relatively easy to make measurable improvements. That is the crucial point: If you shift your paradigm from simple black-and-white answers to shades of gray (or should we say green), then the possibilities for environmental successes are unlimited.

The subject of green buildings has been widely discussed and often written about. This book does not attempt to be an exhaustive text on the pros and cons of going green. It also does not try to engage in a detailed discussion of green buildings. Many fine books are available on both subjects.

The goal of this book is to help designers and other members of the building construction team better understand the green building material selection and specifying process. By attaining this goal, we hope to take one more step toward reaching our ideal.

Notes

1. In the words of the landmark World Commission on Environment and Development (the Brundtland Commission), we should "meet the needs of the present without compromising the ability of future generations to meet their own needs." Cited in Joel Darmstadter, *Global Development and the Environment: Perspectives on Sustainability,* Resources for the Future, Washington, DC, 1992.
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CHAPTER 2

Why Use Green Building Materials?

An ounce of prevention is worth a pound of cure.

—Anonymous

Using green building materials can help divert indoor air quality (IAQ) liability claims, respond to consumer demand, and provide for compliance with certain regulatory requirements. And, oh yes, it's the right thing to do.

Liability concerns regarding healthy buildings and healthy sites are rising in proportion to our growing understanding of the potential hazards associated with certain materials. Asbestos and lead are classic examples. Green building products, especially those fabricated from nontoxic, natural, and organic materials, can reduce IAQ contaminants and the accompanying complaints and claims.

Consumer demand for healthy buildings and for energy-efficient structures also drives manufacturers and designers to explore options for green products. Meeting consumer demand is good business. Failure to meet consumer expectations is likely to remind you about the liability concerns.

As more and more green buildings are completed and begin to welcome both occupants and visitors, they are demonstrating why using green building materials pays benefits beyond avoiding liability claims. These buildings can result from a desire to be altruistic or to obtain a financial return on investment. Examples of buildings that exhibit "the right thing to do" are:

The Chesapeake Bay Foundation's Philip Merrill Environmental Center[1] in Annapolis, Maryland. The building incorporates an external shading system made from salvaged wood from old pickle barrels that helps the building control the sun for natural heating and lighting; structural insulated panels as an alternative to conventional framing; cork flooring and wall panels from cork oak trees, wood that is Forest Stewardship Council (FSC) certified or obtained from sustainably managed forests; and metal siding and roofing panels made locally from recycled steel. In these ways the building leads the way in conserving raw materials as well as energy and water. Located on the Chesapeake Bay, the building physically demonstrates the Foundation's efforts

to restore the natural habitat of the bay, reduce pollution, and replenish fish stocks. By locating the building on the site of a former beach club, previously undisturbed portions of the site were left untouched and the building's impact on the bay minimized. The building also minimized the use of raw materials by simply using less. This was achieved by exposing much of the structure to view with a design calling for a minimal number of interior walls. The building also avoids the use of finishes wherever possible. The resulting built environment is a healthy and energy-efficient one that offers occupants natural ventilation and light and views of the bay. Upon completion, the building received the U.S. Green Building Council's LEED® Green Building Rating System's platinum rating, its highest.

The Solaire, a 27-story, 293-unit residential building located in Battery Park City in New York, was built on landfill on the west side of the city's financial district. The building includes a green roof, materials containing recycled content, and materials that are healthy for the occupants. All of the materials incorporated into the building are free of formaldehyde and contain low or no volatile organic compounds (VOCs). A prospectus for the building touts its green features by prominently featuring the words *natural materials* and *live naturally*. The building was so successful in attracting occupants that a second building with the same features was constructed nearby.

Four Times Square, located in midtown Manhattan, is a 48-story, 1.6-million-square-foot office building that demonstrates energy efficiency, excellent indoor air quality, and the use of green building materials. The developer of the building, the Durst Organization, knew from the start that the building would be ecologically responsible. They used the building's environmental features as a marketing device, while conserving resources and making a healthy place to work. Technologies installed in the building include fuel cells, CFC- and HCFC-free HVAC systems, and photovoltaic panels integral with the curtain wall system. In the end, the building required a higher initial investment but offset this with savings on operating costs.

These economic forces are reflected in the regulatory arena. Voluntary and mandatory environmental guidelines developed at the local, national, and international levels are increasingly applicable to building design and construction. Environmental regulations can present economic and administrative headaches when approached from a business-as-usual standpoint. Conversely, green building materials and methods can make compliance much, much easier.

Altruism, however, is the most frequently cited reason to use green building materials, and we would be remiss to exclude it. As custodians of the built environment, daily decisions we make with respect to product selection have a ripple effect on the natural environment that merits a significant level of professional care. Selection of products used in buildings impacts the Earth directly and indirectly. The building industry is a major consumer of raw materials. Obviously, the type and quantity of raw materials that are extracted and how they are processed constitute the direct impact. Which materials are selected also affects how the building occupants (and, often the community in general) use the building. By obligating occupants, neighbors, and the community to use buildings in certain ways, the selection of building materials constitutes the indirect impact. If, for example, a building uses a membrane roofing system, the installation is likely to involve the release of solvents in the air. If the membrane is black, it is likely to have a negative impact on the energy demands

of the building and of the adjacent structures because of the *albedo* (the reflected heat that raises temperatures in the microclimate). If it is a single-ply membrane system, it is likely to be fabricated entirely from synthetic chemicals and virgin materials rather than recycled materials. Single-ply systems, especially adhered systems, make future disassembly and recycling unfeasible.

Altruism is certainly the most laudable reason to use green building products. Self-interest, however, is generally the most compelling. Using green building materials can satisfy some very self-interested motives: deflection of liability, economic gain, and simple regulatory compliance. Self-interested motives beautifully illustrate the relative worth of an ounce of prevention and a pound of cure.

Liability Issues

The Americans with Disabilities Act (ADA) of 1990 ushered in, among other changes, a new term—*biochemically handicapped*—that is not specifically cited in Title III of the ADA (the part that addresses building design). Title III prohibits discrimination on the basis of disability by public entities. *Biochemically handicapped* describes individuals diagnosed with multiple chemical sensitivity (MCS). Such individuals are acutely affected to varying degrees by chemicals commonly found in building products. They suffer headaches, nausea, rashes, and potentially life-threatening asthmatic attacks. Remember the boy in the bubble? He now has recourse under the ADA, as do all of us. But that recourse is still relatively nebulous. ADA case law presents an interesting phenomenon. While hundreds of cases involving MCS have been filed, few, if any, have gone to trial. Apparently, no building owner or material manufacturer wants to test this far-reaching document relative to responsibilities for environmental hazards. No one wants to risk the potential public liability. No one wants to set the precedent on the books. Nevertheless, various agencies and jurisdictions have recognized MCS as a handicap under certain circumstances. Although the Department of Justice (DOJ) declined to state categorically that environmental illness (also known as MCS) was a disability, it recognized that sometimes an individual's respiratory or neurological functioning is so severely affected that he or she satisfies the requirements to be considered disabled under the ADA.[2] In other words, determination of whether or not MCS is a disability is made on a case-by-case basis.

The single greatest culprit in triggering multiple chemical sensitivity reactions—and subsequent ADA filings—is poor IAQ, often referred to as *sick building syndrome*. According to the World Health Organization (WHO), as many as 30 percent of buildings exhibit some kind of sick building syndrome problem. The EPA has stated that the health risks associated with breathing indoor air are 2 to 5 times the risks of breathing outdoor air. The EPA places poor IAQ fourth on the list of high cancer risks, with 3,500 to 6,000 deaths per year attributable to indoor air pollution. According to the National Institute for Occupational Safety and Health (NIOSH), the relative causes of indoor air pollution are as follows:

53 percent inadequate ventilation

15 percent indoor contaminants

19 percent outdoor contaminants

13 percent unknown

Poor IAQ is expensive; estimates range from tens of thousands to billions of dollars annually in employee sick leave, earnings, and productivity losses. There may also be significant costs associated with IAQ issues for those who find themselves part of a growing body of IAQ legislative case history. Examples of IAQ case law include:[3]

1. *Bloomquist v. Wapello County, 500 N.W.2d 1 (Iowa 1993).* Plaintiffs sued employers and builders for providing an unsafe work environment due to an inadequate HVAC system. The jury awarded $1 million, finding chemical exposure associated with pesticide application and inadequate ventilation. The judge set aside the verdict because of inadequate scientific basis. However, the Iowa Supreme Court reversed the judge's decision and reinstated the original verdict.
2. *Flores v. Winegrad, No. 87-283 4 5 B, Harris County, District Court, Texas.* The owners and manager of apartment complexes terminated the services of a licensed pest control operator in April 1985 and used their own maintenance staff to apply termiticides. When they sprayed chlordane negligently, without notice to tenants, 311 plaintiffs brought a class action seeking compensatory and punitive damages, alleging negligence. As a test case, a number of the plaintiffs were awarded $10.5 million by the jury as a result of the exposure to the misapplied chlordane.
3. *Uricam Corp. v. Partridge Investment Co., No. CJ882691, OK D.C. (Oklahoma 1988).* The owner of an asbestos-contaminated building occupied by the Oklahoma Department of Commerce sued the building's prior owner for $2.9 million, the cost of asbestos inspection, abatement, and damages. The suit was based on a breach of seller's representations and warranties. The asbestos was discovered by Department of Commerce employees. In addition to damages, the complaint sought indemnification against third-party liability. The suit was settled.
4. *Bloomfield Co. v. State, 3AN-87-2082 (Alaska).* The state of Alaska moved out of a building owned by Bloomfield Company, alleging sick building syndrome. When the landlord sued the state for $1.8 million for vacating the premises, the state countersued for $1 million in moving expenses. The case was settled.
5. *Janna Andrejevic, et al v. Board of Education of Wheaton-Warrenville School District et al., Ill. Circ., DuPage Co., No. 200, No. 99 L 00671 (Illinois).* A class action suit was brought against a Wheaton, Ill., school district alleging that numerous children attending a school were exposed to mold and other unhealthy conditions that caused respiratory ailments. The class action alleges that students suffered and continue to suffer permanent respiratory ailments, causing their parents to suffer financial losses associated with medical bills and lost wages. The plaintiffs are seeking $67 million for injuries and injunctive relief to close the school until the allegedly poor environmental conditions are remedied.[4]
6. *Knauf et al Chinese Drywall Litigation.* In late 2006, reports began surfacing of drywall imported from China offgassing sulfur-like odors in newly constructed homes in Florida. At the same time, there was evidence of failure of metal devices installed behind sheetrocked walls, such as HVAC systems and electrical wiring and conduit. A shortage of construction materials manufactured in the United States resulted in builders purchasing products from overseas. Testing conducted on behalf of the Florida Department of Health revealed the presence of strontium sulfide in addition to pyrite in the drywall.

> Subsequently, it was discovered that the possibly tainted drywall was installed in new homes in New Jersey, Connecticut, Maryland, New York, and Virginia in addition to Florida. In May 2009, the EPA released new information from tests they conducted on materials used in Chinese drywall, confirming that it contained sulfur and two other organic compounds generally used in the production of acrylic paint but not used in the manufacture of drywall in the United States. By June 2009, over 70 class action cases were pending nationally.[5]

One of the main reasons that manufacturers, designers, and building owners do not want to set precedents relative to MCS and the ADA is that while IAQ may be the main culprit, it is not the only trigger for MCS reactions; it is just the tip of the proverbial iceberg. As scientific evidence continues to accumulate, chemicals previously considered inert or relatively benign come under suspicion. As we learn more about the complex workings of our ecosystems, we begin to recognize how naïve we were not to ask more questions about the scientific wonders the chemical industry heralded. And, of course, we look for the responsible parties, those who made the materials and those who profited from them. The potential legal exposure under ADA is immense. Any building occupant (employee or guest) can file a suit alleging discrimination on the basis of a disability. However unintentional this result may have been, the ADA is perhaps one of the most powerful pieces of environmental legislation on record.

Economic Benefits

Obviously, the potential for liability has a considerable economic corollary. The use of green materials, particularly materials considered green because they are natural, organic, or nontoxic, can help reduce claims made by MCS individuals under the ADA. The costs associated with potential liability are directly proportional to the size, location, type, and function of the building, and they can be pretty hefty. Anyone caught in the situation, with the clarity of hindsight, can appreciate the wisdom of the old adage, *an ounce of prevention is worth a pound of cure*.

Similarly, it is easier and more cost-effective to prevent waste than to clean it up afterward. Waste costs money. An ounce of waste prevention is easily worth a pound of waste mitigation. While trash may be the most familiar manifestation of waste, it is not the only one. Waste exists at every stage of a product's transition from a raw material through manufacturing, transportation, and use. *Waste* refers to the unused byproducts, the excess energy or heat, and the pollution produced along the way. It encompasses everything from packaging to greenhouse gases. Waste is lost profits. It is something you have purchased but cannot sell or use. Cut the waste, and you reclaim lost profits.

By performing an eco-audit of your building design, building operations, and manufacturing process, you can identify waste and possibilities for trimming it. An eco-audit is an earth-friendly review of the materials and operations in your building conducted to identify cost-effective opportunities for improving indoor air quality, water quality and efficiency, energy efficiency, waste minimization, and the environmental integrity of the local ecosystem. An eco-audit is not a review for compliance with environmental regulations. It is a perspective of the building as a living system. An eco-audit reviews the system to

identify the input (the energy, materials, and labor required to create the product or service), the output (the product or service itself), and the byproducts (the waste products created in the process). The systems approach examines processes and relationships in addition to materials. An eco-audit is useful for planned new construction and for evaluating existing construction. Opportunities exist to improve efficiency and to green a building and its operations within all schedules and budgets.

Green products can help mitigate economic losses from waste. Hundreds of opportunities exist in nearly every arena. Water conservation and water quality management, for example, boast numerous products and systems that can pay for themselves quickly.

Water use in the United States more than doubled from 1950 to 1995, increasing from 680 billion liters (180 billion gallons) per day to more than 1.5 trillion liters (400 billion gallons) per day.[6] The U.S. Geological Survey estimates that the country currently uses 410 billion gallons of water each day.[7] Fresh water is the most precious and one of the most limited resources on our planet. The United Nations Population Fund estimates that only 2.5 percent of the water on the Earth is fresh and only about 0.5 percent is accessible ground or surface water. As the global population has grown, increasing threefold over the last 70 years, the use of freshwater resources has increased sixfold. The World Bank reported in 2001 that agriculture accounts for 70 percent of annual worldwide water use, industry for 22 percent, and household use for 8 percent.

The building industry diverts an estimated 16 percent of global fresh water annually. This estimate accounts for the quantity of water required to manufacture building materials and to construct and operate buildings. It does not reflect the impact of the building industry on the quality of water. It is entirely possible that future estimates of the percentage of available fresh water will decrease as we contaminate our limited supply.

Simply replacing a leaky faucet can save 160 liters (36 gallons) per day. Sensor-operated faucets and flush valves are classic examples of automatic controls to reduce waste. Low-flow fixtures are another way to conserve water. Homes with older fixtures use about 75 gallons of water per person per day; homes with water-saving fixtures that are now required by most plumbing codes use between 25 and 50 gallons of water per person per day.[8] The U.S. Department of Defense (DOD), in compliance with Executive Order 12902, "Energy Efficiency and Water Conservation at Federal Facilities—March 8, 1994," installed new multistage dishwashing equipment in a federal cafeteria. Multistage dishwashers reuse water from the rinse cycle to prewash dishes. The DOD installation cost $57,800 and resulted in an annual savings of 500,000 gallons of water, $2,000 in water costs, and $19,000 in labor costs. Payback was 2.7 years and is projected to save almost $500,000 over the 25-year life of the installation.[9]

Selecting indigenous plant material (xeriscaping) instead of decorative hothouse species could reduce municipal water requirements more effectively than low-flow fixtures or sensor-operated faucets. Because native plants are appropriate to the climate, they are easy to maintain. They do not need extra water or care, except perhaps during the 12-month establishment period. Buffalo grass is replacing many lawns in the prairie states. Buffalo grass requires 25 inches of water per year compared to Bermuda grass, which requires 40, Zoysia, which requires 45, and St. Augustine, which requires 50. Compare such water requirements with the average 35.45 inches annual rainfall in the Dallas–Fort Worth area[10] or the average 35.30 inches in Canton, Illinois.[11] Furthermore, not only is less water required but also less chemical fertilizers and pesticides.

Ozonation equipment also offers the dual savings of reduced water requirements and reduced chemical requirements. To this it adds energy savings. Ozone oxidizes bacteria, viruses, and other contaminants up to 3,000 times faster than chlorine, thereby reducing chemical usage up to 95 percent. With the addition of ozone as an oxidant, laundry and dishwashing machines can run at lower wash temperatures for shorter cycles. Washing time can be reduced by nearly half because the rinse cycle can be eliminated. Ozone reduces total dissolved solids, which reduces calcium and scale buildup, so swimming pools need to be drained less often and equipment life is prolonged.

Where droughts are common, rainwater harvesting systems are exceptionally useful at minimizing waste. Rainwater harvesting keeps rainwater on site. It lessens the burden to municipal water facilities and decreases erosion and flooding caused by runoff from impervious surfaces. Rainwater harvesting systems gained high-profile recognition when, in January 1999, the U.S. Postal Service (USPS) opened its first green post office in Fort Worth. This facility incorporated, among other items, a rainwater harvesting system. Droughts are common in Texas; they have occurred somewhere in the state once every decade of this century.[12] Therefore, it is especially important for Texans to use water wisely. The system being tested by the USPS is helping develop a viable technology and bring it to the mainstream.

Energy-efficient products and, in some cases, water-efficient products can generate economic gains that are clearly documented on utility bills. Many utilities, recognizing that it would be cheaper for them to help finance the replacement of thousands of inefficient appliances and equipment with new, efficient units than it would be to build new plants to serve anticipated loads, offered rebates throughout the 1980s and early 1990s. The incredible success of the EPA's voluntary programs, Green Lights and Energy Star, is the result, in large part, of the improvements seen by participants in their bottom lines. In the summer of 2002, the EPA began to investigate ways to enhance the market for water-efficient products as a potential program to respond to the growing demands placed on U.S. water supplies and water infrastructure systems. As a result of their initial investigation, the EPA conducted several stakeholder meetings during 2003 and 2004. Over 100 state and local water officials, environmental organizations, and businesses indicated their support for a water-efficient product-labeling program modeled after the Energy Star program. In June 2006, EPA launched the WaterSense program. Since then, WaterSense has issued specifications for WaterSense labeled single-family new homes, flushing urinals, high-efficiency bathroom sink faucets, and high-efficiency toilets. Specifications are also under development for weather-based irrigation controllers and showerheads.[13] Before computer-controlled, self-regulating heating and air conditioning systems, people built climate-appropriate buildings—buildings that caught the cool breeze on a hot summer day and allowed the sun to shine deep into the interior during the cold days of winter. This approach is called *passive solar design*, and it has a long history. In 360 B.C., Socrates wrote: ". . . in houses with a south aspect, the sun's rays penetrate into the porticoes in winter; but in summer, the path of the sun is right above the roof so that there is shade. If, then, this is the best arrangement, we should build the south side loftier to get the winter sun, and the north side lower to keep out the cold winds." Technological advances permit us to build without regard for climate. However, if we combine the efforts—build in a climate-appropriate way *and* use convenient modern technologies, we can maximize our energy efficiency. Simply locating deciduous plants on the south and west sides of a building can cool a building in

summer with their shade and allow warm sunshine to penetrate the building in winter when their leaves are gone. Another simple climate appropriate consideration is albedo. Albedo can affect energy efficiency because it affects the microclimate—that is, it is a lot hotter walking across black asphalt paving than it is walking across concrete paving, it is hotter walking across concrete paving than it is walking across grass, and it is hotter walking across grass than it is walking across shaded grass. Reductions in surrounding microclimate temperatures mean that the building air conditioning does not need to work as hard. In some urban areas, utility rates are as much as 10 percent greater than in adjacent rural areas. This is because of the albedo of the paved roads and tall buildings in urban areas.[14]

Consumer Demand and New Markets

Green products can help recapture lost profits by mitigating potential liabilities and reducing waste. Manufacturers and building owners have already learned this and are implementing efficiency upgrades in various forms. This raises the benchmark and creates a demand for the identification of other possible lost profits, other opportunities for green products.

In addition to mitigating economic losses, using green building products responds to a growing market demand for organic, nontoxic, energy-efficient, earth-friendly products across the board. Consumer interest in environmental issues has been gaining ground steadily. Health food stores and environmental mail order catalogs abound. It is rare to open a newspaper or watch television without being exposed to information about environmental damage, followed by what people are doing to fix it. How many surveys have you seen estimating the environmental surcharge people are willing to pay on gasoline, cigarettes, or energy? *The Green Consumer Guide,* published in 1988, was a bestseller. Since then, entire publishing companies have been dedicated to environmental issues. The public is hungry for green products and gravitates to green markets wherever they become available.

Mirroring consumer demand, the U.S. federal executive branch requires green practices of the federal government. This supercedes partisan politics. It is about as universal as things get on Capitol Hill. In 1993 President Clinton issued Executive Order 12873, "Federal Acquisition, Recycling, and Waste Prevention," which directed each executive agency to "incorporate waste prevention and recycling in the agency's daily operations and work to increase and expand markets for recovered materials through greater federal government preference and demand for such products." In particular, the order required that all paper purchased by the federal government contain 20 percent post-consumer recycled content by the end of 1994, increasing to 30 percent by 1998. Subsequently, Presidents Bush and Obama endorsed commitments made by previous administrations and then increased them.[15] Such presidential mandates for the U.S. federal government, perhaps the single largest contractor in the world, drive new markets. The U.S. General Services Administration (GSA), which provides the buildings and supplies for the federal government, annually negotiates $200 billion of goods and services bought from the private sector.[16] It purchases the paper, which must contain a minimum of 30 percent recycled materials, that the federal government uses. It is not surprising that paper with recycled content is now readily available and comparable in cost and quality to paper manufactured entirely from virgin trees. To assist federal customers in meeting their environmental goals, the GSA's Federal Acquisition Service publishes a *Global Supply Environmental Products Catalog* containing

information about thousands of products that have recycled or biobased content, conserve energy and/or water, or contain pollutants, as well as environmental services offered by GSA. In addition, GSA's Federal customers can view and purchase environmental products through either the GSA*Advantage!*® and the GSA Global Supply online systems. An environmental specialty category has been added to both online systems enabling customers to select products that are environmentally friendly.[17]

The environmental market, encouraged by the federal government, is shifting away from cleanup to pollution prevention, from Superfund activities to research and design. For years, the EPA has emphasized end-of-pipe regulations, which control pollution only after its creation. The EPA is increasingly focusing its efforts on pollution prevention. Enter the architect, the manufacturer, the landscaper, and the specifier.[18] This shift in emphasis opens up a new market for products and services. The global market for environmental technologies in 1992 was approximately 300 billion dollars and five years later an estimated 400 billion dollars.[19] *Environmental technologies* are defined as those that "advance sustainable development by reducing risk, enhancing cost-effectiveness, improving process efficiency, and creating products and processes that are environmentally beneficial or benign. The word technology is intended to include hardware, software, systems, and services."[20] Both green building products and green design services are factors of the burgeoning environmental technology market.

Some of the most visible displays of this shift in federal approach are the voluntary programs for energy efficiency. For a while, the EPA and the DOE stumbled over each other trying to establish programs. Finally, in 1996 they joined to increase the product categories available under the Energy Star label. Starting in 2000, Green Lights, ClimateWise, and the labeled products program were consolidated under the Energy Star umbrella. The result is impressive. Green Lights is a voluntary program to assist conversion to more energy-efficient technologies such as T-8 lamps, electronic ballasts, occupancy sensors, daylight controls, and compact fluorescent lamps. The Energy Star program expands upon the concepts originally found in the EPA Green Lights program, applying the approach to other technologies, including computers, office equipment, residential appliances, commercial food service equipment, and buildings. EPA currently has specifications for climate controls, data center storage, heat/energy recovery ventilators, integral LED lamps, laboratory grade refrigerators and freezers, pre-rinse spray valves, small network equipment, and uninterruptable power supplies under development.[21] The Energy Star Homes Program requires energy consumption that is at least 15 percent less than homes built to the 2004 International Residential Code (IRC) and include additional energy-saving features that typically make them 20–30 percent more efficient than standard homes.[22] Homes that comply are eligible for energy-efficient mortgages.[20] Since 1995, more than one million Energy Star homes have been built, saving their owners more than $270 million dollars a year on their utility bills while avoiding greenhouse gas emissions equivalent to those from 29 million cars, and at the same time saving $19 billion.[23]

Regulatory Requirements

Still, regulatory requirements are in place at local, state, and federal levels that are not voluntary and that do emphasize end-of-pipe solutions. Regulatory requirements can also

have significant economic effects. Ask any lobbyist. For example, compliance with environmental legislation, such as the National Pollutant Discharge Elimination System (NPDES), requirements of the Clean Water Act, or the abatement requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) can be expensive. Green products can mitigate the expense and help streamline compliance.

NPDES prohibits discharge of pollutants into waters of the United States unless a special permit is issued by the EPA, a state, or, where the authority is delegated, a tribal government on a Native American reservation. NPDES requirements affect permit applications, regulatory guidance, and management and treatment requirements. The Phase I Stormwater program permit application requirements address certain categories of stormwater discharges associated with industrial activity, including manufacturing facilities; construction operations disturbing five or more acres; hazardous waste treatment, storage, or disposal facilities; landfills; certain sewage treatment plants; recycling facilities; power plants; mining operations; some oil and gas operations; airports, and certain other transportation facilities. Government-owned facilities must also comply. The Phase II Stormwater program applies to smaller municipalities and is estimated to include as many as 1.1 million commercial, institutional, and retail sources, and 5,700 municipalities.[24] The Phase II program also covers small construction activities disturbing between 1 and 5 acres of land.

In many circumstances, retention ponds are required to obtain NPDES permits. However, pervious paving can often reduce or eliminate the need for retention ponds. Pervious pavement is a green building product. It includes pervious concrete and interlocking pavers that allow water to percolate through the joints of the pavers and paving forms specifically designed to support soil and grass. Most of the paving forms that are designed to support soil and grass are fabricated from recycled plastic. Use of pervious concrete paving or pervious pavers reduces stormwater runoff from solid surfacing. Pervious pavement can be up to 90 percent permeable, which means that 90 percent of the moisture that hits the paved surface will percolate through it, and 10 percent will run off.

Abatement of contaminated soil is another example of the potential for a green approach to save on regulatory requirement expenses. Ordinarily, contaminated soil is removed and mechanically or chemically treated off-site and burned or landfilled. Phytoremediation is an alternative treatment that can be as much as 50 percent less expensive than standard treatment. This innovative technology utilizes plants and trees to clean up contaminated soil and water. It is an aesthetically pleasing, solar-energy-driven, passive technique that can be used to clean up metals, pesticides, solvents, crude oil, polyaromatic hydrocarbons, and landfill leachates. Plants can break down organic pollutants that contain carbon and hydrogen. Plants can also extract (phytoaccumulate) certain metal contaminants. Nickel, zinc, and copper are the best candidates for removal by phytoextraction because they are the favorites of the approximately 400 plants known to phytoextract contaminants. The plants are harvested as necessary and either incinerated or composted to recycle the metals. Trees have long taproots that act as organic pumps/filters. Poplar trees, for example, can pull out of the ground 30 gallons of water per day. The pulling action of the roots decreases the tendency of surface pollutants to move downward toward groundwater or aquifers.

At the local level, environmental regulations take on a more regional flavor, responding to local environmental quality issues and economic concerns. Like international agreements, however, local developments can translate into national policy. Concerns about air quality

originally localized in New England and California have gained federal attention. Recycling procurement policies, prevalent at the state level, are replicated in federal Executive Orders.

The international level can also give birth to national regulatory requirements. Although international agreements do not obligate the signatory nations per se, they nevertheless carry a great deal of political weight. More than 150 international environmental treaties have been adopted, most since 1970. Ultimately, many are internalized by signatory nations through national legal processes in each country. As seen in Kyoto, even when international environmental treaties are not internalized via the legislative process, they can affect a country. Nations that do not embrace global political agreements often find themselves in an extremely unpleasant spotlight. Thus, despite their relative lack of enforcement mechanisms, international treaties can be powerful tools that affect the development of national regulations and economic strategies.

The Montreal Protocol, authored in 1987, was an international agreement to phase out substances destructive to the ozone layer. It was amended in 1990 and accepted by 93 nations agreeing to phase out five key chlorofluorocarbons (CFCs 11, 12, 113, 114, and 115), carbon tetrachloride, and nonessential uses of fire-extinguishing halons by the year 2000. It also stipulated the phaseout of hydrochlorofluorocarbons (HCFCs) by the year 2020 and established a multilateral fund to help developing nations finance this effort. In 1990, President Bush signed the Clean Air Act Amendments, which internalized the Montreal Protocol for the United States. The Clean Air Act Amendments mandated an increase in controls for acid rain, urban smog, car emissions, toxic air pollutants, and ozone depletion. Under this law, the EPA sets limits on how much of a pollutant can be in the air anywhere in the United States. Individual states may have stronger pollution controls, but no state is allowed to have weaker pollution controls than those set for the country as a whole.[25]

Agenda 21, developed in 1992 at the Earth Summit in Rio de Janeiro, had no less ambitious a goal than to stop and reverse environmental damage to our planet and to promote sustainable development in all countries. Agenda 21 contains 40 separate areas of concern with 120 separate actions and corresponding financial requirements to address: quality of life on Earth, efficient use of natural resources, protection of the global commons, management of human settlements, chemicals and the management of waste, and sustainable economic growth. The U.S. Climate Change Action Plan was a partial internalization of Agenda 21. It emphasizes voluntary programs to achieve a reduction in greenhouse gases to 1990 levels by year 2000. Greenhouse gases (carbon dioxide, ozone, methane, nitrous oxide, chlorofluorocarbon, and others) act like the glass panes of a greenhouse. They allow light, infrared radiation, and some ultraviolet radiation from the sun to penetrate the atmosphere to the Earth's surface, which absorbs much of the solar energy and reflects infrared radiation. Some of the reflected radiation escapes into space, and some is trapped by the greenhouse gases and reflected back to the Earth as heat. When greenhouse gases build up in the atmosphere, more heat is trapped and reflected back to Earth, resulting in global warming. Greenhouse gases have increased significantly since the Industrial Revolution of the mid-1800s. The plan addresses both economic and environmental concerns. By improving efficiencies, the United States improves our national bottom line and prevents the pollution associated with the energy generation. The U.S. Climate Change Action Plan details 45 actions and $1.9 billion in redirected federal dollars, along with an estimated $60 billion savings by year 2000. Estimated savings include 25 percent energy savings in construction

and 40 percent energy savings in building operations. The plan is implemented, in part, through EPA and DOE programs such as Energy Star and Rebuild America.

Of equal importance to international agreements are international standards. Just as numerous standards-making bodies exist at the national level, many such bodies operate at the global level. Of relevance to the building industry and to green building in particular are international standards developed by the International Organization for Standardization (ISO) and by ASTM International (formerly the American Society for Testing and Materials). The development of standards dealing with environmental subjects is covered in more detail in Chapter 5.

Altruism and Professional Responsibility

The costs that may be tracked on a typical assets/liabilities summary may appear significant to the bottom line of a particular project or product, but they pale in comparison to the environmental costs. It may be hard to economically justify basic it's-the-right-thing-to-do logic, but it will be impossible to continue without it, economically and otherwise.

We have only this one planet. It has the same amount of resources—water, air, minerals—that it has had since the beginning of time, yet demand for them is continually increasing. More people and higher standards of living require more and more goods. Most goods are derived from the Earth's natural resources, to be used briefly and then buried in a landfill. By the middle of the next century, the same limited amount of resources is expected to support nearly 12 billion people. We need to be extremely careful of the resources we use and how much of them we use. We must vigilantly ask and answer these questions:

What are we using?

How well are we using it?

Furthermore, our limited resources are not spread out evenly. There are centers of biodiversity. *Biodiversity,* or *biological diversity*, refers to the variety of plant and animal species and the ecological communities in which they live. Scientists have discovered that each species on Earth originated in only one location. Pecans and sunflowers, for example, are believed to have originated in the Oklahoma area. From there, they spread across the earth. Because they originated in Oklahoma, however, the greatest variety of pecan and sunflower types are still found in this area. We rely on biodiversity, the different characteristics of different species, for medical, agricultural, and industrial advances. When we remove all existing vegetation during the construction process, even if we landscape with native vegetation" afterward, we destroy a portion of the biodiversity of the area forever.

We also contribute to the destruction of the Earth's biodiversity when we rely on a single species. Most lumber products, for example, are derived from an extremely limited number of species. Codes, standards, and industry structural tables are limited to a handful of species, such as southern yellow pine. Reliance on a single species or a limited number of species promotes *monoculture,* the antithesis of biodiversity. It was, in part, monoculture that devastated Ireland in the Great Potato Famine of the mid-1800s. At the time, the

Irish relied almost entirely on a single species of potato. When it failed, thousands died of starvation.

Some techno-enthusiasts have argued that a little DDT would have put an end to the potato famine in a hurry. In the short term, that may have been true. But the next generation of Irish would have been much worse off. How much simpler to plant several species of potato to benefit from nature's resiliency in the vast gene pool! How much healthier for us and for the planet to eat potatoes that survive blight without poison! The DDT solution overlooks a basic law of nature, the *conservation of matter*. Everything cycles. *Everything.* Everything moves from physical reservoirs to biological reservoirs and back again. In the summer, the carbon dioxide we exhale may be utilized by the leaf of the tree, which will fall to the ground in autumn, decompose under the winter snow, and nourish our vegetable garden next spring. *Everything cycles*.

By specifying green products—products that are nontoxic, have recycled contents, and are themselves easily recyclable—we can make it safer and easier to cycle materials responsibly and eliminate waste. Waste costs money. It pollutes the planet and consolidates the Earth's resources in singularly useless pits around the world. Most landfill pits are hygienically isolated and rigorously compressed such that the contents are not exposed to oxygen or water and, consequently, do not readily decompose. Even for a site that promotes decomposition, however, decomposition time for plastic is one million years; for paper, one month; for glass, over one million years; for apples, three to four weeks; and for aluminum, 200 to 500 years.[26]

Societal costs can be significant. A tiny island about 2,000 miles from the nearest continent was "discovered" on Easter day in 1722—Easter Island. It was barren, a biological wasteland except for grasses and insects—and the statues. You have probably seen the statues, approximately 200 mammoth stone sentries, some more than 30 feet tall and weighing over 80 tons. These statues were a scientific and historic mystery for years. Now, based on analysis of ancient pollen stratified on Easter Island, we know a little more about the statues and the people who made them. Around A.D. 400, Easter Island was a subtropical paradise, rich in biodiversity, with abundant plant life and animal life. The most common tree was the Easter Island palm, which grew more than 80 feet tall and was ideal for carving into canoes and equipment for erecting statues. The island also produced the toromiro tree, similar to mesquite, which was good for fuel, and the hauhau tree, from which could be obtained a strong fiber ideal for making rope.[27]

We now know that the inhabitants of Easter Island developed a highly organized social structure of approximately 2,000 people. We also know that they exploited their resources to the extreme—to their own extinction. These people are gone. They paid the highest price for their environmental mistakes.

Of course, we have made a few mistakes of our own. Each has had significant societal costs. Here are some recent examples:

1. *Love Canal, New York (1978).* Attributing high rates of illness and birth defects to highly toxic chemicals dumped at the site from 1942 to 1953, New York State forced the evacuation of 740 families from the area. In 1980, the site became the first federal environmental disaster area.
2. *Bhopal, India (December 3, 1984).* A chemical accident at a Union Carbide pesticide plant resulted in approximately 10,000 deaths and 200,000 to 500,000 injuries.

3. *Chernobyl, Russia (April 25–26, 1986).* By far the worst single disaster in the world's nuclear power industry, the meltdown at the Chernobyl nuclear power plant resulted in at least 50,000 deaths and radiation levels that 10 years later were reported to be 40 to 800 rads in the affected area (average normal background radiation is 7 rads; 12 rads is considered dangerously high and requires protective gear to avoid exposure).
4. *Prince William Sound, Alaska (March 24, 1989).* An Exxon supertanker grounded on Bligh Reef and spilled more than 11 million gallons of oil into Prince William Sound. Environmental damage is still being quantified and, unfortunately, debated.

These mistakes did not happen on isolated islands. Radiation, pollution, and chemical spills do not recognize geographical or political boundaries. They are not contained by mountains or oceans. These mistakes affect the global commons, the resources we all share. It should be no surprise, then, that we also share their economic impact. It costs each of us when the environment and our health and welfare are jeopardized. A 1984 WHO Committee report suggested that up to 30 percent of new and remodeled buildings have poor IAQ.[28] Poor IAQ, according to the EPA, costs Americans $1.5 billion in medical bills and tens of billions in lost productivity annually. Up to 10 percent of urban electric demand is spent cooling buildings to compensate for heat gain because of a concentration of buildings, traffic, and dark paved surfaces.[29]

A growing number of statistics quantify societal costs that, historically, were not quantified, nor were they even recognized. If you are susceptible to poor IAQ that can be 100 times worse than poor outdoor air quality, your head may ache, your energy level may diminish, and you may become physically ill—perhaps even suffering long-term health effects. Typically, you will not trace any of these symptoms to the cause; you will merely call in sick to work until your body can rid itself of the debilitating toxins. Then, you will return to your daily routine until the buildup of toxins in your system is, once again, more than you can tolerate. This susceptibility is called MCS, and it might be considered a handicap under the Americans with Disabilities Act.

Other aspects of societal costs are also beginning to be recognized. The World Resources Institute has partnered with General Electric and Goldman Sachs to launch an initiative to measure water-related risks that face companies and their investors. Their goal is to develop a Water Index as a standardized approach to identify and mitigate water-related corporate risk. With water scarcity and quality becoming a problem around the world, it will begin to impact the performance of companies. The Water Index will use data that is publicly available regarding physical scarcity and water quality and overlay regulatory regime and social and reputational issues that have not been incorporated into water risk measurement previously. Ultimately, the Water Index will allow users to combine and compare different components of the water risk assessment.[30]

GNP is an extremely poor indicator of a nation's wealth and economic stability. It is deceptive. It not only fails to subtract environmental damage from a country's assets, it also generally views them as contributing to prosperity. Global warming, for example, is readily acknowledged as costly and problematic. In 1995, the United Nation's Intergovernmental Panel on Climate Change (IPCC), a group of approximately 2,500 scientists, determined that the greenhouse effect was real, and that human activity, particularly the production of greenhouse gases, was affecting global climate patterns. Furthermore, the IPCC advised

that global warming would not mean an even temperature increase across the Earth. Rather, it would mean an uneven increase resulting in significant alterations to global weather patterns. The poles would warm more quickly than the equator and continents more quickly than the deep oceans. Gulfstream and wind patterns, relied on season after season, year after year, will be affected. In turn, climate regulators such as wetlands, rain forests, and oceanic plankton will be affected. Severe phenomena such as floods, hurricanes, droughts, and fires are likely to typify the changing climate. Over the last decade, the world has experienced a significant number of weather-related disasters. Under current economic systems, the costs to repair and replace damaged property, to feed the newly homeless, and to aid the injured are calculated as increasing the GNP. Money changes hands. Services and goods are provided. These are credits to the GNP. They make it appear to rise. There is no balance to the equation, however, no deduction for the property and lives lost, no deduction for businesses delayed or destroyed, and no recognition of the part global warming played in the event. Hurricane Katrina, which devastated New Orleans and the Gulf coast, resulted in losses estimated at greater than $100 billion. The insurance estimates do not take into account lost lives or lost livelihoods. They do not assess the societal costs of contamination or the impacts on wildlife. They look at the lost structures. So does the building industry. Almost before Katrina had ended her fury, the building industry began a feeding frenzy in anticipation of the profits to be made in the rising demand (and corresponding increase in prices) for building materials. Because GDP still does not account for societal costs and ecosystem costs, it looks like Katrina will result in significant economic growth . . . at least on the books.

Government and academia are not alone in recognizing societal costs of environmental degradation. Industry, particularly those segments most directly affected by global warming, is also beginning to acknowledge societal costs. Hardest hit by the climate change have been agriculture, fishery, tourism, and insurance industries. The insurance industry is extremely powerful and wields a great deal of influence. It has taken notice of cause and effect. The first five years of the 2000s cost the insurance industry $57 billion in weather-related losses, compared to $17 billion for the entire previous decade.[31] Because under the current economic valuation system the insurance industry carries a disproportionately large share of the fiscal burden for societal damage to the global commons, it is particularly interested in revising the status quo. Change certainly means accepting the cause-and-effect relationship. It also means a commitment to reducing the pollution contributing to greenhouse gases, which contributes to global warming, which increases extreme weather and related disasters, which costs the insurance industry billions of dollars. It is also likely to involve new criteria for measurement and distribution of societal costs.

More often, economic equivalents are being developed that help us quantify the enormousness of damage. Wetlands, for example, play an important role in the purification of water on the planet, and their function can be equated to water treatment facilities. Of course, they simultaneously perform other services, such as incubating the majority of freshwater aquatic life. If a vandal were to enter a water treatment facility and dump toxins or fill the holding tanks for the sake of development, he or she (or it, in the case of corporations) would be arrested, jailed, and fined. By establishing comparable values for ecosystems relative to their usefulness to humans, we create the mechanisms whereby vandals destroying wetlands are similarly penalized.

Forests are critical for air purification and planetary cooling. James Lovelock, a fellow of the Royal Society, developed the Gaia theory, the theory that Earth functions as a single

organism. He also developed an interesting economic equivalent for one function of the world's forests. He wrote:

> *One way to value the forests as air conditioners would be to assess the annual energy cost of achieving the same amount of cooling mechanically. If the clouds made by the forests are taken to reduce the heat flux of sunlight received within their canopies by only 1 percent, then their cooling effect would require a refrigerator with a cooling power of 6 kilowatts per hectare. The energy needed, assuming complete efficiency and no capital outlay, would cost annually $1300 per hectare. . . . A hectare of cleared tropical forest is said to yield meat enough for about 1,850 beefburgers annually, meat worth at the site not more than about $40, and this only during the very few years that the land can support livestock. . . . The 5 square meters of land needed to produce enough meat for one burger has lost the world a refrigeration service worth about $65.*[32]

Even this does not begin to address the value of forests as medical resources, construction products, and habitat, nor does it consider the intrinsic value of forests, the inherent worth of a living thing and its innate right to life. (Those interested in legal arguments for the inherent rights of living things should review Christopher Stone's thesis, *Should Trees Have Standing? Toward Legal Rights for Natural Objects.*[33])

More recently, an international effort reviewed and tabulated hundreds of studies to compute the value of many of the services the world's major ecosystems provide. Robert Costanza of the University of Maryland and colleagues calculated that the current economic value of the world's ecosystem services (pollination, water purification, climate regulation) is $16 to $54 trillion per year—compared to the gross world product of $28 trillion per year.[34]

Green Building Materials: An Ounce of Prevention

Buildings impact the Earth directly through their use of resources. They work directly on the quantity and quality of the Earth's resources—the amount they use and the degree to which they contaminate what they use. Buildings impact the Earth indirectly through their performance and through their effect on the performance of adjacent structures. Buildings impact the Earth indirectly through design decisions that help drive the market. If you select a green product, you make a philosophical and an economic statement. Manufacturers are listening.

Architects, as custodians of the built environment, have an opportunity and an obligation to confront these issues. Architects can have a huge impact not only on the design of the building (which can affect the people who use it) but also on the design process (which can affect the market, regulatory requirements, and accepted practices). For building industry members associated with commercial or institutional projects, the potential impact is multiplied.

Often, however, the question is not so much whether a greener, more efficient solution exists but rather how to identify and implement such a solution. The expectations of the design and construction industry tend to limit design choices to current industry standards, which are not necessarily the most efficient. They also tend to focus attention on problem solving during the construction phase rather than problem identification during the design

phase, further limiting the range of possible solutions. Standard design and construction strategies often require a pound of cure. Green strategies offer an ounce of prevention.

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CHAPTER 3

What Are Green Building Materials?

Our entire society rests upon—and is dependent upon—our water, our land, our forests, and our minerals. How we use these resources influences our health, security, economy, and well-being.

—John F. Kennedy

Green building materials are those that use the Earth's resources in an environmentally responsible way. Green building materials respect the limitations of nonrenewable resources such as coal and metal ores. They work within the pattern of nature's cycles and the interrelationships of ecosystems. Green building materials are nontoxic. They are made from recycled materials and are themselves recyclable. They are energy-efficient and water-efficient. They are green in the way they are manufactured, the way they are used, and the way they are reclaimed after use. Green building materials are those that earn high marks for resource management, impact on indoor environmental quality (IEQ), and performance (energy efficiency, water efficiency, etc.).

Ideally, we specify only those products that use a minimum amount of perpetual or renewable resources and that use them very, very well at all stages. Ideally, we understand the basic environmental principle of finite, cyclical matter and temper our every action accordingly. Some radical environmentalists do, even in the building industry.

We support this ideal and endeavor to work toward it. Nevertheless, an awful lot of progress may be made by working with people who are not yet convinced and by demonstrating that green building, especially in shades of green, is possible and painless and often profitable. Furthermore, by so doing, we can collectively raise the benchmark and make it easier to build greener and greener buildings. This book is for those who recognize the necessity of addressing environmental issues and who must cope with those who do not. It is for those who want to do the right thing but must balance ideals with tight schedules, limited budgets, and entrenched anti-green perspectives.

While people may recognize that the term *green* means "environmentally friendly," most have several misperceptions about how environmentally friendly products perform

relative to the standard, more familiar products. In the building industry, it is not uncommon for the owner's initial response to the topic to sound something like this:

"Yes! Of *course,* I'm interested in protecting our environment."

"Yes, I'd like to discuss green building options."

"Yeah, so, what kind of cost are we talking about here?"

"Well . . . does it work?"

"And, um, what would this thing look like, you know, if we did go green?"

It is politically correct to express concern for the environment. Paradoxically, it is equally acceptable to express apprehension at implementing green approaches rather than standard approaches.

Information detailing environmental degradation, global warming, and chemical contamination of our earth is readily available. It is disseminated across society, from kindergarten through graduate school, on National Public Radio programs and in CNN news clips. Leading scientists, including about 2,500 scientists from the United Nation's Intergovernmental Panel on Climate Change, concur that human activity causes pollution, vanquishes species, and is linked to global warming.[1] We know that we have a problem.

However, the correlating education and support network that would enable us to respond actively and positively to the environmental warnings is still forming. Partial information, outdated information, and misinformation plague the successful development of green building. The majority of building owners, designers, engineers, contractors, manufacturers, and building officials are receptive to protecting the environment but are *not* receptive to using green materials to accomplish the task. The unfortunate perception is that green building materials look bad, cost a lot, and do not perform well. Understanding this perspective is essential for effectively resolving such concerns. Therefore, in order to better understand what green building materials are, we need to clarify what they are not. We need to get rid of the pervasive misperceptions about green building materials.

What Does Green Look Like?

It is important to recognize the overwhelming societal prejudice in this country against environmental aesthetics. Environmental enthusiasts often overlook this. The resistance is reflexive—a fear of being different. And more, of being odd, and perhaps a little low class. The stereotypical image of environmentalists is that they live off the grid and build with aluminum cans, tires, and straw bales. They wear unwashed jeans and tie-dyed shirts. They have long hair and shaggy beards and eat obscure vegetables.

An awful lot of imagery is associated with the term *environmental*, and it's not all pretty. Many of us are inclined to think about blue skies, lush green foliage, and clear, sparkling water. But the average businessperson and the building owner immediately think low-tech, disheveled, overgrown, uncontrolled, and unprofitable. Translation: dangerous and unwanted.

If we believe that a green material will look trashy, we tend to actually see it that way. Perception filters reality. It adjusts the objective world into subjective information, upon which we formulate decisions and behavior.

It is true that a green product can look distinctive. A photovoltaic panel, for example, is hard to miss. It is also true that aluminum cans and old tires are indeed used directly as building materials. Some people *do* live in old school buses and decorate with found items (trash). This is reuse, pure and simple—but it is *not* what we are talking about here—at least, not only that. We are considering alternative agricultural products, recycled content products, nontoxic products, and energy-efficient products—items that may obviously display an environmental ethic. On the other hand, they may look just like the much more environmentally damaging products they replace. Sustainably harvested wood may have a label on it, but otherwise it looks like wood. In fact, for decades, many products have contained recycled materials. For example, many acoustical ceiling tile lines are fabricated from recycled cellulose. Gypsum board routinely utilizes reclaimed gypsum and recycled paper. Incorporating these materials was an economic decision made by the manufacturers. They determined that the quality of their products could be maintained and the costs lowered if they used recycled content materials instead of raw materials. Previous perceptions, however, viewed such content as trash, so manufacturers did not advertise the ingredients of their products. Some are still reluctant to claim "recycled content" for fear the pendulum will swing again, placing them in the unenviable position of marketing "trash" products.

The style and palette options available for a particular green product are sometimes more limited than for its conventional counterpart. However, the limitations are not necessarily inherent to greenness but often simply the consequence of a new and growing market. There are definitely more options available today than yesterday, and yet more will be available tomorrow. It is difficult to characterize the market impact of a more limited selection because individual response varies so greatly. Some building owners balk at restrictions of any sort. They may have no desire whatsoever to install a metallic-flecked, hot pink flooring system, but they hate the idea of losing the ability to do so. In other circumstances, the limitation is received with elitist fervor. Some building owners glow at the prospect of being the first in the neighborhood to live in a straw bale house or install a rainwater harvesting system.

Decisions about aesthetic acceptability ultimately depend on personal perceptions. They require project-specific evaluation and owner-specific review. We have worked on projects where the building owner felt the proposed green options appeared much more elegant than conventional construction materials; conversely, we have worked on projects where the very same green options were aesthetically unacceptable to the client. While the menu of green styles, patterns, and colors may be less extensive than the traditional smorgasbord of options to which we are accustomed, it still offers plenty from which to choose for interior and exterior finishes and landscaping. In general, there is enough variety in the market to make it accurate to say that, aesthetically, green options are neither better nor worse than conventional design options.

Does Green Work?

Yes, of course. Prior to the Industrial Revolution, society met most of its needs with materials obtained directly from the earth and then returned those materials to the earth after their use. The concern expressed in the "Does it work?" question is that using green materials will require us to decrease our standard of living to preindustrial levels. For some

strange reason, we tend to assume that human ingenuity is limited to the development of petroleum products and synthetic chemicals. Fortunately, a host of entrepreneurs is proving us wrong. New designs for photovoltaic panels have improved efficiencies. New plastics are being derived from agricultural products. Light pipes and heat film (film that becomes opaque when exposed to heat) offer new possibilities in the way we bring natural light into a building.

Perhaps the strongest evidence that green works is that so many green products and systems are gaining in the mainstream. That would be impossible if they did not perform. It would be equally impossible if the products were not cost-competitive.

Isn't Green Expensive?

The owner's question "What kind of cost are we talking about?" reveals the economic perception of green. It costs more. Builders worry about the initial cost of the different and perhaps risky green product as well as about the impact it may have on the overall value of the building investment. Economics is closely related to aesthetics. As many designers have experienced, economics often dictates aesthetics. There is, after all, a tangible economic impact involved in appearances. What is the resale value of your house? Of your car? Can you get a job or a table in a nice restaurant without proper attire?

When cost is discussed relative to environmental issues, it is necessary to consider both the broader societal costs, the costs each of us bears for destruction of the global commons, and the costs directly borne by individuals under the current economic system.

The unfortunate perception of societal costs, however, is that one person does not make much difference. It is not going to matter much if I change the oil in my car and pour it down the storm drain. There is so much water in the world, and this little bit is nothing in comparison. Besides, it is cheaper for me to do it myself than to pay a mechanic, who must comply with the environmental regulations, to do it. The reality, however, is that over 30 times more motor oil is dumped by oil changes and road runoff annually than was spilled by the Exxon *Valdez* supertanker.[2]

Nevertheless, until societal costs are captured, such as with a revised GNP, and distributed proportionally, people will continue to believe that individually they cannot hurt the Earth, and they will continue to act accordingly—that is, if they think about it at all. Even with the abundant wealth in the United States, most people spend the majority of their time devoted to survival tasks: the acquisition of food, housing, and transportation. They don't have a lot of time or money for dealing with such esoteric issues as the health of the planet or community issues such as pollution prevention. We do what is easy and familiar and what costs us the least. Our personal costs are determined by comparing the initial costs and, perhaps, the operating costs (typically maintenance and energy costs) of the readily available options. We are often guilty of the same petty, daily calculations. Building owners are no different. Hard-core environmentalists may object, but if green materials and systems are to compete in the current market, they must do so on the basis of out-of-pocket costs. Happily, many can.

Simple economic comparisons show that green products are often competitive for purchase and installation—especially those that are considered green because they contain

recycled materials. Back when recycled content material was called trash, many mainstream construction products, including ceiling tile, gypsum board, concrete, and steel, contained recycled content materials. The manufacturers made economic decisions—the recycled material performed just as well and was cheaper than processing virgin material. Perhaps most important, however, they could depend on the source. Increasingly, legislation is making it easier and more cost-effective for manufacturers to use recycled content material as feedstock. Legislation that encourages recycling, for example, means that manufacturers are able to depend on recycled materials as a source material; they can retool their plants and redesign their procedures to incorporate recycling without the fear that recycling is simply a fad. Similarly, the elimination of economic subsidies for mining and forestry, originally enacted to encourage settlement of western lands, would decrease the discrepancy between the cost of such materials and the cost of alternative materials. As the infrastructure, legislation, and recycling programs continue to evolve, more industries can take advantage of them.

Energy-efficient products such as light fixtures and appliances must be evaluated in terms of life cycle because they generally are more expensive to purchase and sometimes to install, but less expensive to operate. Probably the single greatest reason (without getting into political discussions of subsidies to oil and mining) is that these are new products; they must bear research and development costs, and they do not have the economies of scale of the less efficient competitors. Happily, if the energy efficiency rating (EER) is good, there is a quantifiable payback.

New, alternative products and systems (or the revival of old systems) may be more expensive to purchase. New products may also be more expensive to install. Composting toilets, for example, aren't common. Although the concept is not difficult, the contractor isn't familiar with it, and it may cost you more until he is. As new markets continue to grow, however, the disparity in initial costs should decrease. As with energy-efficient products, these products are new. The debt they carry is proportionately larger than the comparable mainstream product, and they do not have the economies of scale . . . yet.

Both manufacturers and designers are changing the way they assign cost to a building and to building products. Some manufacturers offer *green leases*. Under a green lease, the product manufacturer is responsible for the disposition of the product at all times. Thus, when the customer no longer requires the use of the particular product or requires an updated model, the manufacturer is obligated to reclaim it and refurbish it or disassemble it for recycling as appropriate.

Green designers and building owners are working with *performance contracts*. The classic example of a performance contract is an Energy Service Performance Contract (ESPC). Overall, initial costs for green projects are often 5 to 15 percent higher than for conventional projects. The increase in cost can be minimized by redefining traditional relationships and by accurately factoring in operating costs. Design fees, which may increase to reflect the additional research and design, can be contractually linked to the operational savings experienced by the building owner. Operational savings can accrue not only from energy efficiency and maintenance procedures but also from substantial increases in worker productivity. Studies indicate that green design (improved lighting and ventilation) has a tremendously positive economic impact on worker productivity in both manufacturing and service businesses. Because labor is the greatest expense by far for most companies, even a

slight increase in worker productivity can have a significant impact on the bottom line. The trick is to determine what performance will be assessed against which benchmark, and how. The U.S. federal government is strongly supportive of ESPCs. Along similar lines, the U.S. Department of Energy and some financial institutions promote energy-efficient mortgages. These recognize that energy-efficient buildings have lower utility bills and, thus, can allow for larger mortgage payments or better terms.

Internally, many companies are adopting the principles of Design for the Environment (DFE). DFE encompasses the product concept, need, and design. Considerations include material selection, energy efficiency, possible reuse, maintainability, and design for disassembly and recycling. DFE is a prerequisite to green leasing. Green leasing necessitates a revision of administrative services. It also requires a basic redesign of products in order to allow for future disassembly and upgrade. DFE and green leasing have the potential to be cost-effective for manufacturers and customers alike because they save much of the energy and materials needed to manufacture the product from virgin materials. They are also extremely resource-efficient. Some major corporations, including Apple and Xerox, are exploring the possibilities of the twin approaches, DFE and green lease.

Perceptions

Perceptions are difficult to change. After World War II, we were surprised that Japan was producing high-quality merchandise. We are equally surprised today to find that manufacturers are producing high-quality *green* merchandise.

Suffice it to say that green may perform the task differently, but it performs it well; green can look different, but it doesn't have to; and, green can cost a whole lot more, but it can also be more cost-effective, especially long term.

Shades of Green

The response to the question "What are green building materials?" is not black and white but rather a shade of gray—or of green. That is an obstacle for the building industry. We are accustomed to specific requirements in order to establish compliance with applicable codes and with accepted standards for professional care. But standards and measurable, prescriptive requirements delineating the greenness of a product are more difficult to define. They are the topic of Chapter 4, "How Does the Product Selection Process Work?"

Let us return to the fundamental benchmarks of sustainability.

What are we using?

How well are we using it?

Obviously, the responses are not simple. They involve a multi-attribute decision-making process. In computer terminology, they involve fuzzy logic. Fuzzy logic develops a response to a complex problem by breaking the problem into a series of simpler questions. As the

answers to each of these simpler questions are derived, the solution to the original problem begins to take shape. In other words, you approach the problem and develop a workable solution, but you are unlikely to generate a simple yes or no response.

The challenge of assessing the relative greenness of a product is that seemingly simple questions may still produce complex answers. For example:

1. *Is it hazardous?* What if one of the byproducts at one of the stages happens to be a synthetic chemical—one of more than 80,000 synthetic chemicals in commercial use that, according the EPA, National Research Council, have *not* been tested for their effect on humans?
2. *Is it locally obtained?* What if one of the input materials in one of the stages happens to be obtained from a location within an endangered ecosystem, such as bauxite for aluminum, mined in the rain forest?
3. *Is it recycled?* What if the input materials are obtained entirely from recycled materials? from recycled petroleum-based materials? What if the only facility equipped to recycle those petroleum-based materials is overseas? What if a product is fabricated entirely from recycled materials but the adhesive resin binder is a known carcinogen?
4. *Is it energy-intensive to make?* What if the fabricating equipment is high-efficiency, non-CFC-producing, state-of-the-art equipment? What if the energy used to power the high-efficiency fabricating equipment is produced in a coal-burning utility plant?
5. *Is it reusable or recyclable?* What if the product in its final stage will probably go straight to a landfill? What if it could be recycled at some point in the future . . . if the facilities or technology could be created to recycle it?

A single product may contain several materials, any one of which may possess green characteristics. Each material may involve hundreds of perpetual, renewable, and nonrenewable resources. It may use some of them well in certain stages of acquisition, manufacture, distribution, and use, and it may not use them well at all during other stages. The information is often difficult to obtain. The product representative is unlikely to know the answers to these types of questions. But good representatives will find out for you—if you ask. Many are genuinely interested. Most want to represent a high-quality product and are often in the best position to communicate to their company the desired quality requirements and new possibilities for meeting and exceeding those requirements.

Balancing the "good" against the "bad" is an unfortunate and, hopefully, temporary reality. Under the current scheme of standards and threat of litigation, it can become an endless pursuit. To best manage the volume of information, to assess it and render an educated, professional opinion, it is helpful to categorize the aspects of green into three categories: (1) resource management, (2) toxicity/IEQ, and (3) performance. These categories are tools to help quickly assess and compare the greenness of one product relative to another. As Life Cycle Assessment (LCA) tools mature, we may adapt or expand the categories for data collection accordingly. For the time being, however, these are currently useful because we have in place ways to quantify and compare information within each of these categories.

Resource Management, Toxicity/IEQ, and Performance

Resource Management

Resource management is a common term in the environmental community, but it is misleading for people more accustomed to the business world. In business, we manage many tasks in great detail. Management hierarchies and methodologies permeate every company, no matter how small. The overriding goal of management is to improve profit. Tangentially, we may focus on maximizing efficiency, improving morale, marketing to new customers, or cutting waste—but the bottom line is the bottom line. In contrast, resource management is not concerned with profits; it is concerned with stewardship. It is not concerned with what can be extracted; it is concerned with what remains. The distinctions are important because the term *resource management* can be used intentionally to confuse the issue. For example, forest management is not necessarily forest stewardship. It might be, but the term more likely refers to the operation of the forest to generate the most timber (profits) possible. Similarly, if you were to hire a waste management firm, your waste is just as likely to go to a landfill as to a recycling center.

Resource management relative to products refers to the impact on the Earth's resources—perpetual resources (solar, wind, tidal energy), renewable resources (timber, soil, grasses), and nonrenewable resources (oil, coal, aluminum)—because of the acquisition of raw materials and the manufacturing process. It considers the impact on biodiversity and ecosystems. Common measurements include recycled content (pre- and postconsumer) and independent environmental certifications of sustainability in acquisition or manufacture. Preconsumer recycled material is material that never made it to the consumer market; it is manufacturing scrap, and most industries utilize their own scraps in some manner. Postconsumer recycled material is the challenge and the better measure of greenness. Utilization of preconsumer waste is green, but it is standard practice. It is baseline. If the product with preconsumer recycled content merely pauses in the consumer's hands en route to the landfill, then it is not a sustainable use of resources. If, on the other hand, a means for collecting the postconsumer material is available that will channel the material back to industry (ideally, back to the original manufacturer), then it is truly recycling.

When resources are managed for the benefit of the Earth and for the benefit of future generations instead of for the maximization of profit, they are considered to be *sustainably managed*. Sustainable resource management requires a perspective that is Earth-centered instead of human-centered. What are we using from the Earth? How well are we using it in terms of the consequences for the Earth, for the water, air, soil, and wildlife?

Sustainable resource management favors these imperatives: reduce, reuse, recycle, and renew. Opportunities for the first three abound in the construction industry.

One opportunity for reduction of waste is utilizing alternative agricultural products such as soy resins, cork, and straw. These products frequently depend on agricultural byproducts (waste), and they are generally biodegradable. In addition, they tend to generate fewer hazardous pollutants during production than their traditional counterparts. This sort of innovative approach is the foundation of the American entrepreneurial spirit. Henry Ford, one of America's most renowned entrepreneurs, developed Model T coil cases made of wheat gluten in 1915. In 1933, he developed soybean paint and plastics. By 1935, two bushels of soybeans went into every Ford car. Ford also developed ways to power vehicles

with ethanol.[3] This approach contributes doubly to the nation's economic prosperity; it not only redirects money spent on waste but also supports the development of new American industries.

Reuse is common among thrift store shoppers and families with small children. For some reason, however, it frequently escapes consideration on a construction project. Potential sites with existing buildings are often overlooked in favor of previously undeveloped sites that can be manipulated more easily and quickly. In many cases, this is a false economy. Salvage! Adapt an existing structure. Redirect existing building components from the waste stream to local community groups, vocational schools, or church groups to give them a new home and you a tax break.

Recycling encompasses not only throwing your empty soda can in the specially marked receptacle but also consciously selecting products with recycled content over products with virgin materials. That simple choice, referred to as *closing the loop*, can save natural resources, the energy to process them, and the waste associated with their production. In 2008, the United States recovered 83 million tons (33.2 percent recovery rate) of materials from the municipal solid waste stream for recycling (including composting).[4] This is an increase of 30 percent over 1980. These materials are no longer classified as waste; they are considered raw materials, feedstock for new products. Estimates for the 1997 value of recovered materials totaled approximately $3.6 billion.[5] Of this, aluminum cans represent one of the highest market values, about $1 billion. Yet, every three months, Americans discard enough aluminum to rebuild our entire airplane commercial fleet. Not only is the material valuable in itself, but recycling one aluminum can saves enough electricity to power a TV for three hours and every glass bottle that is recycled can save enough energy to light a 100-watt light bulb for four hours.[6]

According to the EPA, overall rate of construction waste generation rate (based on studies of residential construction in 2003) is 4.39 lb/ft2.[7] That is, over 4 pounds of waste per square foot of building. We need to recycle. And, in order to recycle, we need recycling infrastructure. As of 2004, the U.S. has more than 1,000 asphalt and concrete recycling facilities, 700 wood waste recycling facilities, and 300 mixed-waste facilities recycle demolition rubble.[8] There are also a number of materials exchange programs that facilitate the exchange of commercial and industrial waste. And, of course, there are more and more products with recycled content.

Building products with recycled content abound. Fiberboard, millwork, and flooring may contain reclaimed wood. Toilet partitions, car stops, and decking may contain recycled plastic. Sheathing and insulation may contain recycled cellulose. Floor mats, dock bumpers, and roof walkway pads may contain recycled tires. Upholstery, carpet cushion, and insulation may contain recycled textiles. Concrete and masonry may contain fly ash or slag. Steel generally contains some percentage of recycled content.

We need to develop opportunities to renew. It is widely believed by environmentalists that we have already exceeded the carrying capacity of the Earth. If this is true, we urgently need to rebuild ecosystems, nurture endangered species, and confront global warming as quickly as possible—before the Earth does it for us. If this is not true, renewal efforts will merely improve the quality of life for all of us. Fixing a problem is always more difficult and costly than avoiding it in the first place. Nevertheless, there are cost-effective options in the building industry. For example, we can reclaim brownfields and other abandoned or underutilized property. We can help stabilize greenhouse gas levels by designing building

programs that utilize urban infrastructure and encourage alternative transportation. We can help stabilize greenhouse gas levels by the simple act of planting trees. We can promote urban agriculture and develop wildlife corridors through urban areas, reinventing the classic garden cities. We can support conversion to renewable energy.

Of course, one of the many positive actions the building industry can take is to develop and use green building products.

Not much information is available about the impact on the Earth's resources attributable to a particular product. We *do* have a lot of information about what has been extracted. It is High Quality. It is Virgin Material. It is Imported. It is 100 percent Pure. But not about what remains. The Depletion. The Degradation. The Contamination. The Social Costs of the Global Commons. However, we do have quite a bit of information about general practices and their results. So while we may not know specifics about Brand X resilient flooring, we do know what the environmental impacts are for the acquisition and manufacture of vinyl-resilient flooring in general.

There are some commonalties among the processes and impacts. Most generate *pollution*; they contaminate ecosystems. Most are guilty of *depletion*; they utilize nonrenewable resources, and they do so inefficiently. And, most cause *destruction*; they ravage ecosystems in order to get at the nonrenewable resources, or they wastefully consume renewable resources, or both.

Pollution. Raw materials for ore and stone ingredients are removed from the Earth through mining, dredging, and quarrying. Raw materials for gas and petroleum ingredients are removed from the Earth through drilling, pumping, and piping. Raw materials for cellulose ingredients are obtained by harvesting. These acquisition processes are typically responsible for soil erosion, pollutant runoff, the subsequent contamination of groundwater, and air pollution. Transportation of the raw materials to the manufacturing facilities involves trains, truck, and boats, and the accompanying fuel, roads, rails, and ports. The greater the distance, the greater the amount of pollution associated with transportation. Fuel is also required in the processing of the raw materials. Emissions from fossil-fuel-burning power plants that generate the energy that runs the manufacturing facilities include greenhouse gases (carbon dioxide, nitrogen oxides, sulfur dioxides), which contribute to global warming and acid deposition. Historically, factories have been located adjacent to natural waterways. Water is used to cool processes, to generate power, and to flush wastes. The ongoing struggles over PCBs in the Hudson River and the contamination of the Great Lakes offer classic examples. Depending on the process and environmental regulations governing the location of the facility, other hazardous substances may also be released into the air, water, and ground. The worst offenders are those who flee strict U.S. federal regulations and establish factories in less regulated areas, especially developing countries. In Mexico, such environmental abuse is so common that there is a word for the perpetrators, *maquiladoras*, or companies that have factories just across the border, exploit the local population, rape their water and soil, export finished products to the United States, and collect the vast profits that our domestic and international governing structures allow them to acquire in such an ignoble manner.

Depletion. In the acquisition of most raw materials, renewable resources and nonrenewable resources are depleted. That we have less of a particular resource is more than just a nuisance or hardship; it is a threat. Survival of any species is dependent, in part, on

the size of the gene pool. Fewer genes, less adaptability. This is especially harmful at a time when we are altering the ecosystem faster than at any point in known history, and species need to be as adaptable as possible to survive. Survival of the ecosystem itself is also often threatened. A rain forest, for example, evapotranspires water into the atmosphere that deluges the adjacent vegetation. When a portion of rain forest is clearcut, the neighboring portion is likely to suffer. Depletion all too often leads to destruction.

Destruction. Direct destruction of ecosystems during acquisition of raw materials or site preparation for construction is readily apparent. However, pollution also destroys ecosystems and habitats and the species that depend on them. The World Wildlife Federation considers the preservation of habitat a primary goal. Without appropriate habitat, the plants, animals, fish, and insects dependent on that habitat die. Many of these species are vital to the functioning of the ecosystems and, consequently, to our own survival. Insects, bats, and birds are crucial players in the web of life. They are pollinators; 80 percent of global crops and 33 percent of U.S. crops are pollinated by wild and semi-wild pollinators.[9] In addition to local habitats, migratory species depend on appropriate sources of nectar-providing plants along their annual routes. Without wildlife corridors, many pollinators are unable to survive the journey. Mining and drilling drastically alter huge tracts of land. Heat and contaminants flushed into our natural waterways destroy the aquatic balance at point of injection and for long distances downstream. Even localized disturbances (e.g., roadways, utility lines) that segregate habitat sufficiently to impede the travel of species for hunting and mating or the pollination of one patch of wildflowers with the next can devastate biodiversity and collapse ecosystems. Conversion of natural areas to so-called productive uses (e.g., the conversion of natural forests to monoculture tree farms) eliminates the necessary complexity of the forest ecosystem. By the time the temporary disruptions (sometimes lasting decades) are restored, the local ecosystems are lost, and, perhaps the larger regional ecosystems are injured beyond repair.

Toxicity/IEQ

Concern for toxicity encompasses indoor and outdoor contaminants and their impact on our health and the health of the planet. Toxicity issues include contamination of the planet and the corresponding degradation of ecosystems and biodiversity, as described in the discussion of resource management. However, because our culture still has a human-centered perspective rather than an Earth-centered perspective, the primary measurement of toxicity in the building industry is indoor environmental quality (IEQ), and within this, indoor air quality (IAQ).

IAQ may be quantified by building owners in terms of worker productivity and customer satisfaction. It is determined more technically by industrial hygienists, researchers, and governing agencies in terms of parts per million (ppm) of a substance relative to current medical opinion of the threshold levels. *Threshold levels* are the points at which risk to human health is considered to transform from negligible to unacceptable.

Logically, this category should be pretty straightforward. Avoid synthetic chemicals in all forms. If nature didn't create a compound, chances are that it can't break it down. The classic example is polystyrene, which is completely nonbiodegradable. It floats across the surf at beaches and rolls around on the side of highways. It appears isolated from nature, an

enigma. However, we are learning that some of the thousands of synthetic chemicals are not quite as isolated from nature as we thought. Rather, they are absorbed up the food chain—not digested and converted but bioaccumulated. When water is contaminated with, for example, DDT, zooplankton living in it may become contaminated as well. They do not process the DDT. They cannot. Minnows eat the zooplankton, and, similarly, store the DDT in their bodies. Larger fish repeat the process. At the top of the food chain, we eat the larger fish. We digest the nutrients and bioaccumulate the DDT. Our bodies, like those of the creatures below us on the food chain, have no way to process it. DDT is not natural. So, like other contaminants, it remains in our bodies until enough of it is accumulated to shut down our reproductive capabilities, our mental capabilities, or all of our life-sustaining functions. We die.

Bioaccumulation is not restricted to ingesting toxins. What we breathe affects us. What we touch may be absorbed through our skin into our bloodstream. A friend of ours taught us this lesson the hard way. He was working on an art project—breathing and touching lots of chemicals—in a structure with poor ventilation and inoperable windows. He fell asleep amid these conditions and never woke up. He was 25 years old. Studies conducted by the Centers for Disease Control and Prevention (CDC) demonstrate that all of us are bioaccumulating synthetic chemicals. The *Fourth National Report on Human Exposure to Environmental Chemicals*, the most comprehensive assessment to date of the exposure of the U.S. population to chemicals in our environment, examines 212 chemicals in people's blood or urine—75 of which have never before been measured in the U.S. population.[10] Findings in the *Fourth Report* indicate widespread exposure to some commonly used synthetic chemicals. For example:

- Polybrominated diphenyl ethers are fire retardants that accumulate in the environment and in human fat tissue. One type of polybrominated diphenyl ether, BDE-47, was found in the serum of nearly all study participants.
- Bisphenol A (BPA), a component of epoxy resins and polycarbonates, may have potential reproductive toxicity. Bisphenol A was found in more than 90 percent of the urine samples from the study participants.

IEQ, IAQ, and bioaccumulation are not typical health, safety, welfare concerns of governmental agencies that license architects, but they should be. By selecting environmentally healthy products, we can help protect the welfare of the community.

Material selection can have a significant impact on IAQ. Even though a product itself may have low volatile organic compounds (VOC) emissions, accessory products such as adhesives may emit VOCs. Also, maintenance may require or encourage the use of products containing VOCs. Similarly, if the product can function as a sink and adsorb emissions from other sources, then the original product's benign characteristics will be overwhelmed when the product is in place. All surfaces adsorb molecules of chemical substances and compounds or particles that are in the air. Adsorption is a chemical-physical bonding that may be either permanent or reversible. The degree that surfaces sorb is a function of the volatility and polarity of the chemical and of the surface area of the sink material. Generally, the rougher the surface, the more sorption is possible. Glass and stainless steel sorb relatively low quantities compared to textiles, wood, and paper. Sinks can be heavily loaded during periods of elevated concentrations, then release (reemit) the substances when the air concentration is lower.

Following are three general guidelines for assessing a product's potential for affecting a building's IAQ:

1. If it outgasses, it will outgas forever, though with decreasing intensity.
2. If it is a dry, packaged product, it was packaged promptly after manufacture, trapping the new smells in the packaging; these will be released when the package is opened.
3. If it is a wet product, it will probably emit VOCs as it cures.

Unfortunately, toxicity/IEQ assessment is not straightforward for two reasons. First, a lot of high-performance building materials contain synthetic chemicals; second, a lot of litigation seeks compensation from those responsible for contaminating the environment (indoor and outdoor).

Many high-performance building materials derived from petroleum and synthetic chemicals have some green characteristics. High-performance glazing, such as low-emmisivity glazing, minimizes the thermal transmission through the glass, thereby improving the energy efficiency of the structure and reducing the amount of pollution generated as byproducts of electricity generation. This high-performance glazing utilizes laminated PVC interlayers and pyrolytic coatings. In place, the glass is inert, and it is potentially recyclable. However, the manufacturing process is guilty of pollution, depletion, and destruction. If we use the product, we share responsibility with the manufacturer for that pollution, depletion, and destruction of the Earth's resources. Single-ply roofing membranes are equally problematic. They offer significant improvements in performance, thereby lengthening the lifetime of the structure below. They are available in light-colored, reflective finishes for improved albedo and corresponding reductions in energy costs. They can be mechanically fastened, making the parts of the roofing systems easier to disassemble and recycle. And they allow the creation of roof gardens, which also help reduce the albedo and reduce stormwater runoff, improve carbon sinking, and contribute to wildlife corridors through urban areas. But, they involve petroleum products and synthetic chemicals that nature cannot break down.

Obviously, high-performance building materials are preferable from a performance standpoint—hence the name, but they are a mixed blessing. Consequently, a lot of time is spent trying to establish acceptable compromises and, in turn, defending against litigation that argues that the compromises were breached or flawed from the beginning.

A lot of time and money is spent on defining, in legal terms, *toxic* and *hazardous*, and on demonstrating scientifically that each of the new, non-natural materials is harmless to humans and to nature.

The Toxic Substances Control Act (TSCA), 15 U.S.C. s/s 2601 et seq. (1976), was enacted by Congress to test, regulate, and screen all chemicals produced by or imported into the United States. The act, as its name implies, declares that there may be some potential harm to human health and the environment. The purpose of the act appears to be far-reaching:

> §2601. Findings, policy, and intent
>
> (a) Findings: The Congress finds that
>
> (1) human beings and the environment are being exposed each year to a large number of chemical substances and mixtures;

(2) among the many chemical substances and mixtures which are constantly being developed and produced, there are some whose manufacture, processing, distribution in commerce, use, or disposal may present an unreasonable risk of injury to health or the environment; and
(3) the effective regulation of interstate commerce in such chemical substances and mixtures also necessitates the regulation of intrastate commerce in such chemical substances and mixtures.

(b) Policy: It is the policy of the United States that
(1) adequate data should be developed with respect to the effect of chemical substances and responsibility of those who manufacture and those who process such chemical substances and mixtures;
(2) adequate authority should exist to regulate chemical substances and mixtures which present an unreasonable risk of injury to health or the environment, and to take action with respect to chemical substances and mixtures which are imminent hazards; and
(3) authority over chemical substances and mixtures should be exercised in such a manner as not to impede unduly or create unnecessary economic barriers to technological innovation while fulfilling the primary purpose of this chapter to assure that such innovation and commerce in such chemical substances and mixtures do not present an unreasonable risk of injury to health or the environment.

However, in the subsequent Definitions Section, the act dramatically limits the scope outlined in the previous section by defining the term *chemical substance* to mean "any organic or inorganic substance," excluding "any pesticide (as defined in the Federal Insecticide, Fungicide, and Rodenticide Act (7 U.S.C. 136 et seq.) . . . tobacco or any tobacco product . . . [and] any source material, special nuclear material, or byproduct material (as such terms are defined in the Atomic Energy Act of 1954 (42 U.S.C. 2011 et seq.) and regulations issued under such Act). . . ."[11]

The Toxic Substances Control Act does not define the term *toxic*.

OSHA offers the following definitions.

Hazardous chemical means "any chemical which is a physical hazard or a health hazard."

Physical hazard means "a chemical for which there is *scientifically valid* evidence that it is a combustible liquid, a compressed gas, explosive, flammable, an organic peroxide, an oxidizer, pyrophoric, unstable (reactive), or water-reactive. (Emphasis added.)

Health hazard means "a chemical for which there is *statistically significant* evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees." The term *health hazard* includes chemicals that are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents that act on the hematopoietic system, and agents that damage the lungs, skin, eyes, or mucous membranes. (Emphasis added.)

Under OSHA, the chemicals considered hazardous or carcinogenic are listed in the National Toxicology Program (NTP) "Annual Report on Carcinogens"; the International

Agency for Research on Cancer (IARC) "Monographs"; or 29 CFR part 1910, subpart Z, Toxic and Hazardous Substances, OSHA.

In an appendix, OSHA affirms that determining the specific hazards is difficult and complex, stating, "The goal of defining precisely, in measurable terms, every possible health effect that may occur in the workplace as a result of chemical exposures cannot realistically be accomplished." The truth is that we do not know enough about the complex working of our planet to be able to predict how our actions may affect life's intricately balanced systems. We do not know how the products we use will directly and indirectly affect our own health. Already our ignorance has resulted in some nasty surprises. A more responsible approach would be to use known nontoxic, organic, and natural products to the greatest extent possible. Potentially toxic materials, materials whose reaction in the Earth's ecosystems is not known, should not be used.

Performance

Performance considerations address the indirect environmental impacts associated with a particular product. They examine installation methods, maintenance materials and processes, durability, energy efficiency, and the ability of the product to be recycled or reused at the end of its useful life in the building. Performance issues also include broader considerations regarding the impact of a product on the global commons, such as the albedo of the exterior finishes and the permeability of the paving. Typical measurements include energy efficiency ratings (EER) and, increasingly, worker productivity, and customer satisfaction.

Energy efficiency improvements mean less energy. Less energy means less pollution. Simple.

Longer-lasting, more durable products mean less replacement. Less replacement means less total strain on our resources. Also simple.

In addition to these issues are installation considerations. Where acceptable to code, mechanical fastening is preferable from an IAQ perspective and with respect to disassembly for future reuse. Related materials, which are required for installation of a particular product, can have environmental consequences of their own. Which finishes, adhesives, caulks, or solvents are recommended by the manufacturer? How does the product cure? What, if any, waste materials are generated because of the incorporation of the product into the building?

How much packaging is associated with the product? Opportunities abound on a construction project to reduce and to reuse packaging. Negotiate with manufacturers to explore packaging options. If the design professional never asks, the manufacturer is never made aware of the need. What kind of packaging is associated with the product? Plastic? Cardboard? Building product manufacturers can better position themselves in the changing market by proactively responding to packaging issues. Reduction is fairly commonplace because it makes obvious economic sense. Less money spent on packaging easily translates into more money received in profits. Reuse is beginning to generate comparable results. The type of packaging and the associated labeling remains to be explored. Certainly cardboard with recycled content and the familiar circular arrows are a step in that direction. There are developments on the horizon for greater use of starch-based plastics, not only for packing peanuts but also for vacuum wrapping. Imagine dropping a package of instant soup into hot water—package and all. Soy-based inks are preferable for printing labels. Also, if the plastic is petroleum-based, what kind? Many recycling programs distinguish between HDPE and

PET, for example, just as they distinguish between colored paper and white paper. Unfortunately, most end users cannot readily distinguish plastic type. Plastic needs to be labeled.

Packaging is a high-profile topic for both environmentalists and manufacturers. There are numerous books on the subject of sustainable packaging. There is even an organization dedicated to the topic—the Sustainable Packaging Coalition.

When Are Green Building Materials *Not* Green?

Not only must design professionals ask themselves which building materials are green but also, similarly, they must be cognizant of "green" building materials that are not really green.

The explosive growth of interest in green building projects and the resultant demand for green building materials has encouraged manufacturers to market to that demand. As companies try to paint their products and practices green, we have seen the word *greenwash* become part of our vocabulary. *Greenwashing* is "giving a positive public image to commonly accepted or supposedly environmentally unsound practices." The term arose in the aftermath of the Earth Summit held in Rio de Janeiro in June 1992. For example, products once advertised for their disposability are now marketed for their recyclability.

Knowing when building materials are not green requires going beyond the attributes of the product to its manufacture. You should ask whether the manufacturer has a written environmental policy, a primary point of contact, and a department that addresses environmental issues (both risk management and proactive, green building opportunities).

Greenwash (a take-off on "whitewash") refers to the superficial and unreliable dissemination of environmental hype.

As professionals in the building industry, we must police ourselves so that, in the quest to achieve differentiation, we do not harm but rather support the credibility of our industry. Even more critical is the knowledge that green design standards can establish important precedents. Nonconformance with these standards, exacerbated by greenwash, can result in costly legal actions down the road. If you wonder what the potential harm could be, rent the movie *Erin Brockovich*.

While initially dazzled with greenwash, clients are becoming more educated on the topic and will soon demand a functional depth of knowledge from manufacturers and consultants. Those companies that have not expended the time and resources to develop this depth will not be successful in the long run. As a professional in the field, you can avoid greenwash in several ways:

1. *Do your homework*. Green design is a complex discipline difficult to grasp primarily because the body of knowledge is vast, holistic, and constantly being updated. There are no overnight experts. Certainly knowledge of LEED and similar rating systems is important. Unfortunately, *LEED* is also rapidly becoming a buzzword and a prime leverage point for greenwash. In reality, only a handful of projects across the country have achieved LEED certification. Such rating programs are continuing to evolve. As a design professional, it is not enough to attain LEED accreditation without first developing a base of sustainable design knowledge. The reality is that clients will become informed and begin to ask the difficult questions that will separate those truly committed to green design principles from those serving greenwash.

2. *Make alliances.* Green design requires a holistic view. It is not merely the selection of an energy-efficient system or accreditation in a standards program. To provide a true green design strategy requires knowledge of ecology, biology, chemistry, products, and building methods and techniques. Related knowledge of history, political science, and law is helpful too. This necessitates the expertise of many people, and few companies have the resources to provide them in-house.
3. *Market responsibly.* Greenwash is not merely unethical; it can also result in costly litigation. Marketing is the front line of risk management. To avoid future liability requires that you be careful not only of the information you communicate but also of the information you obtain from consultants and from product manufacturers. Remember CFCs and asbestos—no one knew they would be the subject of lawsuits until decades later.

Overcoming Entropy

If we discredit negative perceptions of the cost, performance, and appearance of green products, and if we educate ourselves regarding green evaluation of products relative to resource management, toxicity/IEQ, and performance, we still have one final hurdle to be overcome: entropy.

Unfortunately, we use what we know, what we used on the last project—even if it wasn't perfect. Why? Well, presumed liability for one. If a material has been in use for an extended period, even with only moderate success, the liability is known—and shared. If everyone is using it, then the standard of care a professional can reasonably be expected to take is established. If a manufacturer, designer, or contractor steps outside the circle and tries something new, the liability is entirely theirs. But so is the success.

Many times, we fall back on the familiar because we are not permitted the time required to examine all the other possibilities. The pace at which our culture approaches life is astounding. The building industry is no exception. The fast track is the norm, and we are constantly searching for ways to improve production speed—from design through construction. Does the use of green building materials slow a job? Maybe. Design time may be extended depending on the project requirements, the client's schedule, and the designer's experience with green building. Construction time may also be affected. The contractor may not be familiar with the product or special installation requirements—but then, that could be true of anything you specify. It is also conceivable that the use of a green product could facilitate permitting and approval processes for sites subject to sewer moratoriums, waste mandates, and so on.

We need to reinvent patterns and habits as drastically as we did during the Industrial Revolution—which upset the balance in the first place. Prophetically, John F. Kennedy observed our dependence on the Earth's natural resources and the necessity for stewardship. Would that we had heeded his environmental message as enthusiastically as we did his challenge to conquer space.

Notes

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8. www.epa.gov/epawaste/conserve/rrr/imr/cdm/recycle.htm
9. Lester R. Brown, Christopher Flavin, Hilary French, et al., *State of the World 1997: A Worldwatch Institute Report on Progress Toward a Sustainable Society* (New York: W.W. Norton, 1997), 102.
10. The blood and urine samples were collected from participants in CDC's National Health and Nutrition Examination Survey (NHANES), which is an ongoing survey that samples the U.S. population every two years. Each two-year sample consists of about 2,400 persons. The Fourth Report includes findings from national samples for 1999–2000, 2001–2002, and 2003–2004. The data are analyzed separately by age, sex, and race/ethnicity groups. www.cdc.gov/exposurereport/.
11. OSHA § 2602. "Definitions," The Toxic Substances Control Act (TSCA), 15 U.S.C. s / s 2601 et seq., 1976.

CHAPTER 4

How Does the Product Selection Process Work?

Hurt not the Earth, neither the Sea, nor the Trees . . .

—Revelations 7:3

The product selection process for green products is becoming quite complex. This is a good news—bad news situation. The good news is that there are lots of innovative products and a wide assortment of green product standards, metrics, and certifications with which to assess them. The bad news is that the explosion of green claims includes some that are just greenwash. Furthermore, even if all of the claims were valid, few are directly comparable to each other. Product selection for green products requires the specifier to sift through all of this data to find the information that is most useful. Step 2 in the Product Selection Process, identification of performance criteria (see below), is critical to managing the tremendous amount of data in a meaningful way.

The product selection process is the same for green products as for standard (nongreen) products. All of the typical considerations for the quality, performance, aesthetics, and cost of a product are explored as usual. Add to this list, green. What are the environmental impacts of the product? How will the earth, the sea, and the trees be hurt? How will they be helped?

The standard product selection process includes the following steps:

1. Identify material categories.
2. Identify performance criteria.
3. Identify building material options.
4. Gather technical information.
5. Review submitted information for completeness.
6. Evaluate materials.
7. Select and document choice.

Obviously, some basic understanding is required at each step. You must understand requirements for how a building is put together in order to identify the material categories necessary for a project. Also, you must have a working knowledge of current construction techniques in order to assess building material options and to know what technical information is necessary for proper evaluation. Concrete, for example, has different performance criteria than does waterproofing. Some considerations, such as durability and cost, are common to all material categories, but the expectations for different materials will be different. A building owner may expect the roof to last 10 to 20 years with relatively little maintenance but may anticipate replacing the carpet every 5 to 7 years.

Most design professionals are unable to personally assess the available material options. There are simply too many and their properties are too complex. Consequently, the building industry relies heavily on reference standards and on the expertise of consultants and trade associations to establish current standards of care for the various material options.

The first challenge for the design professional in assessing green material options is evaluating the green information sources. Which green reference standards have merit? Which consultants? Do the trade associations have green expertise? Do the environmental nonprofits have construction expertise? It is imperative to understand the general concept of green (refer to Chapter 3, "What Are Green Building Materials?") and to know where to obtain the most current standard of care information regarding green. That is the subject of this chapter. You must know what green is in order to know what questions to ask and what technical information to request. You must know where to obtain current standard of care information to be able to verify a manufacturer's claims. You must consider the source . . . carefully. The task is sometimes intimidating but is in essence no different from exploring and evaluating other aspects of a product. If you were determining the strength of concrete, you would need to know enough about the nature of concrete to be able to ask informed questions and obtain technical information appropriate for the requirements of the particular project. You would also need to know where to obtain that information and where to validate it. The *process* of inquiry is the same.

Step 1: Identify Material Categories

During the schematic design phase, general material categories are identified. The Construction Specifications Institute (CSI) MasterFormat™ lists broad categories, which can be used to organize data. The 2004 edition lists 49 categories, while the 1995 edition only listed 16.[1] These categories are organized into groups and subgroups as follows:

MasterFormat 1995		*MasterFormat 2004***	
Division 1	General Requirements	Division 01	General Requirements
		Division 02	Existing Conditions
Division 2	Site Construction	Division 31	Earthwork
		Division 32	Exterior Improvements
		Division 33	Utilities
		Division 35	Waterway and Marine Construction

MasterFormat 1995		*MasterFormat 2004***	
Division 3	Concrete	Division 03	Concrete
Division 4	Masonry	Division 04	Masonry
Division 5	Metals	Division 05	Metals
Division 6	Wood and Plastics	Division 06	Wood, Plastics, and Composites
Division 7	Thermal and Moisture Protection	Division 07	Thermal and Moisture Protection
Division 8	Doors and Windows	Division 08	Openings
Division 9	Finishes	Division 09	Finishes
Division 10	Specialties	Division 10	Specialties
Division 11	Equipment	Division 11	Equipment
		Division 42	Process Heating, Cooling, and Drying Equipment
		Division 43	Process Gas and Liquid Handling, Purification, and Storage Equipment
		Division 44	Pollution and Waste Control Equipment
		Division 45	Industry-Specific Manufacturing Equipment
		Division 46	Water and Wastewater Equipment
Division 12	Furnishings	Division 12	Furnishings
Division 13	Special Construction	Division 13	Special Construction
		Division 25	Integrated Automation
Division 14	Conveying Systems	Division 14	Conveying Systems
		Division 34	Transportation
		Division 41	Material Processing and Handling Equipment
Division 15	Mechanical	Division 21	Fire Suppression
		Division 22	Plumbing
		Division 23	Heating, Ventilating, and Air Conditioning
Division 16	Electrical	Division 26	Electrical
		Division 27	Communications
		Division 28	Electronic Safety and Security
		Division 48	Electrical Power Generation
–	No Equivalent	Division 40	Process Integration

***Note*: Gaps in Division numbering above are to permit future expansion.

During the design development phase, many different subcategories (CSI sections) will be explored. Although you may want to use masonry for the exterior walls, you may still be exploring different types of masonry—clay, concrete, or stone.

Step 2: Identify (Green) Building Material Performance Criteria

Building material/product performance criteria will relate to the overall project goals. Is the focus on energy efficiency? Zero waste? Is there a desire to earn an award? Certification to a green building rating program? Clarification of overall project goals can help establish the general performance criteria for building products.

For each green performance criteria, there will be many options for metrics. Not a few. Not several. MANY. These criteria can be grouped into three general categories:

Single-attribute criterion

Multi-attribute criteria

Life cycle criteria

You need to match the green performance criteria to the green goals of your projects. State these generically. For example, the owner cites human health issues as the top priority. More specifically, the focus is on the health of the building occupants, although other impacts on human health are of interest and concern as well. The corresponding green performance criteria could be:

Single-attribute criterion: Good indoor air quality; achieved by selecting products with low or zero VOCs (volatile organic compounds)

Multi-attribute: Good indoor environmental quality; achieved by selecting products with low or zero VOCs, products with low or zero PBTs (persistent bioaccumulative toxins), products that facilitate occupant control over temperature and humidity, and, products that facilitate full spectrum lighting.

Life cycle: Minimal negative and maximum positive health impacts across the product's life cycle; achieved by a review of product components (ingredients) and byproducts as well as the product itself.

State-of-the-art in green performance criteria is probably multi-attribute criteria. While single-attribute criterion still have merit, they are no longer the best solutions. We know more about systems interactions now. We know that solving a problem in one dimension all too often only shifts the problem to another dimension. We know that it is possible to have a product that excels in one attribute but not in another. Worse, it is possible for a product to appear very, very green for one attribute but be an environmental offender in another attribute. If green claims highlight the good attribute but avoid the bad, that's a form of greenwash. The information available through single-attribute criterion may be valid, but it is always limited.

The rules and supporting infrastructure for life cycle criteria have advanced considerably. The U.S. Life Cycle Inventory (LCI) Database,[2] a public-private partnership between

the Department of Energy and the National Renewable Energy Laboratory (NREL), has been freely available to users since 2003 and as of 2010 has approximately 200 unit process data sets. This online database provides a cradle-to-grave accounting of energy and material flows into and out of the environment associated with producing a material, product, or assembly. Consistent with leading LCA software platforms and with high-profile institutional user demands (e.g., federal government, Wal-Mart, USGBC); it has significantly improved efficiencies in LCA development. Nevertheless, there remain numerous challenges facing experts in the field. Establishing standard scoping parameters and product category rules will take some time.

Life cycle criteria are a complete examination of the environmental impacts of a product. That is currently the goal. It is likely to become the predominant approach in the not-too-distant future.

Single-attribute criterion are the present and soon-to-be past approach.

Using multi-attribute criteria is the current best practice. It is sort of the middle ground between single-attribute criterion and life cycle criteria. It is reasonably achievable now. And, there are a fair number of competing approaches. Some of the major mainstream competitors are:

ASTM International. ASTM Work Item 18435 is a draft Standard Classification for Environmentally Preferable Building Products. The proposed standard defines three levels of performance in each of five criterion categories: energy efficiency and renewable energy, carbon equivalents and global warming potential, water efficiency and quality, material optimization, and, public and ecosystem health protection. The ASTM International Certification Programs offers certification of products (materials, products, services and systems) as well as personnel. A product certified through ASTM's program would be tested, at the direction of ASTM International, by a third-party laboratory to determine the product's ability to conform to one or more ASTM standards.

ICC-ES (International Code Council Evaluation Service). The Sustainable Attributes Verification and Evaluation™ Program (SAVE™) is a program created by ICC-ES to certify green claims made by manufacturers. As of 2010, ICC-ES offers only single attribute green standards, but progress on the ICC draft International Green Commercial Code indicates that product criteria and associated "approved" product lists will need to be multi-criteria. Thus, it is expected that the ICC-ES will develop multi-criteria programs.

NSF-ISR (NSF-International Strategic Registrations). NSF offers several programs to help manufacturers understand and reduce environmental impact. Programs include environmentally preferable product registration, material formulation review and testing, and CleanGredients™ reviews. NSF offers several validation/registration services, including Greenhouse Gas Validation/Verification, ISO 14001, and Chain of Custody Certification and sustainability report verification.

UL Environment. UL offers a Sustainable Product Certification service that tests and certifies environmentally friendly products, processes, and materials to current environmental standards, including single and multi-attribute standards.

Step 3: Identify (Green) Building Material Options

In addition to the standard array of material subcategories, identify green subcategories. Adobe masonry units, rammed earth, and straw bale might be viable options for exterior masonry walls. Also, identify green options within the material subcategories. If you want to use masonry, consider clay masonry fabricated from petroleum-contaminated soil, or concrete fabricated with fly ash and slag. Explore local options for natural stone and reclaimed masonry units.

Greener options are available for almost every conventional building material. Increasingly, these are listed in mainstream product references such as Sweets. Several green building product reference books are available and a wealth of product information is available via the Internet. Following are resources listing green product manufacturers:

- Austin Energy Green Building Program
  721 Barton Springs, RD
  Austin, TX 78704-1194
  (512) 482-5300
  (512) 974-2000
  www.ci.austin.tx.us/greenbuilder

  The website offers the *Sustainable Building Sourcebook*, which explains how and why applying green building principles makes sense. Each chapter includes a list of professionals and resources. Fact sheets offer green building information in a condensed form and includes various building materials.

- Bay Area Build It Green
  Smart Solutions from the Ground Up
  Alameda County Waste Management Authority & Recycling Board (ACWMA)
  1434 University Avenue
  777 Davis Street, Suite 100
  Berkeley, CA 94702
  San Leandro, CA 94577
  (510) 845-0472
  www.builditgreen.org
  www.stopwaste.org

  The searchable database lists green products, local suppliers, and service providers that comply with green building guidelines developed by ACWMA. The *Green Building Materials Resource Guide* is also available. Build It Green is the result of the 2005 merger of the Green Resource Center (est. 1999) and Bay Area Build It Green (est. 2003.)

- Buyer's Guide to Recycled Products
  METRO
  600 NE Grand Avenue
  Portland, OR 97232-2736
  (503) 797-1700
  www.metro-region.org

  This is an online guide to recycled-content products in a searchable database.

- Coconino County Sustainable Building Program (CCSBP)
  Program Manager; Amanda Acheson
  Department of Community Development
  2500 North Fort Valley Road, Building 1
  Flagstaff, Arizona 86001
  (928) 679-8853
  (800) 559-9289, ext. 8853
  www.coconino.az.gov/comdev.aspx?id=148

  Directory of companies that provide services in sustainable building.

- Construction & Green Building Directory
  25 Bank St. N.
  Attleboro, MA 02760
  (401) 954-2983
  (401) 952-8097
  www.newenglandmetalroof.com/construction_directory/

  This directory lists green building contractors and home improvement companies that provide earth-friendly building products and services.

- Construction Waste Management Database
  Whole Building Design Guide
  National Institute of Building Sciences (NIBS)
  1090 Vermont Avenue NW, Suite 700
  Washington, DC 20005
  (202) 289-7800; fax (202) 289-1092
  www.wbdg.org/ccbref/cwm.php

  This database contains information on companies that haul, collect, and process recyclable debris from construction projects. The database is searchable by state, zip code, or material(s) recycled.

- Ecolet
  19 Rausch Street, Suite C
  San Francisco, CA
  94103
  (877) 326-5328 x2
  www.ecolect.net/

  Provides list of alternative eco-materials.

- Energy Efficient Building Products
  Shelter Supply, Inc.
  Dakota Supply Group
  151 East Cliff Road, Suite 30
  Burnsville, MN 55337-1586
  (800) 762-8399
  www.sheltersupply.com

  Lists products and technologies for energy-efficient, healthy home construction.

- EcoBusinessLinks
  "Sustainable Building Materials"
  www.ecobusinesslinks.com/links/sustainable_building_supplies.htm

  This is a directory of companies that sell sustainable building material products.

- Environmentally Preferable Purchasing Guide, The Solid Waste Management Coordinating Board (SWMCB)
  Minnesota Counties of Anoka, Carver, Dakota, Hennepin, Ramsey, and Washington
  477 Selby Avenue
  St. Paul, MN 55102-1726
  (651) 222-7227
  www.swmcb.org/EPPG
  www.rethinkrecycling.com/government/eppg

  This guide lists environmentally preferable products in over 30 product areas and includes the latest field information, details on cost, performance, and vendors.

- Environmentally Preferable Purchasing Database
  U.S. Environmental Protection Agency
  1200 Pennsylvania Ave. NW
  Mail Code 7409-M
  Washington, DC 20460
  http://yosemite1.epa.gov/oppt/eppstand2.nsf

  This searchable database lists products and services with reduced environmental impacts.

- Forest Certification Resource Center
  Metafore
  1306 NW Hoyt St.
  Suite 403
  721 NW Ninth Avenue, Suite 300
  Portland, OR 97209
  (503) 224-2205
  www.metafore.org

  The center lists search tools for certified forest products, certified forests, certified businesses, and approved certifiers.

- Green 3D Home
  green3dhome@engineering.com
  www.green3dhome.com/

  This company helps homeowners reduce their energy use by providing: contact information for builders, designers, green building products, and software to model homes in 3D.

- Green Book Product & Resource Guide
  Environmental Design & Construction
  2401 W. Big Beaver Road, Suite 700
  Troy, MI 48084

(248) 244-1280
www.edcmag.com/greenbook
www.edcmag.com/FILES/HTML/EDC_buyers_guide

Searchable database of products and resources by company name, city, state, and/or product category.

- Green Building & Sustainable Design Books & Manuals
  Northwest Builders Network, Inc.
  85305 Jasper Park Rd.
  Pleasant Hill, OR 97455
  (888) 810-8296
  www.nwbuildnet.com/stores/bookloft/green/

  This directory lists books that help in successfully adopting green building and facility management practices.

- Green Building/Sustainable Building
  Illinois Sustainable Technology Center, University of Illinois at Urbana-Champaign
  1 Hazelwood Dr
  Champaign, IL 61820
  UIUC Mail Code: 676
  (217) 333-8940
  www.istc.illinois.edu/info/library_reference_green_building.cfm#Directories

  This reference guide includes information regarding books, periodicals, service directories, associations/organizations, conferences, and newsgroups/email lists.

- Green Building Materials Fact Sheets
  Environmental Works Community Design Center
  402 15th Avenue East
  Seattle, WA 98112
  (206) 329-8300
  www.eworks.org

  Fact Sheets describes environmentally friendly materials containing recycled content, materials that have energy-efficient and nonpolluting production processes, materials that are sustainably harvested, and those materials that generate minimal offgassing when installed. Each fact sheet provides an overview of the product and discusses raw materials, the manufacturing process, benefits, environmental impacts, health impacts, recyclability, alternatives products, list of suppliers, and a list of references/resources.

- Green Building
  City of San Francisco Environment Department
  11 Grove Street
  San Francisco, CA 94102
  (415) 355-3700
  www.sfenvironment.org

  Lists green building services and materials available in the Bay Area. The website also offers fact sheets covering various building materials.

- Green Building Directory: A Guide to Sustainable Building Materials and Methods in Santa Cruz County

  County of Santa Cruz Department of Public Works Recycling and Solid Waste and the City of Santa Cruz Planning Department, in cooperation with Ecology Action and the County of Santa Cruz Planning Department (2007)
  www.ecoact.org/PDF/GBD.pdf

  The guide offers a broad introduction to green building materials and waste reduction methods. It provides a basic overview of environmental considerations and an outline of environmentally friendly alternatives to conventional techniques.

- Green Building Materials Resource List
  Contra Costa County Green Building Program
  651 Pine Street, 4th Floor, North Wing
  Martinez, CA 94553
  (925) 335-1290
  www.cccounty.us/depart/cd/recycle/greenbuilding/
  www.cccrecycle.org/greenbuilding

  This resource lists green products with local suppliers.

- Green Building Pages
  1350 March Street
  San Luis Obispo, CA 93401
  www.greenbuildingpages.com/

  An online, sustainable design and decision-making tool for building industry professionals and environmentally and socially responsible consumers. Its mission is to create a clear, concise, public format for communicating comprehensive, current, and transparent information to enable building industry professionals and consumers seeking a healthy, sustainable lifestyle to choose building materials that preserve health and the environment, and whose production and manufacturing processes promote social equity and economic sustainability.

- Green Building Resource Guide (1997)
  John, Hermannsson, AIA, Architect
  The Architectural Machine
  P.O. Box 3808, Redwood City, CA 94064
  www.greenguide.com

  This is a database of over 600 green building materials and products selected specifically for their usefulness to the design and building professions, rather than merely their green material content. It includes a "Price Index Number," which is a factor comparing the cost of the green product shown versus the Price Index Standard (non-green equivalent product). Available on a CD or printed reference guide.

- Green Building Sherpa
  www.greenbuildingsherpa.com

This is an online source for environmentally friendly products, services, and information as these pertain to building design, construction, management, and operation.

- Green Directory
  The Lighthouse
  Scotland's Centre for Architecture Design and the City
  11 Mitchell Lane
  Glasgow G1 3NU
  +44 (0)141 221 6362
  www.sust.org/tgd/

  The *Green Directory* is the first dedicated resource for products, manufacturers, and service providers of green products in Scotland. Each of the entries is referenced according to geographic location to help users to source locally. In Scotland, you can search for information within Local Enterprise Company (LEC) regions. The *Green Directory* is a partnership project with SEDA (Scottish Ecological Design Association) and the Ecological Design Group at Duncan of Jordanstone, University of Dundee.

- Green Home Guide
  U.S. Green Building Council
  www.greenhomeguide.com/index.php/product/C157/

  Green Home Guide's subject editors meet quarterly to share their product research, debate pros and cons, and vote on possible inclusions in this directory. In most meetings, only a minority of products are approved.

- Green Page Online
  Green America
  1612 K Street NW, Suite 600
  Washington, DC 20006
  (800) 584-7336
  www.greenpages.org
  www.coopamerica.org/pubs/greenpages/Green Pages

  This online is a directory of green businesses offering over 25,000 products from 2,000 green companies.

- GreenPeople
  41 Highland Ave. Suite #206
  Highland Park, NJ 08904
  (732) 514-1066
  www.greenpeople.org/about.htm

  Directory of eco-friendly and holistic health products: organic food; pet supplies; natural childbirth, beauty, and home improvement products; hemp; organic cotton; holistic health products; and recycled products.

- GreenPLUS (National GreenPLUS Registry)
  theGreenTeam, Inc.
  136 E. 18th Street
  Tulsa, OK 74119
  (918) 295-8326
  www.greenplusregistry.com

  This is a free online tool homeowners can use to rate their homes for health, safety, and welfare (HSW) related to environmental stewardship. It also offers a product directory of over 600 manufacturers of eco-friendly, green building products. It provides product reviews (with 1–5 green star ratings) from other consumers.

- GreenSage Sustainable Building & Furnishing
  GreenSage.Com
  P.O. Box 360525
  Columbus, OH 43236-0525
  (614) 269-8709
  www.greensage.com/

  Provides information about sustainable materials, professionals, and resellers who recycle materials.

- Green Seal
  1001 Connecticut Avenue, NW Suite 827
  Washington, DC 20036-5525
  (202) 872-6400
  www.greenseal.org/

  Green Seal provides science-based environmental certification standards that are credible, transparent, and essential in an increasingly educated and competitive marketplace. Green Seal also provides links to certified products and services.

- GreenSpec Directory
  BuildingGreen, Inc. LLC
  122 Birge Street, Suite 30
  Brattleboro, VT 05301
  (802) 257-7300
  www.buildinggreen.com

  This directory lists more than 1,800 environmentally preferable building products with descriptions, manufacturer information, and links to additional resources. All listings are screened and written by BuildingGreen's staff. It includes guideline specifications and is organized according to CSI 1995 MasterFormat numbering system.

- Habitat for Humanity International
  Construction & Environmental Resources Department
  121 Habitat Street
  Americus, GA 31709-3490

(800) 422-4828
(229) 924-6935
www.habitat.org/env/

The website provides information and training on a variety of construction issues such as construction management and methods, building materials, energy efficiency, healthy indoor air quality, house design, and accessibility.

- Informed Building Build Smart for a Better Tomorrow
  Sustainable Building Directory
  www.informedbuilding.com/

  Directory provides technical information regarding sustainable building.

- Metro Detroit Green Building Resource Directory, The WARM Training Center
  4835 Michigan Avenue
  Detroit, MI 48210
  (313) 894-1030,
  www.warmtraining.org

  This is a searchable database that lists building materials by category available in the Detroit area.

- Minnesota Building Materials Database
  Center for Sustainable Building Research
  College of Architecture and Landscape Architecture
  University of Minnesota
  1425 University Avenue SE
  Minneapolis, MN 55455
  (612) 624-7327,
  www.buildingmaterials.umn.edu

  This is a searchable database of sustainable materials, products, systems, and services for commercial and residential building construction in Minnesota. The database uses life cycle thinking to analyze sourcing, health, end of use, LCA tools, properties, and costs.

- Minnesota Recycled Products Directory
  Minnesota Office of Environmental Assistance/Pollution Control Agency
  520 Lafayette Road
  St. Paul, MN 55155-4194
  (651) 296-6300
  (800) 657-3864
  www.moea.state.mn.us/rpdir/index.cfm

  A searchable database of recycled-content products made by Minnesota companies. Includes agricultural, construction, janitorial, landscape, office, and packaging. Website also includes buy-recycled tips, and other resources.

- National Recycling Coalition
  www.nrc-recycle.org/affiliates.aspx

  NRC offers access to state, regional, and national networks. NRC has affiliation agreements in place with organizations in the following states/territories: Arizona, California, Colorado, Connecticut, Georgia, Illinois, Indiana, Kansas, Minnesota, Missouri, New Mexico, New York, Ohio, Oklahoma, Pennsylvania, Tennessee, Texas, Utah, and Wisconsin.

- Oikos Green Building Source
  Iris Communications Inc.
  P.O. Box 6498
  Bend, OR 97708-6498
  (541) 317-1626
  http://oikos.com; www.irisinc.com

  The website lists green product information. The product database is searchable by either product category or company name. Includes consulting services directory.

- Open Directory Project: Sustainable Architecture
  www.dmoz.org/Business/Construction_and_Maintenance/Building_Types/Sustainable_Architecture/

  This is a directory of green services, products, and information regarding sustainable architecture.

- Pennsylvania Green Building Products Directory
  333 East Carson Street, Suite 331
  Pittsburgh, PA 15219
  (412) 431-0709
  www.pa-greenbuildingproducts.org/building_product_directory.aspx

  The directory connects Pennsylvania green building products manufacturers with green building specifiers, including architects, engineers, designers, contractors, and other green building professionals. The goal of the directory is to use Pennsylvania-produced green building products in green buildings throughout Pennsylvania, the United States, and abroad.

- Planet ReUse
  (816) 298-7947
  www.planetreuse.com/index.aspx

  This website facilitates material exchange, provides opportunity to list reclaimed materials wanted and reclaimed materials available. It targets architects and design professionals.

- Real Goods
  360 Interlocken Blvd, Suite 300
  Broomfield, CO 80021
  (800) 994-4243; fax (800) 508-2342
  www.realgoods.com

The website lists energy-efficient products and technologies for the home, power generation, off-the-grid living, electric vehicles, and more.

- RecyclingMarkets.net
  P.O. Box 577, Ogdensburg, NY 13669-0577
  (800) 267-0707
  www.recyclingmarkets.net

  Online recycling database with over 5,000 cross-referenced, certified listings of manufacturers and distributors of recycled, remanufactured, reused, and reprocessed products. It contains over 1,000 product classifications.

- South Carolina Green Building Directory (SCGBD)
  Bryan Cordell
  (843) 529-3416
  www.scgreenbuildingdirectory.org/contact.php

  The goal of the SCGBD is to provide users with information they need to find products and services that support green building practices for new construction or remodeling of residential and commercial facilities in South Carolina. It offers a resource for those within the southeast region of the United States and beyond.

- Sustainable Building Resource Directory (SBRD)
  Virginia Sustainable Building Network
  P.O. Box 6539
  Arlington, VA 22206
  (703) 486-2966
  www.sbrd.net/

  The *Sustainable Building Resource Directory* provides information on regionally based businesses, services, and programs that are helping to create healthy, energy-efficient, and resource-conserving buildings, in the residential, public, and commercial, sectors. A special section is designated for products and services that have been utilized by affordable housing organizations.

- Sustainable Design Resource Guide
  American Institute of Architects Denver Chapter and
  Architects, Designers, and Planners for Social Responsibility Colorado Chapter
  www.aiacolorado.org/SDRG

  Includes an overview of the environmental issues applicable to each CSI division as well as additional resources. Lists green products and materials in CSI 1995 MasterFormat classifications.

- Viva Green
  Santa Barbara, CA 93111 US
  (310) 995-7139
  www.vivagreen.com/

  Company provides a green and sustainable resources directory.

- WoodWise Consumer Guide Better Paper Project
  Green America
  1612 K Street NW, Suite 600
  Washington, DC 20006
  (800) 584-7336
  www.woodwise.org

  The *WoodWise Consumer Guide* contains forest-saving idea, tools, referrals, and an expanded resource directory listing forest-friendly wood and paper products.

Step 4: Gather Technical Information

Technical information regarding the greenness of building products is much easier to obtain today than it was a few years ago. Sources include: product representatives, governmental agencies, building codes, trade organizations, industry standards, material safety data sheets, green rating programs, and environmental nonprofit organizations.

Product Representatives

If you have a specific green product in mind, the primary source of information is probably the product representative. Green product representatives can be extremely helpful in explaining the greenness of their product and potential applications for it. When researching green products, recognize that you may be dealing with someone who, while very familiar with the product and with the environmental issues, may not be as conversant with building industry practices as you typically expect, with things that you tend to take for granted. While the product representative is teaching you about environmental issues, you may need to teach the product representative about standard performance requirements such as compression testing or fire ratings. This is an extremely beneficial exchange for both parties.

For product representatives of green materials and systems, refer to the source listing in green material options just cited.

Note also that green materials are rapidly evolving. This is a fast-paced industry that defines a first-to-market advantage. Thus, the advertisement for the product may be placed (and the performance claims made) a little before the product is ready for delivery. The product may have a good concept, but there is no pricing available and there is a long lead time. Don't dismiss these; they might be great. But, do manage expectations and do have a backup plan.

Governmental Sources

When verifying manufacturer information or when researching general possibilities, one of the first sources of information that comes to mind relative to environmental issues is the government. Not a comfortable source for most industries that too often find themselves forced to deal with paperwork of mythic proportions and tangles of red tape in department after department. And for good reason; there are countless agencies enforcing myriad different, and sometimes conflicting, environmental regulations.

Nevertheless, federal, state, and local governments can provide excellent sources of information about the issues and the current requirements. Generally, regulatory requirements affect manufacturing facilities and procedures more than the product itself. There

are some important exceptions for the building industry. Examples include: VOC limits, energy efficiency, water efficiency, biobased content, and recycled content.

More than specific regulations, political activity is an important indicator of environmental trends and of related economic issues. Consider the effect on the HVAC industry after the international ratification of the Montreal Protocol and the subsequent amendments to the Clean Air Act (1990), which banned the manufacture of CFCs in the United States, and consider the effect on the lighting industry from the National Energy Act (1992), which banned the manufacture of certain lamp types and mandated minimum energy standards for new construction.

For designers and manufacturers who wish to remain ahead of the pack, it is vital to monitor political activity relative to environmental issues on a wide range in order to anticipate future developments and position themselves to take advantage of the opportunities. It is also advisable to monitor funding opportunities from governmental agencies. The Department of Agriculture, for example, sponsored the Alternative Agricultural Research and Commercialization (AARC) Corporation, a wholly owned government corporation that made equity investments in private companies to commercialize nonfood uses of agricultural materials and animal byproducts. Some of the building materials that AARC subsidized include: Agriboard, Environ by Phenix Biocomposites, and Primeboard.[3]

The American Recovery and Reinvestment Act (ARRA) of 2009 is widely credited with funding a new green economy. Billions of dollars have been dedicated to green-building projects and to energy efficiency and renewable energy programs. By the start of 2010, $16.8 billion was provided for programs within the Department of Energy, including the Weatherization Assistance Program, Energy Efficiency and Conservation Block Grant, State Energy Program, and Energy Star. Guaranteed loans of $6 billion have been reserved for renewable energy and electric transmission technologies, covering things like advanced batteries and smart-grid developments. Approximately $9 billion is available to modernize, renovate, and repair school buildings to meet recognized green-building standards, such as USGBC's LEED, GBI's Green Globes, and the EPA's Energy Star. The General Services Administration and the Department of Housing and Urban Development have appropriated funds for green retrofits and new construction projects for federal buildings, residential housing, and communities. The investments will resonate for years to come.

If you have not yet ventured into the arenas of politics and economics, perhaps the least painful way is by visiting the EPA website (www.epa.gov) and downloading information on their voluntary partnership programs. EPA Partnership Programs address a wide variety of environmental issues by working collaboratively with companies, organizations, communities, and individuals. More than 13,000 firms and other organizations participate in EPA Partnership Programs. Even if you do not utilize the programs, the information they provide is very helpful. EPA programs related to green building include:[4]

Carpet America Recovery Effort (CARE)

CARE is an industry-government partnership aiming to increase the amount of recycling and reuse of postconsumer carpet and reduce the amount of waste carpet going to landfills.

Climate Leaders

Climate Leaders is an industry-government partnership that works with companies to develop comprehensive climate change strategies. Partner companies commit to

reducing their impact on the global environment by completing a corporate-wide inventory of their greenhouse gas emissions based on a quality management system, setting aggressive reduction goals, and annually reporting their progress to EPA. Through program participation, companies create a credible record of their accomplishments and receive EPA recognition as corporate environmental leaders.

Coal Combustion Products Partnership (C2P2)

C2P2 is a joint industry-government program to increase the beneficial use of coal combustion products to reduce energy consumption and greenhouse gas emissions, and increase industrial recycling. The goals of the C2P2 program are to increase the use of coal ash as a replacement for Portland cement in concrete, which will reduce future greenhouse gas generation by over 6.5 million tons annually.

Combined Heat and Power (CHP) Partnership

The CHP Partnership is a voluntary program seeking to reduce the environmental impact of power generation by promoting the use of CHP. CHP, also known as cogeneration, is considered to be an efficient, clean, and reliable approach to generating power and thermal energy from a single fuel source.

Decentralized Wastewater Treatment Systems Program (Specific Systems)

This program provides national direction and support to improve the performance of decentralized systems by promoting the concept of continuous management and facilitating professional standards of practice.

Design for the Environment (DfE)

DfE's goal is to facilitate the identification, creation, and use of products, processes, and technologies that are safer for human health and the environment. The program helps manufacturers assess green chemistry alternatives and select safer chemicals for their products. When safer chemical alternatives have not yet been identified, DfE collaborates with partners to determine and implement best practices to minimize pollution. DfE's Safer Product Labeling Program helps consumers identify the safest household cleaners and other products.

ENERGY STAR

ENERGY STAR is a joint program of EPA and the U.S. Department of Energy to identify and promote energy efficient products bearing the ENERGY STAR label, raise energy efficiency standards for new home construction and existing home renovations, and improve the efficiency of commercial and industrial facilities through strategic energy management practices.

Federal Electronics Challenge

The Federal Electronics Challenge is a voluntary partnership program that encourages federal facilities and agencies to: (1) purchase greener electronic products, (2) reduce the impacts of electronic products during use, and (3) manage obsolete electronics in an environmentally safe way.

Green Engineering

The Green Engineering program promotes design, commercialization, and use of processes and products, which are feasible and economical, while minimizing (1) the generation of pollution at the source and (2) risks to human health and the environment.

Green Power Partnership

The Green Power Partnership is a voluntary program that encourages organizations to buy green power as a way to reduce the environmental impacts associated with purchased electricity use. Through the program, EPA provides partners with expert advice, tools and resources, and opportunities for recognition.

GreenScapes

GreenScapes is an industry-government partnership that promotes the reduction, reuse, and recycling of waste materials in large-scale landscaping by providing cost-efficient and environmentally friendly solutions that conserve natural resources and energy.

Indoor Air Quality Tools for Schools

The IAQ Tools for Schools Program provides a variety of products, materials, and tools at no cost to help schools implement an indoor air quality management program. In addition to the IAQ TfS Action Kit, specialized fact sheets, brochures, and software programs are available to provide in-depth information on environmental topics.

Labs 21

Labs 21 is a voluntary program operated jointly by the EPA and the U.S. Department of Energy. It helps new and retrofitted laboratories cut their energy costs and reduce environmental damage. The goal is to create energy self-sufficiency for all EPA labs, modeling these savings for other science labs throughout the country.

Nanoscale Materials Stewardship Program (NMSP)

The NMSP was developed to help provide a firmer scientific foundation for regulatory decisions by encouraging submission and development of information for nanoscale materials. The data will also help to determine next steps in development of environmental health and safety data and appropriate regulatory actions under TSCA. EPA believes that participation in the NMSP will encourage responsible development of nanoscale materials and will benefit all stakeholders.

National Partnership for Environmental Priorities (NPEP)

NPEP is a partnership program focused on reducing the use of potentially hazardous chemicals from products and processes. The goal of the program is to encourage, through recognition, networking, and case example distribution, the minimization of hazardous and industrial wastes, particularly those waste streams containing one or more of the 31 priority chemicals.

Pesticide Environmental Stewardship Program (PESP)

PESP is a voluntary program that forms partnerships with pesticide users to reduce the potential health and environmental risks associated with pesticide use and implement pollution prevention strategies. In addition to promoting the use of biopesticides, PESP advocates the adoption of integrated pest management (IPM) programs or practices. IPM is the coordinated use of pest and environmental information with available pest control methods to prevent unacceptable levels of pest damage by the most economical means and with the least possible hazard to people, property, and the environment.

Plug-In to eCycling

Plug-In to eCycling is a partnership program between EPA and leading consumer electronics manufacturers, retailers, and mobile service providers that fosters and promotes opportunities for individuals to donate or recycle their electronics. Plug-In also partners with governments and nonprofits that play a key role in the reuse and safe recycling of unwanted consumer electronics.

Responsible Appliance Disposal Partnership (RAD)

The RAD program is a program where partners recover ozone-depleting chemicals from old refrigerators, freezers, air conditioners, and humidifiers. Using best practices, RAD partners ensure that: refrigerants are recovered and reclaimed or destroyed; foams are recovered and destroyed, or the blowing agent is recovered and reclaimed; metals, plastic, and glass are recycled; and PCBs, mercury, and used oil are recovered and properly disposed.

Schools Chemical Cleanout Campaign

The Schools Chemical Cleanout Campaign is a multi-agency effort with the Department of Education and several other agencies (NIOSH, CDC, DOI-BIA) to achieve three goals: remove inappropriate, outdated, unknown, and unnecessary chemicals; prevent future chemical mismanagement in schools through training, curriculum and policy change, and long-term management solutions; and raise awareness of chemical issues in schools and promote sustainable solutions.

The Green Suppliers Network (GSN)

The GSN is a program of the EPA and the U.S. Department of Commerce to help manufacturers stay competitive and profitable while reducing their impact on the environment.

WaterSense

WaterSense is an industry-government partnership that seeks to protect the future of the U.S. water supply by promoting water efficiency and enhancing the market for water-efficient products, programs, and practices. The WaterSense label indicates that these products and programs meet water efficiency and performance criteria. WaterSense is partnering with irrigation professionals and irrigation certification programs to promote water-efficient landscape irrigation practices. WaterSense is also partnering with manufacturers, retailers and distributors, and utilities to bring WaterSense products to the marketplace and make it easy to purchase high-performing, water-efficient products.

The U.S. federal government has developed and/or sponsored other useful programs for green building materials as well. The IAQ Building Evaluation and Assessment Tool (I-BEAM) was designed to be used in commercial buildings. I-BEAM enables users to conduct an IAQ building audit, plan IAQ-compatible energy projects, and calculate the cost, revenue, and productivity impacts of proposed IAQ activities. Recognizing that 20 percent of the population or nearly 55 million people spend their days in elementary and secondary schools, the EPA also developed "Indoor Air Quality (IAQ) Design Tools for Schools." See programs listed above. The USDA operates VegSpec, a web-based decision support system that assists designers and land managers in plant selection.[5] VegSpec contains data on over 2,000 species of frequently used plants. It uses soil, plant, and climate data to identify

plant species that are (1) adapted to a specific site, (2) suitable for the selected practice (treatment), and (3) appropriate for the purposes and subpurposes for which the planting is intended.

As you enter the fray, you will find that many environmental specialists will speak a language consisting almost entirely of abbreviations and acronyms. And, as you become greener, you will of necessity learn those that are most integral to your particular market(s). Many have to do with governmental agencies, regulations, or policies. Following are examples; refer to the Glossary for additional terms.

- CAA

  The Clean Air Act (CAA); 42 U.S.C. s/s 7401 et seq. (1970): "The Clean Air Act is the comprehensive Federal law that regulates air emissions from area, stationary, and mobile sources. This law authorizes the U.S. Environmental Protection Agency to establish National Ambient Air Quality Standards (NAAQS) to protect public health and the environment. The goal of the Act was to set and achieve NAAQS in every state by 1975. The setting of maximum pollutant standards was coupled with directing the states to develop state implementation plans (SIP's) applicable to appropriate industrial sources in the state. The Act was amended in 1977 primarily to set new goals (dates) for achieving attainment of NAAQS since many areas of the country had failed to meet the deadlines. The 1990 amendments to the Clean Air Act in large part were intended to meet unaddressed or insufficiently addressed problems such as acid rain, ground-level ozone, stratospheric ozone depletion, and air toxics."[6]

- CERCLA

  Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) 42, U.S.C. s/s 9601 et seq. (1980): "Congress enacted the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), commonly known as Superfund, on December 11, 1980. This law created a tax on the chemical and petroleum industries and provided broad Federal authority to respond directly to releases or threatened releases of hazardous substances that may endanger public health or the environment. Over five years, $1.6 billion was collected and the tax went to a trust fund for cleaning up abandoned or uncontrolled hazardous waste sites. CERCLA established prohibitions and requirements concerning closed and abandoned hazardous waste sites; provided for liability of persons responsible for releases of hazardous waste at these sites; and established a trust fund to provide for cleanup when no responsible party could be identified. The law authorizes two kinds of response actions. Short-term removals where actions may be taken to address releases or threatened releases requiring prompt response. Long-term remedial response actions that permanently and significantly reduce the dangers associated with releases or threats of releases of hazardous substances that are serious, but not immediately life threatening. These actions can be conducted only at sites listed on EPA's National Priorities List (NPL). CERCLA also enabled the revision of the National Contingency Plan (NCP). The NCP provided the guidelines and procedures needed to respond to releases and threatened releases of hazardous substances, pollutants, or contaminants. The NCP also provided the NPL. CERCLA was amended by the Superfund Amendments and Reauthorization Act (SARA) on October 17, 1986."[7]

- CWA

  The Clean Water Act (CWA); 33 U.S.C. s/s 121 et seq. (1977): "The Clean Water Act is a 1977 amendment to the Federal Water Pollution Control Act of 1972, which set the basic structure for regulating discharges of pollutants to waters of the United States. The law gave EPA the authority to set effluent standards on an industry basis (technology-based) and continued the requirements to set water quality standards for all contaminants in surface waters. The CWA makes it unlawful for any person to discharge any pollutant from a point source into navigable waters unless a permit (NPDES) is obtained under the Act. The 1977 amendments focused on toxic pollutants. In 1987, the CWA was reauthorized and again focused on toxic substances, authorized citizen suit provisions, and funded sewage treatment plants (POTW's) under the Construction Grants Program. The CWA provisions for the delegation by EPA of many permitting, administrative, and enforcement aspects of the law to state governments. In states with the authority to implement CWA programs, EPA still retains oversight responsibilities."[8]

- EPACT

  The Energy Policy Act of 2005: "This act specifies revisions to and the continuation of the previous EPACT. Although the legislation falls short of making energy efficiency a cornerstone of U.S. energy policy, there are several important energy-efficiency provisions that help Americans save money and energy, while reducing pollution. Also, there are provisions for federal energy efficiencies. For example, Section 109 requires federal buildings to meet the 2004 International Energy Conservation Code (IECC) for residential buildings and the ASHRAE Standard 90.1-2004 for commercial buildings. New federal buildings are directed to use at least 30 percent less energy than mandated by either the ASHRAE standard or the IECC."[9]

- EPCRA

  The Emergency Planning and Community Right-to-Know Act (EPCRA); 42 U.S.C. 11011 et seq. (1986): "Emergency Planning and Community Right-to-Know Act, also known as Title III of SARA, EPCRA was enacted by Congress as the national legislation on community safety. This law was designed to help local communities protect public health, safety, and the environment from chemical hazards. To implement EPCRA, Congress required each state to appoint a State Emergency Response Commission (SERC). SERC's were required to divide their states into Emergency Planning Districts and to name a Local Emergency Planning Committee (LEPC) for each district. Broad representation by fire fighters, health officials, government and media representatives, community groups, industrial facilities, and emergency managers ensures that all necessary elements of the planning process are represented."[10]

- ESA

  The Endangered Species Act (ESA); 7 U.S.C. 136; 16 U.S.C. 460 et seq. (1973): "The Endangered Species Act provides a program for the conservation of threatened and endangered plants and animals and the habitats in which they are found. The U.S. Fish and Wildlife Service (FWS) of the Department of the Interior maintains the list. Species include birds, insects, fish, reptiles, mammals, crustaceans, flowers, grasses, and trees. As of February 2010, 614 U.S. animal species are listed and 749 U.S. plant species are listed. Anyone can petition FWS to include a species on this list. The law prohibits any action, administrative or real, that results in a "taking" of a listed species, or adversely

affects habitat. Likewise, importing, exporting, and interstate and foreign commerce of listed species are all prohibited. The EPA's decision to register a pesticide is based in part on the risk of adverse effects on endangered species as well as environmental fate (how a pesticide will affect habitat)."[11]

- Executive Order 13423

  Executive Order (EO) 13423, "Strengthening Federal Environmental, Energy, and Transportation Management": This order was signed by President George W. Bush on January 24, 2007. EO 13423 instructs federal agencies to conduct their environmental, transportation, and energy-related activities under the law in support of their respective missions in an environmentally, economically and fiscally sound, integrated, continuously improving, efficient, and sustainable manner. The Order sets goals in: energy efficiency, acquisition, renewable energy, toxic chemical reduction, recycling, sustainable buildings, electronics stewardship, fleets, and water conservation. EO 13423 rescinds several previous EOs, including EO 13101, EO 13123, EO 13134, EO 13148, and EO 13149.

- Executive Order 13514

  Executive Order (EO) 13514, "Federal Leadership in Environmental, Energy, and Economic Performance": This order was signed on October 5, 2009 by President Obama. It expands upon the environmental performance requirements of EO 13423. EO 13514 sets numerous federal requirements in several areas, including: accountability, planning, greenhouse gas management, water efficiency, and sustainable buildings and communities. Agency efforts and outcomes in implementing EO 13514 must be transparent and disclosed on publicly available federal websites.

- Farm Bill 2008

  The Food, Conservation, and Energy Act of 2008 (Pub.L. 110-234, 122 Stat. 923: Enacted May 22, 2008, H.R. 2419, also known as the 2008 U.S. Farm Bill): "A $288 billion, five-year agricultural policy bill that largely continues programs of the 2002 Farm Bill. It continues the United States' long history of agricultural subsidy as well as pursuing areas such as energy, conservation, nutrition, and rural development. It also continues support of the biobased products program. The Farm Security and Rural Investment Act of 2002 (Farm Bill 2002) included a requirement for federal agencies to develop a procurement program for biobased products. Section 9002 of that act required each federal agency to give preference in their purchases (including construction materials) to items "composed of the highest percentage of biobased products practicable."[10] This section also mandates the establishment of a voluntary program to label biobased products as a "U.S.D.A. Certified Biobased Product." With the publication of the final rule incorporating "Guidelines for Designating Biobased Products for Federal Procurement" in February 2005, the Federal Biobased Products Preferred Procurement Program (FB4P) began the process of evaluating potential products for listing. The evaluation process will begin by determining whether products: (1) are cost competitive with nonbiobased products, (2) meet industry performance standards, and (3) are readily available on the commercial market. The FB4P has assembled a list of biobased items that will be used for designation under the program."[12]

- NEPA

  National Environmental Policy Act of 1969 (NEPA); 42 U.S.C. 4321-4347: NEPA is the basic national charter for protection of the environment. It establishes policy, sets

goals, and provides means for carrying out the policy. "The purposes of this Act are: To declare a national policy which will encourage productive and enjoyable harmony between man and his environment; to promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man; to enrich the understanding of ecological systems and natural resources important to the Nation; and to establish a Council on Environmental Quality."[13]

- NPDES

  National Pollutant Discharge Elimination System (NPDES): Created by EPA in 1972 under the authority of Public Law 92-500, the Federal Water Pollution Control Act is: ". . . intended to control discharges to the Nation's waters from industrial, commercial, and municipal point sources; these discharges presented a threat to water quality and health. Initial efforts focused on traditional pollutant discharges from industrial manufacturing processes and municipal waste water treatment plants. Later amended to become the CWA, this law provides broad authority for EPA or States (authorized by EPA) to issue NPDES permits. Specific reporting requirements are established in the permits to require monitoring and reporting of discharges. The CWA establishes two types of standards for conditions in NPDES permits: technology-based standards and water quality-based standards. These standards are used to develop effluent limitations and special conditions in NPDES permits. Numeric effluent limitations establish pollutant concentration limits for effluents at the point of discharge. Since the implementation of the CWA requirements, EPA has begun to address nontraditional sources of pollution, such as those that result from Wet Weather Flows (WWF). The NPDES program currently requires permits for point sources, but not for NPSs."[14]

- Phase I

  This typically refers to an environmental site assessment. Financial interests in particular want to determine potential environmental concerns on a given site since environmental regulations place responsibility for abatement and liability for contamination upon ALL entities that have touched the material, including building owners, contractors, and architects. Insurance companies and lending institutions do not want to inherit environmental debts. The primary purpose of the Phase I environmental site assessment is to observe site conditions and identify any areas of potential environmental concern. ASTM E 1527, *Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process,* and ASTM E 1528, *Standard Practice for Environmental Site Assessments*: *Transaction Screen Process*, are alternative approaches to records review, site reconnaissance, interviews, and reports. One offers broad guidance for investigation, the other specific questionnaires. Both seek to define commercial standards for conducting environmental site assessments with respect to contaminants under CERCLA and to petroleum products; that is, to establish the practices that constitute all appropriate inquiry under CERCLA. The goal is to determine the requirements necessary for the user to claim an innocent landowner defense to CERCLA liability.

- Phase II

  This typically refers to an environmental site assessment. The goal is the same as for Phase I, limiting liability. When suspicious conditions are identified in a Phase I Site Assessment, a Phase II Site Assessment is recommended to perform more detailed analysis. ASTM E1903, *Standard Guide for Environmental Site Assessments: Phase II*

Environmental Site Assessment Process was developed specifically to identify a professional standard of care for conducting a Phase II Site Assessment. It outlines customary practices relative to a range of contaminants, which are within the scope of CERCLA, as well as petroleum products.

- RCRA

  The Resource Conservation and Recovery Act (RCRA); 42 U.S.C. s/s 321 et seq. (1976): "RCRA (pronounced 'rick-rah') gave EPA the authority to control hazardous waste from 'cradle to grave.' This includes the generation, transportation, treatment, storage, and disposal of hazardous waste. RCRA also set forth a framework for the management of nonhazardous wastes. The 1986 amendments to RCRA enabled EPA to address environmental problems that could result from underground tanks storing petroleum and other hazardous substances. RCRA focuses only on active and future facilities and does not address abandoned or historical sites (see CERCLA). HSWA (pronounced 'hiss-wa'), the Federal Hazardous and Solid Waste Amendments, are the 1984 amendments to RCRA that required phasing out land disposal of hazardous waste. Some of the other mandates of this strict law include increased enforcement authority for EPA, more stringent hazardous waste management standards, and a comprehensive underground storage tank program."[15]

- REACH

  The Regulation on Registration, Evaluation, Authorization and Restriction of Chemicals (REACH) for chemicals of the European Union: REACH makes industry responsible for assessing and managing the risks posed by chemicals and providing appropriate safety information to their users. The European Chemicals Agency (ECHA), located in Helsinki, Finland, manages the REACH administrative processes. The first registration deadline for the Registration, Evaluation, Authorization and Restriction of Chemicals (REACH) occurs December 2010. Unless otherwise exempt, phase-in substances that are manufactured and/or imported into the European Community in excess of 1,000 metric tons per annum (high-production-volume chemicals) and/or are considered to be a carcinogen, mutagen, and/or toxic to reproduction at a volume greater than 1 metric ton per annum at least once after June 1, 2007 and/or are considered to be very toxic to aquatic organisms at a volume greater than 100 metric tons per annum are required to be registered by December 2010. According to ECHA, 65,000 companies were issued notices for 143,000 substances during the initial preregistration period (prior to December 1, 2008). There are no definitive numbers available now on how many late preregistrations notices were issued. To date, Germany and France appear to have nominated the most substances.

- RoHS

  The Directive on the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment (2002/95/EC): This directive is commonly referred to as the Restriction of Hazardous Substances Directive or RoHS. RoHS was adopted in February 2003 by the European Union and took effect on July 2006. It restricts the use of six hazardous materials in the manufacture of various types of electronic and electrical equipment and is closely linked with the Waste Electrical and Electronic Equipment Directive (WEEE) 2002/96/EC, which sets collection, recycling and recovery targets for electrical goods and is part of a legislative initiative to solve the problem of huge amounts of toxic e-waste. The RoHS directive is being revised, and it is being reviewed in the European parliament. The final text of the revised law is expected late 2010. In this regard, the European

Union member states are also discussing the overlap between RoHS and REACH, and potential ways to address redundancies and inefficiencies caused by this overlap.

- S.E.E.C.

  The Sustainable Energy and Environment Coalition (S.E.E.C.): The S.E.E.C. was founded at the start of the 111th United States Congress to be a strong voice in the U.S. House of Representatives in advancing policies that promote clean energy innovation and domestic manufacturing, develop renewable energy resources, create green collar jobs, and help arrest global warming and protect our nation's clean air, water and natural environment. S.E.E.C. was founded by co-chairs Rep. Jay Inslee (D-WA) and Rep. Steve Israel (D-N.Y.), and other Democratic members of the U.S. House of Representatives. S.E.E.C. has begun to promote and affect positive change in regard to these issues.

- TSCA

  The Toxic Substances Control Act (TSCA); 15 U.S.C. s/s 2601 et seq. (1976): "The Toxic Substances Control Act of 1976 was enacted by Congress to test, regulate, and screen all chemicals produced or imported into the United States. Many thousands of chemicals and their compounds are developed each year with unknown toxic or dangerous characteristics. To prevent tragic consequences, TSCA requires that any chemical that reaches the consumer marketplace be tested for possible toxic effects prior to commercial manufacture. Any existing chemical that poses health and environmental hazards is tracked and reported under TSCA. Procedures also are authorized for corrective action under TSCA in cases of cleanup of toxic materials contamination. TSCA supplements other federal statutes, including the Clean Air Act and the Toxic Release Inventory under EPCRA."[16]

In addition to the activity at the federal level, many states and municipalities have taken an active role in promoting green buildings. Among the notable local programs is the one introduced by New York City in December 2009. The legislation, known as the "Greener, Greater Buildings Plan," targets a reduction in the city's carbon footprint of 5 percent. The legislation is a component of PlaNYC, a broad strategy introduced two years earlier with the goal of reducing New York City's carbon footprint 30 percent by 2030. The four major building-related elements of the legislation are: the creation of a citywide energy code, a benchmarking requirement, lighting system upgrades and tenant submetering, and required energy audits and retrocommissioning. Other states such as: Arizona, Hawaii, Idaho, Maryland, Minnesota, Montana, and Oregon have created tax incentives, and the trend is continuing to grow.

Building Codes

Building codes are intended to protect the health, safety, and welfare of the public. They are inherently flawed in that they must respond to changing conditions and empirical evidence after the fact. New technologies present new hazards as well as new benefits previously unimagined. We try to codify the new systems based on old understandings. Fire standards, which became the focus of attention after the great Chicago fire, were developed around our understanding of how wood burns. These test methods must be continually reviewed and revised to adapt to changing materials and expected combinations of materials. Smoke

released in a wood fire is different from smoke generated in a treated wood fire, and more different still from that released from plastics. Seismic regulations changed drastically after the San Francisco bridge collapsed and, shortly thereafter, the Northridge quake toppled apartment buildings. We learned a lot about security construction, and lack thereof, after the Murrah Federal Building in Oklahoma City was bombed. Federal agencies quickly revised their security design requirements and remodeled many facilities accordingly.

The limitations of hindsight are magnified in a world moving as rapidly as ours does today. Unfortunately, if the environmental experts are correct, we have already exceeded the carrying capacity of the Earth. We are already using more of the Earth's natural resources than can be replenished annually. We are already polluting and destroying ecosystems faster than the Earth can renew itself. We have already damaged the ozone layer and altered the Earth's global climate patterns. We have already irreparably lost precious species and biodiversity. But no single disaster has focused our attention on the need for revising building codes. There has been no calamity that we recognize as on par with the Chicago fire, the San Francisco quake, or the Oklahoma City attack. Nevertheless, building codes are beginning to encompass environmental health, safety, and welfare requirements.

The City of Boulder is an early adopter. It added environmental requirements to its residential permitting process in 1996. Unlike other green building programs such as in Austin, Texas, and the statewide program in Colorado, the City of Boulder developed a green building program that is mandatory. Its Green Points Program applies to new residential construction and additions larger than 500 square feet. The program requires building permit applicants to earn a minimum of 25 points from the city's green points list. By requiring an additional point for every 200 square feet of floor area over 2,500 square feet, it balances "excess" use of the Earth's resources with proactive environmental efforts. Items that are fairly straightforward may be self-certified; otherwise, inspection by the city is required. For example, recycled content roofing earns 3 points and may be self-certified by the building owner. Structural alternatives to wood earn 10 points and require city inspection.

In January 2010, Governor Arnold Schwarzenegger announced the California Building Standards Commission unanimously adopted a mandatory Green Building Standards Code (CALGREEN) requiring new buildings in the state to be more energy efficient and environmentally responsible. Taking effect on January 1, 2011, CALGREEN requires that every new building constructed in California reduce water consumption by 20 percent, divert 50 percent of construction waste from landfills and install low pollutant-emitting materials. It also requires separate water meters for nonresidential buildings' indoor and outdoor water use, with a requirement for moisture-sensing irrigation systems for larger landscape projects and mandatory inspections of energy systems (e.g., heat furnace, air conditioner, and mechanical equipment) for nonresidential buildings over 10,000 square feet to ensure that all are working according to their design efficiencies. The California Air Resources Board estimates that the mandatory provisions will reduce greenhouse gas emissions by 3 million metric tons equivalent in 2020. Upon passing state building inspection, California's property owners will have the ability to label their facilities as CALGREEN-compliant.

Then, there is the International Green Construction Code (IGCC). This is likely to be a massive game changer. In June 2009, the ICC announced a partnership with the American Institute of Architects (AIA) and ASTM International to develop of a model green commercial building code, the IGCC. Other organizations with representation on

the IGCC drafting committee, known as the Sustainable Building Technology Committee (SBTC), include the U.S. Green Building Council Green, the Green Building Initiative, and many other key experts.

The IGCC is designed specifically to integrate and coordinate with the other International Codes already being enforced by governmental code officials at all levels. All 50 states and more than 20,000 U.S. jurisdictions use the International Codes developed by the Code Council for safety and sustainability. The International Codes also serve as the basis for construction of federal properties around the world, and as a reference for many nations outside the United States. This is mainstream green; it achieves a stated goal for most if not all of the voluntary green building rating programs. And, it raises the bar considerably.

The first public version of the IGCC is scheduled for public review March–August 2010. The IGCC will then go through another round of review, comments, and public hearings in 2011 for publication in the 2012 ICC Family of Codes.[17]

In the interim, we have the opportunity to obtain variances. Anyone who has attempted to build a structure just a little bit differently from the manner outlined by the applicable building code will appreciate the hurdles many green designers and builders face. It is not an easy proposition. Most of the traditional, time-tested building methods, such as adobe, rammed earth, and straw bale, are today classified as "alternative" methods. Perversely, native, indigenous materials are required to demonstrate their ability to meet structural, energy, and fire standards on a project-by-project basis. This is a costly proposition because it must be done on an individual basis. It may also be difficult, since most test method standards were designed to accommodate specific materials and systems, which generally do not include straw or mud. The challenge is further intensified because most indigenous building methods are not proprietary. Therefore, no manufacturer has a stake in paying for the testing necessary to demonstrate compliance, even when appropriate test methods exist.

Happily, several environmental interest groups are helping to create an information and support network. Straw bale construction, for example, has a well-defined network of designers, builders, and consultants. Assistance is readily available for details, mortgage financing, and code compliance. While there are many jurisdictions that allow straw bale building under the alternative materials and methods provisions of the existing codes, there are also some that have specific provisions for straw bale construction, including parts of Arizona (the City of Tucson, Pima County, Pinal County, the Town of Guadalupe); California (State Guidelines and several counties and municipalities); Boulder, Colorado; the state of New Mexico; and Austin, Texas. The Environmental Building Network (EBNet) makes available an extensive series of tests and research on the material properties of straw bale structures. They provide structural, moisture, fire, and thermal test data. All of which is vitally important when seeking a variance. (Refer to the appendices for contact information on EBNet and other environmental organizations.)[18]

Trade Organizations and Publications

Many independent sources of technical information exist for environmental issues. The challenge is that historically, these sources have been isolated from the channels of communication and information exchange in the building industry. Slowly, connections are

being made. Those making these first connections, however, have discovered that the language and methods of communication for environmentalists and for building industry are very, very different. They differ on specifics. "FS" to a specifier means "federal specifications," but to an environmentalist, it is likely to mean "forest service." More importantly, they differ on fundamentals. Environmentalists stress ideals, whereas the building industry (or any industry, for that matter) focuses on the practical. Where they come together in increasing numbers is on improving efficiencies—improving energy efficiency, reducing waste, improving water quality, and improving indoor air quality. Similarly, both the captains of environmentalism and the captains of industry are "big-picture" people and recognize the global impact of human activity.

Sources of green information are beginning to develop a very cohesive and reliable network that, at certain points, overlaps the mainstream building industry information network. Professional and trade organizations dedicated to green issues and green building can be very helpful. Examples include: U.S. Green Building Council, the Electric Power Research Institute, Environmental Business Association, Institute of Scrap Recycling Industries, Urban Land Institute, and Global Environmental Management. (Contact information for these organizations and others are available in the appendices.)

Sources of green information include specialty publishers, such as:

- John Wiley & Sons, www.wiley.com
- Chelsea Green Publishing www.chelseagreen.com
- CRC Press/Lewis Publishers, www.crcpress.com
- greenleaf publishing, www.greenleaf-publishing.com/
- Island Press, www.islandpress.org
- United Nations Environmental Programme, www.unep.org/publications/
- World Resources Institute, www.wristore.org

And they include specialty magazines and periodicals such as:

- *Eco-structure*
  1415 Highway 54 W., Suite 105
  Durham, NC 27707
  (919) 402-9300
  www.eco-structure.com

  Features articles on green building projects, the latest green building products, and new technology and techniques in the green building industry.

- *Environmental Building News*
  122 Birge Street
  Brattleboro, VT 05301
  (802) 861-0954
  www.BuildingGreen.com

  Focuses on environmentally sustainable design and construction, featuring checklists, latest news, reviews of building products, case studies, and information sources. Provides well researched, in-depth technical articles.

- *Environmental Design & Construction*
  2401 W. Big Beaver, Suite 700
  Troy, MI 48084
  (248) 362-3700
  www.EDCmag.com

  Covers aspects of environmentally sound building design and construction, including recycled-content materials, energy efficiency, alternative building sources, and indoor air quality.

- Green@Work
  www.greenatworkmag.com/magazine.html

  Addresses the business world's growing embrace of sustainability. It covers corporate responsibility from a positive point of view, relating best practices and demonstrating the growing business case for green strategies.

- *GreenSource*, the Magazine of Sustainable Design
  McGraw-Hill Companies
  866-664-8243
  greensource.construction.com/

  Covers the sustainable design of commercial buildings and green homes, environmental building projects, LEED projects, and green-building products

- *High Performance Building Magazine*
  American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
  http://hpbmagazine.org/

  A quarterly magazine published by ASHRAE and intended to help decision makers in the building community learn about the benefits of innovative technologies and energy-efficient design and operation. Provides case studies.

- *International Journal of Remanufacturing* (IJREM)
  Inderscience Enterprises Limited
  www.inderscience.com/browse/index.php?journalCODE=ijrem

  Discusses remanufacturing in all its guises from products to buildings. It aims for the first time to bring together the broad spectrum of knowledge, practice and research in remanufacturing in order to facilitate a holistic understanding of remanufacturing across all the disciplines concerned. Addresses remanufacturing from all aspects of sustainability, namely environment, economic and societal perspectives.

- *Journal of Green Building*
  College Publishing
  12309 Lynwood Drive
  Glen Allen, VA 23059
  (800) 827-0723
  www.collegepublishing.us

An interdisciplinary, peer-reviewed journal that seeks to advance the state of knowledge about green buildings and high-performance, sustainable facilities and infrastructure systems.

- *Journal of Industrial Ecology*
  www.yale.edu/jie/

  Published by John Wiley & Sons for Yale University on behalf of the School of Forestry and Environmental Studies. The official journal of the International Society for Industrial Ecology. Industrial ecology is a rapidly growing field that systematically examines local, regional, and global materials and energy uses and flows in products, processes, industrial sectors, and economies. It focuses on the potential role of industry in reducing environmental burdens throughout the product life cycle from the extraction of raw materials, to the production of goods, to the use of those goods and to the management of the resulting wastes.

- *Solar Today*
  The American Solar Energy Society
  2400 Central Avenue, Suite G-1
  Boulder, CO 80301
  (303) 433-3130
  www.solartoday.org

  Features articles on solar technologies for transportation and building applications. Includes thermal systems, photovoltaics, environmental concerns, legislation, and products and services.

- SUSTAINABILITY: The Journal of Record
  Mary Ann Liebert, Inc., publishers
  140 Huguenot Street, 3rd Floor
  New Rochelle, NY 10801-5215
  (914) 740-2100 or (800) M-LIEBERT
  www.liebertpub.com/index.aspx

  Provides information and resources to foster collaboration among sustainability managers, educators, corporate executives, administrators, policymakers, economists, and technology innovators.

Material Safety Data Sheets

Much information regarding the chemical composition of a product and the corresponding precautionary recommendations is available via Material Safety Data Sheets (MSDSs). MSDSs are required under the Occupational Safety and Health Administration (OSHA) Hazard Communication Standard (1910.1200) as one of the vehicles for employers to inform their employees about the hazards of the chemicals in their workplace. They are also extremely useful tools for greening a building.

MSDSs address chemicals. They do not address articles, such as door hardware. They do address coatings, adhesives, sealers, and cleaning agents. Although they contain some

very technical data, they include a lot of useful information for evaluating the toxicity of a product.

According to OSHA, an MSDS must include the following information (1910.1200(g)(2)):

- Product name
- Chemical and common name(s) of all ingredients that have been determined to be health hazards or physical hazards
- Physical and chemical characteristics of the hazardous chemical (such as vapor pressure, flash point)
- Physical hazards of the hazardous chemical, including the potential for fire, explosion, and reactivity
- Health hazards of the hazardous chemical
- Primary route(s) of entry
- OSHA-permissible exposure limit (threshold limit)
- Whether the chemical is listed in the National Toxicology Program (NTP) Annual Report on Carcinogens or the International Agency for Research on Cancer (IARC) Monographs, or by OSHA
- Precautions for safe handling and use
- Control measures, such as appropriate engineering controls, work practices, or personal protective equipment
- Emergency and first-aid procedures
- Date of preparation of the material safety data sheet or the last change to it
- Name, address, and telephone number of the chemical manufacturer, importer, employer, or other responsible party preparing or distributing the MSDS

There is no OSHA-specified format for an MSDS. However, the American National Standards Institute (ANSI) has developed recommendations for a standard format (ANSI Z400.1) that is commonly used. The ANSI standard is intended to promote consistency and to help convey information in a manner that is useful and understandable across education levels, from the janitor to the emergency room physician. It includes 16 sections. The first 10 address the specific requirements under OSHA; the last 6 identify information that OSHA does not require, but that may be necessary in order to better address requirements in other countries. Because the last six sections are not legal OSHA requirements, many MSDSs do not provide data for them. Nevertheless, these last six are of particular interest for specifiers of green building materials because they identify the impact of the chemical(s) on the Earth in addition to the impact on human health.

Following is a summary of the 16 sections of the ANSI standard MSDS format:

Section 1

Chemical Product and Company Identification. This section indicates the name, address, and phone number of the company, manufacturer, or distributor of the chemical. Emergency contact information should be included here.

Section 2

Composition/Information on Ingredients. This section is of limited use to most building industry professionals. It identifies chemicals and their percentage content. Note that only those chemicals referenced in 29 CFR part 1910, subpart Z, OSHA Toxic and Hazardous Substances, are likely to be listed. This section may also include OSHA Permissible Exposure Limits (PEL) and the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLV).

Section 3

Hazards Identification. This section will tell you whether the material is considered a carcinogen and what the known potential health effects are. Note that only those chemicals referenced in the National Toxicology Program (NTP), *Annual Report on Carcinogens*; the International Agency for Research on Cancer (IARC) "Monographs"; or 29 CFR part 1910, subpart Z, OSHA Toxic and Hazardous Substances, are likely to be listed. The *Registry of Toxic Effects of Chemical Substances*, published by the National Institute for Occupational Safety and Health indicates whether a chemical has been found by NTP or IARC to be a potential carcinogen.

Section 4

First-Aid Measures. This section is fairly self-explanatory. It should be written for untrained individuals.

Section 5

Fire-Fighting Measures. This section indicates the flammability and explosivity of the product, with firefighting instructions. It also indicates potential hazardous byproducts from combustion.

Section 6

Accidental Release Measures. This section describes responses to material spills, leaks, or accidental releases.

Section 7

Handling and Storage. This section is self-explanatory. It might include overexposure warnings and hygiene instructions.

Section 8

Exposure Controls/Person Protection. This section describes the engineering controls and protective gear that will reduce personal exposure. Obviously, the greater the danger, the more protective gear is required.

Section 9

Physical and Chemical Properties. This section may be of limited use to building industry professionals. It should include information regarding the appearance, odor, pH, physical state, vapor pressure, boiling point, vapor density, freezing/melting point, solubility in water, and specific gravity or density.

Section 10

Stability and Reactivity Data. This section will indicate known incompatibilities with other materials and potential hazardous decomposition. This information provides an indication of the potential interactions in the ecosystem.

Section 11

Toxicological Information. This section should include data used to determine the hazards cited in Section 3. This information provides an indication of the potential toxicity/IEQ impacts. It may discuss acute data, carcinogenicity, reproductive effects, and target organ effects. Do not be surprised to find "No data available."

Section 12

Ecological Information. This section should include data regarding environmental impact in the event of an accidental release. This information provides an indication of the potential interactions in the ecosystem. Do not be surprised to find "No data available."

Section 13

Disposal Considerations. This section should include data regarding the proper disposal of the chemical. It may include information regarding recycling and reuse. It may indicate whether or not the product is considered to be "hazardous waste" according the U.S. EPA Hazardous Waste Regulations.

40 CFR 261. This information provides an indication of the potential interactions in the ecosystem.

Section 14

Transportation Information. This section should include basic shipping information such as the hazard class. As with Section 8 for exposure control, the greater the precautions, the greater the environmental and health risks.

Section 15

Regulatory Information. This section should include the regulations applicable to the material. References may include federal regulations such as TSCA or SARA, and state specific information such as California's Proposition 65, the Safe Drinking Water and Toxic Enforcement Act.

Section 16

Other Information. This section may include hazard ratings, preparation of the MSDS, and additional labeling information.

Last, although it is not part of the OSHA requirements or the ANSI format, there will be a disclaimer. Following is a sample:

The information and recommendations set forth herein are believed to be accurate. Because some of the information is derived from information provided by our suppliers, and because we have no control over the conditions of handling and use, we make no warranty, express or implied, regarding the accuracy of the data or the results to be obtained from the use thereof. The information is supplied solely for your information and consideration, and we assume no responsibility from use or reliance thereon. It is the responsibility of the user of our products to comply with all applicable federal, state, and local laws and regulations.

Eco-Labels, Green Standards, and Product Certifications

Green product labels and certifications can provide a quick, helpful shorthand for evaluation of green claims. That is, they can if they are good. Thus, it is necessary to first evaluate the

eco-label. Eco-labels now come in a wide variety of shapes and sizes and are, therefore, addressed in a separate chapter.

It is worth repeating that such certifications are a shorthand. In most cases, it will still be necessary to review options utilizing the fundamental questions:

What are you using?

How well are you using it?

Step 5: Review Submitted Information for Completeness

While standards for green building products are plentiful, they may or may not satisfy the green performance criteria. Many reflect the single interest that orchestrated their creation—especially those that highlight a single attribute as the basis for environmental preferability. Many are performance-based, not prescriptive-based. Consequently, the designer is left in the position of recommending products in the absence of industry-recognized acceptable minimums that we like to have to clearly designate responsibilities and liabilities. The designer is forced to render an educated, professional opinion. This is not a comfortable position for architects in a litigious society, but it is a necessary one. The codes and standards that guide our decisions today evolved via this same process of trial and error, mixed with educated, professional opinion. Undeniably, environmental issues are health, safety, and welfare issues for the individual occupants of a given building and for the community as a whole. Eventually, we will evolve specific industry-recognized standards addressing all aspects of construction relative to environmental issues.

In some cases, such as products with recycled content, the comparison of green products to their conventional counterparts is apples to apples. It is possible to use existing standards to establish performance quality and use other certification or assessment processes to demonstrate green qualities (biodegradable, energy-efficient, nontoxic, recycled contents).

In other cases, the comparison is apples to oranges. For those products that are meeting a need in a new way, such as agriculturally based products and alternate energy systems, there may be no existing appropriate performance standards. The green products perform differently from their conventional counterparts, although they accomplish the purpose of the assembly. Many of these products are viable but have difficulty competing in an industry that relies so heavily on independent third-party qualification. In recognition of this, new standards are being developed. Green building is a rapidly evolving industry segment. New products, systems, regulations, and standards are appearing with increasing frequency to meet growing consumer demand.

Although the performance of a green product may be comparable to that of its conventional counterpart, the difficulty is finding credible information to make the comparison in the first place; in this respect, green is not yet on equal footing with conventional design and specification methods. Architects and specifiers must expend additional effort to determine not only that a product exists but also that the quality assurance information exists. It is not unusual that a new manufacturer needs some education as to what type of quality assurance information may be required.

As time goes on, the testing data that officially documents greenness will be developed. The empirical evidence may be more difficult to come by. While some of the green products are simply rediscovered products we used to use, others are new and cannot cite 10 to

20 years of satisfied customers. Keep in mind that manufacturers of green products want to make a profit just like the next guy. They can't do that if you don't buy their products. You won't buy their products if those products don't perform.

Step 6: Evaluate (Green) Materials

Perhaps the most important step in the product selection process is the evaluation. In a perfect world, all the information you need would be readily available and well organized so that you could simply add up the scores and pick the best. Realistically, at some point, even if you haven't obtained all the information you want, the bell rings and you must make a decision. As in all matters, there is the theory . . . and then there is practice.

First, let's review the theory. Practice is nearly always altered by reality, but it is founded in theory, so that's a good place to start. In theory, the greenness of materials is determined by answering as best you can the two questions:

What are you using?
How well are you using it?

Are you using perpetual resources, renewable resources, or nonrenewable resources? How are you affecting the quality of the resource (present and future) and the cycle of the resource (rate of flow, diversion, etc.)? Consider local, regional, and global implication of choices. This is especially important for people in the United States to understand. We have both money and power. What we do matters a lot, but it is amazingly difficult for the average American to grasp that. Many—most—of the negative consequences of our actions (energy inefficiency, resource mismanagement, and waste) are felt in developing countries. Not only do Americans consume a vastly disproportionate share of the Earth's limited resources, but we also export waste (including hazardous waste) to developing countries for "disposal" at a nominal fee. Furthermore, corporate America may site its factories in developing countries to avoid the more stringent environmental regulations at home. The immediate damage is removed from our direct view, but it will drift back to us.

In practice, answers to the two questions will be both descriptive and quantitative. They will also have economic implications. In theory, there is a universally accepted formula—the holy grail of Life Cycle Assessment (LCA) methodologies—that will process all the variables and spit out the answer. The LCA concept sounds fairly straightforward: quantify the input, the output, and the byproducts, and you will have your answer. But LCA is not simply a matter of adding and subtracting all the variables and comparing the total to some EPA-approved matrix. It is a complex, intricate, holistic approach that defies the codes and standards with which the design and construction industry is familiar. The EPA estimates that a complete LCA of a product costs $100,000.00.[19] With continued development of the U.S. LCI Database and advancement in LCA software tools, those costs are decreasing, but, how many of us have worked on a project where there was enough money and enough time to perform the kind of research necessary in a complete LCA? Furthermore, even if given an open checkbook and an open schedule, much of the information is hotly debated within the scientific community, let alone the political and economic communities.

Even more distressing, the solution that you do manage to find often reveals an apples-to-oranges comparison between green products and standard construction products and between one green product and another. Many green products are charting new territory. The existing standards have been developed over decades by the industries they support, by the industries that have a vested interest in maintaining the status quo. Their power base is founded in current valuations of resources, tax structures, and subsidies, and in the current interpretations of regulatory requirements. The coating companies in California spent a great deal of money and effort lobbying against the development of VOC regulations by the South Coast Air Quality Management District (SCAQMD). Nevertheless, each of them developed coatings with low VOCs in compliance with the applicable SCAQMD regulations. Consumers were adamantly in favor of reducing the VOC content of coatings. Similarly, alternative wood treatment, such as borates, is handicapped by the monopoly the chromated copper arsenate (CCA) industry has on standards and the inclusion of those standards in model building codes. With increasing public awareness, this too is likely to shift.

In practice, green design solutions are not always simple and straightforward. For example, the knee-jerk reaction to tropical wood is to avoid it so as not to devastate the rain forest. Consider, however, that if there is not some economical value to the tropical wood, and if there is tremendous financial encouragement to clearcut to raise cattle (which there is), there is no reason to respect and protect the wood. The tropical wood needs some economic value in order to be venerated and protected.

Through informative, responsible evaluation, building industry professionals can help improve the process. By making green information an integral part of the design process, building industry professionals can provide a higher quality of service to their customers and better protect the health, safety, and welfare of the community.

Step 7: Select and Document Choice

Whatever you do, including electing to avoid making a decision, will have an impact on the environment. What you do will shape the daily reality of the people who use the building. What you design will affect energy and water usage. The building will use a great many of our limited natural resources. The building will probably create pollution directly and indirectly.

Solving all of the problems simultaneously is as unrealistic as avoiding them. A more constructive approach is to do what you can and continue improving. Sustainability is the goal. It is difficult to define, let alone achieve, in all areas today, but we can work toward it and raise the benchmark for everyone. Following are general rules of thumb for designing, specifying, and building green:

- Maximize the durability.
- Maximize the energy efficiency.
- Maximize the future recyclability: Mechanical fastening is preferable to adhesive/solvent welding. Request (and track) products with green leases or take-back programs that reclaim the products at the end of life.

- Maximize the maintainability.
- Maximize the recycled content: Close the loop. Collecting and recycling is not the goal. We must incorporate the recycled products into the building, and, when the product's current usefulness wanes, it should be recyclable into yet another useful product—not sent to a landfill.
- Maximize the use of local materials/regional materials.
- Minimize embodied energy: Promote the highest and best use of a material to avoid wasting the embodied energy. The highest and best use of a 500-year-old redwood tree is not paper pulp.
- Minimize the use of hazardous natural chemicals (asbestos, lead, etc.).
- Minimize the use of synthetic chemicals: Synthetic chemicals should be considered guilty until proven innocent.

That's not too difficult. Even in practice.

While the product selection process is essentially the same for both green and nongreen products, the variability of green certifications and standards places a greater burden on the specifier. Similarly, because green building product information is not typically available through mainstream building industry information resources, the burden on the specifier is also increased. However, once you have become familiar with environmental resources and with environmental issues, the selection process is no more difficult than for mainstream products—and it is much more satisfying.

The next step is to specify what you have selected.

Notes

1. CSI retired the 1995 edition of MasterFormat at the end of 2009. Nevertheless, much of the building industry still uses the 1995 edition, so both formats are included here.
2. www.nrel.gov/lci/database/default.asp.
3. *Alternative Agricultural Research and Commercialization (AARC) Corporation Sourcebook 1998;* Department of Agriculture, Washington, DC.
4. EPA Partnership Programs; www.epa.gov/partners/ (accessed October 20, 2009).
5. USDA VegSpec; vegspec.sc.egov.usda.gov/vegSpec/index.jsp (accessed October 19, 2009).
6. EPA, summary of laws and regulations, Internet listing; www.epa.gov/epahome/rules.html.
7. Ibid.
8. Ibid.
9. www.epa.gov/oust/fedlaws/publ_109-058.pdf
10. EPA, summary of laws and regulations, Internet listing; www.epa.gov/epahome/rules.html.
11. www.biobased.oce.usda.gov/public/index.cfm.
12. The list can be viewed at www.biobased.oce.usda.gov/public/categories.cfm.

13. The National Environmental Policy Act.
14. EPA, summary of laws and regulations, Internet listing as of 9/98; www.epa.gov/epahome/rules.html.
15. Ibid.
16. Ibid.
17. Information on activities about the IGCC is available for review at www.iccsafe.org/igcc.
18. www.ecobuildnetwork.org/index.htm.
19. Annual USGBC Conference. (1994). EPA presentation on Life Cycle Assessment; NIST, Gaithersburg, MD.

CHAPTER 5

Eco-Labeling, Green Standards, and Product Certification

What's in a name? That which we call a rose by any other name would smell as sweet.

—*Romeo and Juliet (II, ii, 1-2)*; William Shakespeare

Eco-labels abound. They grace magazine pages, billboards, television, radio, and Internet. They commingle with corporate branding initiatives and appear on little placards across retail shelves. Everyone and everything is green.

Disentangling the useful eco-labels from the marketing spin requires a review of the eco-label source. Is the eco-label based on a green standard? Who created the standard? What are their qualifications? Is it the same entity that certifies the standard?

In general, it is preferable to rely upon consensus-based standards developed through a transparent process and implemented by an independent entity.

Consensus-based means that all stakeholders have a meaningful opportunity to participate. It also denotes balance among the stakeholders. According to the International Social and Environmental Accreditation and Labeling (ISEAL) Alliance, a global association of organizations focused on social and environmental issues and labeling, that balance should reflect both the subject matter and the geographic application of a standard. Moreover, ISEAL acknowledges that standards development can be time-consuming and costly, so smaller entities—who may be the most impacted—are often the least able to participate. Thus, the ISEAL Code of Good Practice for Setting Social and Environmental Standards (yes, a standard for sustainability standards) specifically highlights outreach to developing countries and small and medium-sized enterprises. Consensus can't just be an open process. It has to be an inclusive process. There is a difference.

Transparent process means that the administrative procedures that govern the standards development are made known to the stakeholders and to the public. What are the rules governing participation? Is membership by invitation only? Is there an outrageous fee (pay-to-play) required? How is a topic or potential new standard introduced? How is it developed and what are the balloting procedures? Does a simple majority determine the

outcome? Is there a mechanism to challenge the validity of the process? Truly transparent processes must include some mechanism for appeal. They must have some means for regular review and verification that the rules are being followed. Are the results of the ballots published? Transparency should apply not only to the procedural rules but also to the results developed by those rules. For example, if a stakeholder voices an objection, the adjudication of that objection should not occur inside a black box. Boxes are not transparent.

Independent entity refers to the entity utilizing the standard to certify a product or assign an eco-label. To declare independence, such entity should exist separate from the standards development organization. It should not share founders, funding, or a board of directors. A good test for independence is whether or not only one certification entity exists. If only one entity is authorized to use the standard, it really isn't independent. Many eco-labels are awarded by the organization that developed the associated standard. In some instances, the organization also provides consulting services to help you comply with its standard so that you can earn its eco-label. Such proprietary programs make up a substantial percentage of the eco-labels available today. In part, this reflects the relative maturity of the market. Lots of different people are struggling to figure out "the answer." It also is a function of a global society empowered by the Internet. It is possible for individual entities (and individuals) to manage massive amounts of data and create brilliant standards/eco-labels. Proprietary programs may be quite substantive. They may have tremendous environmental merit. But, the fox is in the hen house. Independence provides quality control. If the certification is not independent, then the responsibility is on the user to assess credibility of the standard and the label.

Consensus, transparency, and independence are preferred. True. However, that does NOT mean that good eco-labels MUST be arrived at by consensus, transparent, or independently applied. Frankly, a consensus process can be time-consuming. Additionally, by definition it involves compromise. Such compromise usually means a lesser degree of environmental initiative. Thus, an eco-label developed and implemented by a single entity could be very, very good. Don't rule out such eco-labels. But, do examine them carefully.

Standards Development Organizations

Eco-labels and certifications are based upon green standards which, in turn, are created by a standards development organization (SDO). SDOs exist on many levels. There are trade and professional organizations that set quality requirements for their own areas of expertise. Examples include the Business and Institutional Furniture Manufacturer's Association (BIFMA) and the Carpet and Rug Institute (CRI). Environmental nonprofit organizations generate standards. Examples include Green Seal and the Forest Stewardship Council (FSC). Federal agencies can function as SDOs when they develop federal specifications, military standards, or procurement guidelines. Even individual companies develop standards and associated eco-labels—usually to brand their service(s) or product(s). Perhaps the best example of company SDO activity is in the retail industry. Increasingly, retailers are behaving as SDOs when they develop green criteria with which to market certain product lines. Examples include the Eco-Easy tag utilized by Staples and the Eco Options tag from Home Depot. The retailer is the SDO and also the labeling entity. At the sole discretion of

Home Depot, products may or may not earn its Eco Options label. Home Depot's website provides a limited description as follows:

> *The Eco Options brand makes it easy for you to identify products that make a difference, one choice at a time. Every product with the Eco Options label has less of an impact on the environment than competing products. Specifically, Eco Options products offer one or more of the following benefits: Energy Efficient, Water Conservation, Healthy Home, Clean Air and Sustainable Forestry.*[1]

In 2009, Walmart unveiled a worldwide Sustainability Index Initiative intended to promote sustainability across their supply chain and to communicate results with customers. There is a degree of transparency to the Initiative that exceeds other retail eco-label programs. And, although Walmart clearly controls the program, there has been a significant outreach effort to obtain input from academia, consumer representatives, and environmental organizations. Walmart states that the Initiative "... can create a new retail standard for the 21st century."[2] First step: assess the products they sell. Walmart has over 100,000 global suppliers, each being asked 15 questions.[3] The list of questions is broken down into 4 categories as illustrated below.

Walmart Sustainability Product Index: 15 Questions for Suppliers

Energy and Climate: Reducing Energy Costs and Greenhouse Gas Emissions

1. Have you measured your corporate greenhouse gas emissions?
2. Have you opted to report your greenhouse gas emissions to the Carbon Disclosure Project (CDP)?
3. What is your total annual greenhouse gas emissions reported in the most recent year measured?
4. Have you set publicly available greenhouse gas reduction targets? If yes, what are those targets?

Material Efficiency: Reducing Waste and Enhancing Quality

1. If measured, please report the total amount of solid waste generated from the facilities that produce your product(s) for Walmart for the most recent year measured.
2. Have you set publicly available solid waste reduction targets? If yes, what are those targets?
3. If measured, please report total water use from facilities that produce your product(s) for Walmart for the most recent year measured.
4. Have you set publicly available water use reduction targets? If yes, what are those targets?

Natural Resources: Producing High Quality, Responsibly Sourced Raw Materials

1. Have you established publicly available sustainability purchasing guidelines for your direct suppliers that address issues such as environmental compliance, employment practices and product/ingredient safety?
2. Have you obtained 3rd party certifications for any of the products that you sell to Walmart?

(*Continued*)

People and Community: Ensuring Responsible and Ethical Production

1. Do you know the location of 100 percent of the facilities that produce your product(s)?
2. Before beginning a business relationship with a manufacturing facility, do you evaluate the quality of, and capacity for, production?
3. Do you have a process for managing social compliance at the manufacturing level?
4. Do you work with your supply base to resolve issues found during social compliance evaluations and also document specific corrections and improvements?
5. Do you invest in community development activities in the markets you source from and/or operate within?

While it remains unclear how the results of the survey will be assessed or communicated, one thing is quite clear: eco-labeling is here to stay. Eco-labeling has gone mainstream.

ASTM International (ASTM)

ASTM International is the primary SDO in the United States and a leader in global SDOs. It is familiar in the building industry (and many other industry sectors). It is as mainstream in standards as Walmart is in retail.

On Earth Day 2009, ASTM International set a global precedent, becoming the first mainstream SDO to convene a comprehensive committee on sustainability. Not just a workshop. Not prioritizing a single aspect (energy, water, etc.) Not limited to one industry sector. A comprehensive committee.

Sustainability is complex. Best practices in one area can result in unintended negative consequences for another. This is the web of life. Everything is connected. And, those connections are environmental, social, and economic. A forum to explore the complexity was necessary. Further, each piecemeal effort to address an aspect of sustainability for a given industry sector was obliged to develop fundamental guidance on its own. The redundancy of effort was inefficient and spiraling. Each effort began with the question "What is out there?" Each determined the answer on their own. As would be expected, all the answers were similar but just different enough in flavor and format to be problematic in combination. A means to coordinate the efforts was badly needed. A portal to sustainability standards—something that allowed the various efforts to create better, more consistent gap analyses—was necessary.

ASTM is probably one of the few entities with the experience and structure to meet such a demand. Moreover, it is one of the few entities that meet the ISEAL criteria.

ASTM is a voluntary organization created at the turn of the last century (1898) that develops standards for everything from dishwashing liquid to concrete curing compounds. It maintains over 12,000 standards, used all over the world. ASTM is designed to be a balanced organization and voting membership on any of the 140+ committees is limited to 50 percent manufacturing interests. The remainder is composed of users, government, academia, and general public. Much of the process occurs online. However, each committee typically meets twice annually at varying locations so that everyone is equally

inconvenienced. Membership largely reflects U.S. interests, but in 2000 ASTM began a global outreach program, with special emphasis on developing countries. As of October 2009, participation includes over 7,800 international members from 135 countries. (Total membership is approximately 30,000.)

After more than a decade successfully exploring, developing, and publishing international standards on sustainability related to building, ASTM created a new committee on sustainability that encompasses all industry sectors, ASTM International Committee E60. This committee met formally for the first time on Earth Day, 2009, in Vancouver. Already, it has over 600 members and numerous efforts in progress. Highlights include standards related to:

Product Assessment and Marketing Claims:

- E2129-05 Standard Practice for Data Collection for Sustainability Assessment of Building Products
- WK23356 Product Category Rules for Building Products and Systems
- WK3161 Marketing and Product Claims Related to Sustainable Building
- WK24444 Environmentally Preferable Products for Buildings and Construction
- E1991-05 Standard Guide for Environmental Life Cycle Assessment (LCA) of Building Materials/Products
- WK24856 Chain of Custody
- WK24855 Extended Producer Responsibility

Building Assessment:

- E2432-05 Standard Guide for General Principles of Sustainability Relative to Buildings
- WK23556 Minimum Environmental, Social, and Economic Requirements for a Building Promoting Sustainability
- WK4879 Standard Practice for Assessing Environmental Performance Improvements of Electric Power Generation Facilities and Infrastructure
- E1971-05 Standard Guide for Stewardship for the Cleaning of Commercial and Institutional Buildings

Water Stewardship:

- E2635-08 Standard Practice for Water Conservation in Buildings Through In-Situ Water Reclamation
- WK22284 Estimating Environmental Load of Residential Wastewater
- WK22285 Assessment of Rain Water Quality
- WK22286 Water Stewardship in the Design, Construction, and Operation of Buildings
- WK18419 Water Stewardship and Plumbing Fixtures

Indigenous Construction:

- E2392-05 Standard Guide for Design of Earthen Wall Building Systems
- New standards for straw bale construction

Vegetated Green Roofs:

- E2396-05 Standard Test Method for Saturated Water Permeability of Granular Drainage Media [Falling-Head Method] for Green Roof Systems
- E2397-05 Standard Practice for Determination of Dead Loads and Live Loads associated with Green Roof Systems
- E2398-05 Standard Test Method for Water Capture and Media Retention of Geocomposite Drain Layers for Green Roof Systems
- E2399-05 Standard Test Method for Maximum Media Density for Dead Load Analysis of Green Roof Systems
- E2400-06 Standard Guide for Selection, Installation, and Maintenance of Plants for Green Roof Systems
- WK25385 new Standard Guide for Green Roof Systems
- New Standard Practice for the Assessment of Green Roofs
- WK25761new Standard Guide for Use of Expanded Shale, Clay and Slate (ESCS) as a Mineral Component in Growing Media for Green Roof Systems

Hospitality:

- WK22056 Standard Practice for the Evaluation and Selection of Hotel and Meeting Accommodations related to meetings, events, conferences, conventions and trade shows.
- WK22057 Standard Practice for the Evaluation and Selection of Audio Visual (A/V) Equipment for Meetings, Events, Trade Show and Conferences
- WK22666 Standard Practice for the Evaluation and Selection of Communication Supplies for Meetings, Events, Trade Show and Conferences
- WK22668 Standard Practice for the Evaluation and Selection of Destinations for Meetings, Events, Trade Show and Conferences
- WK22669 Standard Practice for the establishment of Exhibits for Meetings, Events, Trade Show and Conferences
- WK22672 Standard Practice for the Evaluation and Selection of Food and Beverage for Meetings, Events, Trade Show and Conferences
- WK22674 Standard Practice for the Evaluation and Selection of Meeting Venue for Meetings, Events, Trade Show and Conferences
- WK22676 Standard Practice for the establishment of Onsite Offices for Meetings, Events, Trade Show and Conferences
- WK22678 Standard Practice for the Evaluation and Selection of Transportation for Meetings, Events, Trade Show and Conferences

In addition to the usual work of an SDO (i.e., creating standards), ASTM E60 has within its scope the goals of "Monitoring the public need for standards related to sustainability" and "Providing support and services as a resource to other[s]."[4] Others include not only other ASTM committees but also other organizations. Many ASTM Committees address

sustainability issues such as: infrastructure/built environment, water, agriculture, energy, products, waste, materials, and toxics. These ASTM Committees include:

- C01 Cement
- C09 Concrete
- C16 Thermal Insulation
- D03 Gaseous Fuels
- D04 Road and Paving
- D05 Coal and Coke
- D18 Soil and Rock
- D19 Water
- D20 Plastics
- D22 Air Quality
- D34 Waste Management
- D02 Petroleum
- E06 Performance of Buildings
- E35 Pesticides
- E44 Solar Energy
- E47 Biological Fate
- E48 Biotechnology
- E50 Environmental Assessment
- F40 Declarable Substances

Even more numerous are the other organizations addressing sustainability. Remember, nearly every organization now functions as an SDO for eco-labeling schemes. Trade/professional groups, nonprofits, government agencies, and individual companies—all have published green standards. Thus, a prerequisite to supporting the work of others is knowing what that work is—answering the basic question, "What is out there?" To accomplish this, ASTM E60 unveiled the ASTM Sustainability Standards Database.[5]

The ASTM Sustainability Standards Database is free and open to the public. Anyone can access it. Anyone can submit standards for inclusion. The database is a listing of standards. It does not tell you which is (or is not) a good standard. But, it is an important first step in any gap analysis. Information for each standard includes:

- Designation & Title of Standard
- Organization that Developed the Standard
- Industry Sector(s) Addressed by the Standard
- Sustainability Aspect(s) Targeted by the Standard (i.e. environmental, economic, and/or social)

- Keywords (i.e., Water Stewardship, Risk Management, Sustainable Building, Ecosystem Stewardship, Biodiversity, Biobased Content, Recycled Content, Waste Management, Energy Efficiency, Human Health, Renewable Energy, Indoor Air Quality, Labeling/Reporting, Life Cycle, Acoustics, Terminology)

The database includes nearly 1,000 green building standards. Of these, approximately half are ASTM standards. This is a new project. The building industry is the first industry sampled. However, the database is structured to accommodate all industry sectors. It is a tremendous resource for all SDOs.

International Organization for Standardization (ISO)

ISO is a volunteer SDO with over 50 years of experience. The technical work of ISO is highly decentralized, carried out in a hierarchy of some 2,900 technical committees, subcommittees, and working groups. Each technical committee has subcommittees, and each subcommittee has working groups. Although the greater part of the ISO technical work is done by correspondence, there are, on average, a dozen ISO meetings taking place somewhere in the world every working day. Every country is allowed a single vote. To render the vote, each nation designates a voting member body. For the United States, the voting member body is the American National Standards Institute (ANSI). ANSI is essentially a facilitator that designates (for each ISO technical committee) an entity responsible for developing the American opinion. Each entity forwards the opinion (the vote, comment, etc.) through ANSI to ISO. Most of the entities reside in ASTM.

The ISO Technical Committee (TC) on Environmental Management (ISO/TC 207) covers "standardization in the field of environmental management tools and systems" and is responsible for the best known ISO environmental standards: the ISO 14000 series of standards. The most commonly cited is ISO14001, Environmental management systems—Requirements with Guidance for Use, which identifies the elements of an environmental management system (EMS) necessary for an organization to effectively manage its impact on the environment. The ultimate objective of the standard is to integrate the EMS with overall business management processes and systems so that environmental considerations are a routine part of business decisions. Typically, such management is primarily intended to prevent negative environmental impacts and assure environmental regulatory compliance. However, it can also be used to promote positive impacts. ISO TC207 standards are broadly applicable to all industry sectors, including the building industry, and include:

- ISO Guide 64:1997 Guide for the inclusion of environmental aspects in product standards
- ISO 14004:2004 Environmental management systems—General guidelines on principles, systems and support techniques
- ISO 14015:2001 Environmental management—Environmental assessment of sites and organizations (EASO)
- ISO 14020:2000 Environmental labels and declarations—General principles
- ISO 14021:1999 Environmental labels and declarations—Self-declared environmental claims (Type II environmental labeling)

- ISO 14024:1999 Environmental labels and declarations—Type I environmental labeling—Principles and procedures
- ISO 14025:2006 Environmental labels and declarations—Type III environmental declarations
- ISO 14031:1999 Environmental management—Environmental performance evaluation—Guidelines
- ISO/TR 14032:1999 Environmental management—Examples of environmental performance evaluation (EPE)
- ISO 14040:2006 Environmental management—Life cycle assessment—Principles and framework
- ISO 14044:2006 Environmental management—Life cycle assessment—Requirements and guidelines
- ISO/TR 14047:2003 Environmental management—Life cycle impact assessment—Examples of application of ISO 14042
- ISO/TR 14048:2002 Environmental management—Life cycle assessment—Data documentation format
- ISO/TR 14049:2000 Environmental management—Life cycle assessment—Examples of application of ISO 14041 to goal and scope definition and inventory analysis
- ISO 14050:2002 Environmental management—Vocabulary
- ISO/TR 14062:2002 Environmental management—Integrating environmental aspects into product design and development
- ISO 14063:2006 Environmental management—Environmental communication—Guidelines and examples
- ISO 14064-1:2006 Greenhouse gases—Part 1: Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals
- ISO 14064-2:2006 Greenhouse gases—Part 2: Specification with guidance at the project level for quantification, monitoring and reporting of greenhouse gas emission reductions or removal enhancements
- ISO 14064-3:2006 Greenhouse gases—Part 3: Specification with guidance for the validation and verification of greenhouse gas assertions
- ISO 14065:2007 Greenhouse gases—Requirements for greenhouse gas validation and verification bodies for use in accreditation or other forms of recognition
- ISO 19011:2002 Guidelines for quality and/or environmental management systems auditing

ISO TC207 is also working on a draft standard, ISO/CD14006 Environmental management system—Guidelines on Ecodesign, for "ecodesign" of a product, process, or system. It is intended to provide guidance for top managers regarding the potential benefits of ecodesign and related business strategies; for environmental managers as to how ecodesign activities can be incorporated into and managed under an EMS, and, for designers, to identify the design issues they should address.

In 1997, ISO designated an ad hoc committee to investigate the international viability and necessity of standards for sustainable building and to review the many building rating systems that have been produced in the United Kingdom, Canada, Norway, Sweden, and the United States. By unanimous agreement, the Ad Hoc Group on Sustainable Building proposed that ISO/TC 59 develop a new Subcommittee.

So, in 2003, ISO initiated a new Subcommittee (TC59/SC17) on Sustainability in Building Construction. This subcommittee deals with standardization in the field of sustainability of the built environment with environmental, economic, and social aspects of sustainability included as appropriate. Standards efforts for which it is responsible include:

- ISO 15392:2008 Sustainability in building construction—General principles
- ISO/CD 21929-1 Sustainability in building construction—Sustainability indicators—Part 1: Buildings
- ISO/TS 21929-1:2006 Sustainability in building construction—Sustainability indicators—Part 1: Framework for development of indicators for buildings
- ISO 21930:2007 Sustainability in building construction—Environmental declaration of building products
- ISO/TS 21931-1:2006 Sustainability in building construction—Framework for methods of assessment for environmental performance of construction works—Part 1: Buildings
- ISO/DIS 21931-1 Sustainability in building construction—Framework for methods of assessment for environmental performance of construction works—Part 1: Buildings
- ISO/AWI TR 21932 Buildings and constructed assets—Sustainability in building construction—Terminology

Trade and Professional Organizations

Trade organizations are also publishing standards and opinions on environmental issues. Not surprisingly, trade organizations typically focus on their industry sector. The American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) is a prominent example. ASHRAE has developed standards relative to indoor air quality and energy efficiency, including:

- ASHRAE 90.1-2007, Energy Standard for Buildings Except Low-Rise Residential Buildings—This standard provides minimum requirements for the energy-efficient design of buildings, except low-rise residential buildings.
- ASHRAE 90.2-2007, Energy-Efficient Design of Low-Rise Residential Buildings. This standard provides minimum requirements for the energy-efficient design of residential buildings.
- Standard 55-2004, Thermal Environmental Conditions for Human Occupancy— Specifies the combinations of indoor space environment and personal factors that will produce thermal environmental conditions acceptable to 80% or more of the occupants within a space.

- Standard 62.1-2007, Ventilation for Acceptable Indoor Air Quality—This standard specifies minimum ventilation rates and indoor air quality that will be acceptable to human occupants and are intended to minimize the potential for adverse health effects.
- Standard 62.2-2007, Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings—This standard defines the roles of and minimum requirements for mechanical and natural ventilation systems and the building envelope intended to provide acceptable indoor air quality in low-rise residential buildings.

The ASHRAE 189 standard, *Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings*, is something of the exception to the rule for trade organizations. Its scope is not limited to the organization's industry sector and/or its associated area of expertise. Through partnership with the U.S. Green Building Council (USGBC) and the Illuminating Engineering Society of North America (IESNA), ASHRAE expanded its normative subject matter to include all aspects of green building design. Originally drafted in 2006, the collaboration was disbanded in October 2008. ASHRAE reconfigured and reconvened the 189 Committee some months later and released a final version in January 2010. The original effort began as a minimum green building standard; the new and improved version targets high-performance, including aggressive energy targets.

Government

Internationally, the World Trade Organization (WTO) is the single greatest driver of standards, including eco-labels. The WTO deals with the global rules of trade between nations. It was founded in 1995 as a result of revisions to the General Agreement on Trade and Tariffs (GATT). As of 2008, there are 153 member countries in the WTO. Membership in the WTO is highly sought after as the most effective way to enter the global market and the race for international investment. In obtaining membership, countries commit to abide by the WTO Agreements.

The WTO Agreements—or "trade rules"—cover goods, services, and intellectual property. There are about 60 agreements, annexes, decisions, and understandings. One of the most significant is the Agreement on Technical Barriers to Trade (WTO-TBT). Although there is allowance for some exceptions, in general the WTO-TBT elevates international consensus standards above domestic policies. Member countries are obligated to comply with and to utilize international standards. Section 2 of the WTO-TBT states:

> *Where technical regulations are required and relevant international standards exist or their completion is imminent, Members shall use them, or the relevant parts of them, as a basis for their technical regulations except when such international standards or relevant parts would be an ineffective or inappropriate means for the fulfillment of the legitimate objectives pursued, for instance because of fundamental climatic or geographical factors or fundamental technological problems.*[6]

Since the creation of the WTO and the subsequent TBT Agreement, standards have assumed new prominence as an essential part of international commerce and the process

of globalization. Many view the WTO, a relatively young institution, as one of the greatest engines of change today. Some view the change as progress; others view the change as catastrophic. Regardless of your perspective, it is critical to understand the hidden life of international standards, how and why they are created, and their implications for sustainable development.

The U.S. federal government formally supports consensus-based standards. Public Law 104-113, also known as the National Technology Transfer and Advancement Act (NTTAA), requires U.S. federal agencies to "use technical standards that are developed or adopted by voluntary consensus standards bodies" in both their procurement and rulemaking unless such use is inconsistent with applicable law or otherwise impractical. In cases where no voluntary consensus standards exist, agencies can use other technical standards. It also directs agencies to participate in consensus SDOs. Consensus SDOs are defined by the following attributes:

(i) Openness.

(ii) Balance of interest.

(iii) Due process.

(iv) An appeals process.

(v) Consensus, which is defined as general agreement, but not necessarily unanimity, and includes a process for attempting to resolve objections by interested parties, as long as all comments have been fairly considered, each objector is advised of the disposition of his or her objection(s) and the reasons why, and the consensus body members are given an opportunity to change their votes after reviewing the comments.[7]

Once in the market, eco-labels fall under the examination of various governmental and nongovernmental entities. All of them are watching to see who is (and is not) telling the truth.

In the U.S., the Federal Trade Commission (FTC) addresses such market issues. Section 5 of the FTC Act prohibits unfair or deceptive practices. The FTC publishes the Environmental Guides, often referred to as the "Green Guides," to indicate how the FTC will apply Section 5 of the FTC Act to environmental marketing claims. The Green Guides were originally published in 1992, and revised in 1998. As of 2010, they are in process for additional revisions. The current revision process is examining: green building and textiles claims, green packaging claims, and marketing of carbon offsets and renewable energy certificates (RECs).

The FTC has brought law enforcement actions targeting allegedly false or unsubstantiated environmental claims. It is worth noting, that manufacturers watch each other's claims very closely. When a manufacturer identifies an objectionable claim from a competitor, they tend to work first through the National Advertising Division (NAD) of the Better Business Bureau. Then, if no resolution is forthcoming, they move to the FTC. NAD specializes in alternative dispute resolution regarding contested marketing claims. Cases are often resolved quickly, many times while the ad campaign is still running. While NAD keeps confidential all data it receives, the challenger's and advertiser's positions, NAD's decision, and a statement by the advertiser are made public. Consumers as well as businesses can file claims through NAD.

The FTC Green Guides outline general principles that apply to all environmental marketing claims and then provide guidance on specific green claims, such as biodegradable, compostable, recyclable, recycled content, and ozone safe. In general, claims should:

- Clearly state environmental benefits
- Explain environmental characteristics
- Explain how benefits are achieved
- Ensure that claims about comparative differences are justified
- Ensure that negative factors are taken into consideration
- Only use meaningful terms and pictures

Claims should avoid:

- Vague statements. This includes terms such as "environmentally friendly," which are too general in nature to be of any use to consumers trying to make an informed decision.
- Implied certification. For example, use of a graphic designed to look like a certification stamp or use of the word "certified" can mislead people into thinking that the product or company meets or has been assessed as meeting a standard.
- Implied endorsement. Repeating an environment group's policy position in marketing can be used to imply endorsement that the product or business does not have.
- Selective use of data. Sometimes failing to disclose contextual information can be misleading. For example, providing fuel consumption data for a car without disclosing under what conditions this data was obtained. Similarly, providing information about one, minor environmental aspect/impact while ignoring other, possibly more significant, environmental aspect/impacts is misleading.

Labeling

Eco-labels come in two basic flavors:

1. Conformance to green standard(s)
2. Statement of green attribute(s)

Eco-labels associated with standards generally correspond to single-attribute criterion or multi-attribute criteria. Eco-labels associated with statements or "product declarations" typically relate to life cycle thinking, which may or may not involve a formal Life Cycle Assessment. Either may have certification.

The discussion of green building material performance criteria in Chapter 4 offers prime examples of green building product standards. These include standards developed by ASTM International, ICC-ES, NSF-ISR, and UL Environment. Additional examples from other industries are provided in Appendix E, "Examples of Sector-Specific Initiatives toward Sustainability."

Statements of green attributes originally consisted of nothing more than a manufacturer's marketing claims. Some are still basically that. Perhaps with a trendy "eco-name"

appended to the brand. However, there is a mounting pressure to create some consistency in the statements. Enter "product declarations." An Environmental Product Declaration (EPD) is an eco-label that discloses the environmental performance of a product or service over its life cycle. While Life Cycle Assessment (LCA) and the standardized approach to EPDs are still developing, customers are demanding them.[8] Beginning January 1, 2011, all high-volume consumer products sold in France will be required to have an EPD label on them. With France leading the way, other countries have already begun work toward implementing similar standards for mandatory EPDs. These regulations will probably be seen next in the European Union and Japan.

Unlike other performance criteria, each new green standard seems to spawn a related label. You don't see this type of phenomenon for "non-green" criteria. There isn't a family of labels associated with tensile, shear, and compression tests. You don't evaluate competitive labels for screw pull-out. There aren't any special labels branding screw pull-out. There are standards. There is test data. In the green market, however, there are lots of labels accompanied by a corresponding growth in certification. At its best, certification aids in discerning the reasonable statements and labels from those that have less substance supporting them. At its worst, certification only amplifies the noise. The difference lies in the expertise and integrity of the certifying entity.

Certification

Certification, and, specifically, independent third-party certification, is necessary because our society long ago abandoned the "gentleman's agreement" as an acceptable contractual arrangement. In our increasingly complex and litigious world, it is impossible for one person to have detailed knowledge on all topics. Consequently, we rely heavily on the impartial expertise provided by independent experts. The design and construction industry, for example, no longer relies on the innate desire of a contractor to produce quality craftsmanship or the reliability of the owner to fairly compensate a contractor. Rather, the industry relies on form contracts, legislation, building codes, and trade standards. It is natural in this system for an owner to expect to verify the authenticity of the "sustainable" aspects of sustainably harvested wood through such independent methods. Questions subsequently arise as to what defines "sustainability," who verifies the parameters, what are their qualifications, and how much does it cost. Enter certification.

The certifying entity and method are critical. Independent environmental organizations, for so long considered to be on the radical fringe, are quickly stepping in to fill this void. Their environmental expertise and enthusiasm for educating industry and the public can be extremely valuable assets.

Environmental NGOs have credibility because of their long history of altruistic pursuits. They are exquisitely objective. In contrast to industry organizations whose primary goals are to facilitate commerce and promote the products of their membership, environmental organizations have one purpose: protect the environment. In addition to NGOs, there is now a buffet of certifying entities. And, yes, accreditation entities to certify the certifiers. Take your time and do your homework.

Certification addresses both types of eco-labels. Certifications associated with standards are very similar to test reports demonstrating a product's performance. Certifications

for product declarations are more like notarized statements with a certain level of quality control review included. In each case, the reason to certify is to demonstrate compliance with current best practices. This sounds fairly obvious today. But, just a few years ago, environmentalists and industry representatives were in opposite camps, separated primarily by the working definition of the term "sustainability." ASTM E2432, *Standard Guide for General Principles of Sustainability Relative to Buildings,* changed that dynamic. It brought discussion of best practices to the foreground. For better or for worse, it brought stakeholders together and ushered in a new era of sustainability standards, certifications, rating programs, eco-labels, and codes.

ASTM E2432 – Standard Guide for General Principles of Sustainability Relative to Building

One of the most important new standards for the green building industry is ASTM E2432, *Standard Guide for General Principles of Sustainability Relative to Buildings*. This standard concisely and clearly articulates the critical components underpinning a viable framework for sustainable development. It identifies the three general principles associated with sustainability—environmental, economic, and social. It emphasizes the need for balance and continual improvement in application of those principles. And, most uniquely and importantly, it distinguishes between "ideal" and "applied" sustainability. This last component is a game changer. It has facilitated development of green building standards, rating programs, and codes. It has promoted discussion of current best practices while still advancing sustainability theories.

Clearly, the lofty goals of sustainable development are idealistic. If we target ideal sustainability, we will fail. It isn't possible to be perfect. Nobody wants to fail—especially mainstream businesses for which success is a tangible commodity and failure to achieve any one task may drag down an entire company. By distinguishing between ideal and applied sustainability, ASTM E2432 changed the goals and the dialogue. Now, companies can approach ideal theories with applied best practices. While maintaining recognition of an ultimate goal, the standard acknowledges the viability of more realistic interim objectives, helping establish manageable steps towards "ideal" sustainability.

ASTM E2432 aids development of new green products. The most prominent challenge resulting from the focus on the ideal rests in the perspective of risk. Risk is inherent in development of any new process or material. It is the nature of scientific discovery and exploration. It is how humanity advances. It is fundamental to new product development—including new green products. When ideal sustainability is invoked, it becomes virtually impossible to experiment with new technology.

The Precautionary Principle, a prime example of ideal sustainability, eschews adoption of any action or material that may pose a threat to human health or the environment. As an ideal goal, it is laudable. Make no mistake, we support this ideal. As a practical exercise, however, it is extremely problematic.

At an international level, the precautionary principle was first recognized in the World Charter for Nature, adopted by the United Nations General Assembly in 1982. It attained public exposure in Principle 15 of the Rio Declaration. The Rio Declaration, also known as Agenda 21, from the 1992 United Nations Conference on Environment and

Development stated: "*In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as reason for postponing cost-effective measures to prevent environmental degradation.*"[9] In 2000, the European Commission issued a Communication on the Precautionary Principle endorsing its application.[10] Various local initiatives have also embraced the Precautionary Principle. For example, the City of San Francisco passed a Precautionary Principle Purchasing ordinance in 2005 that "requires the selection of the alternative that presents the least potential threat to human health and the City's natural systems."[11]

In its strictest interpretation, the Precautionary Principle forbids all action if there is a reasonable concern for negative impact on human health or the environment. Without ASTM E2432, it is virtually impossible for a manufacturer to reasonably implement the Precautionary Principle.

Another significant challenge associated with ideal sustainability is that it presupposes a utopia. In reality, society has certain limitations in both its administrative systems and its physical infrastructure. Manufacturers may want to use postconsumer recycled content materials. They may have designed their product line to utilize postconsumer recycled content materials. But, without the social infrastructure to support collection and processing of postconsumer recyclables, it isn't going to happen. Prior to ASTM E2432, many manufacturers simply waited for infrastructure to be developed. Now, manufacturers are working with communities and challenging all of us to improve the infrastructure.

From a business perspective, the emphasis on continual improvement is familiar. It is consistent with recognized industry protocols such as the ISO 9000 series, Quality Management Standards, and ISO 14000 series, Environmental Management Standards.[12] It is also basic corporate practice. Technologies and regulatory requirements evolve; what is most cost-effective and efficient today will change tomorrow.

From an environmental perspective, the emphasis on continual improvement is critical. Society does not know how many species there are on the planet. In 1758, the number of earth's species was estimated at 20,000. Today, there are approximately 1,500,000 recorded species and estimates for total species range from 4,000,000 to 100,000,000. Examples of new species recently identified include:

- *Oct 2001*: UK, butterfly (*Leptidea reali*)
- *May 2003*: Monterey Submarine Canyon, jellyfish (*Granrojo*)
- *May 2005*: Tanzania, monkey (*Lophocebus kipunji*)
- *Feb 2006*: New Guinea, 20+ species of frogs
- *Mar 2006*: South Pacific, lobster or crab (*Kiwa hirsute*), a new specimen so distinct scientists created a new taxonomic family for it

If we cannot estimate the number of species within a few million, how can we presume to attempt anything other than continual improvement? In application, sustainability is more a process of becoming than a state of being. ASTM E2432 recognizes this and directs that: *"Decisions should be based upon an ever-evolving knowledge base and an understanding of the complex interactions among economic, environmental, and social systems. . . . Decisions should be based upon local, regional, and global opportunities and*

challenges." Furthermore, the standard notes: *"In striving for sustainability, decisions and their implementation should be continually monitored, assessed, and adjusted, as necessary, in a process that incorporates continual improvement."* We must reevaluate previous decisions as new information is developed.

Future Developments

There are intricate connections among industry sectors. Technical connections. Environmental connections. Economic connections. The potential mutual benefits of such connections are the basis of industrial ecology. But, how does that potential become realized broadly? How does it become so integrated mainstream—across and between industry sectors—that it is truly business as usual?

Implementation of the concept of sustainability is one of the most critical imperatives of our generation. There are numerous efforts in various industries that attempt to provide detailed requirements. There are repeated political statements and academic studies acknowledging the need for coordinated action on an assortment of initiatives. However, there are few practical examples of such connections. Moreover, prior to the creation of ASTM Committee E60 on Sustainability, there was virtually no such forum available to identify, capture, and build upon the synergies between industries.

ASTM Committee E60 is critical to this transformative vision, to weaving sustainability into the warp and woof of daily life. There are lots of voices in the green market. ASTM E60 establishes a viable, multi-industry, standards development forum in which all can be heard. This is fundamental to progress in and implementation of sustainability. It will facilitate the creation of consistent criteria and infrastructure, both prerequisites to sorting through all of the eco-labeling options.

Notes

1. www6.homedepot.com/ecooptions/index.html?cm_mmc=Thd_marketing-_-Eco_Options_Site_07-_-Vanity-_-Home (accessed 10/6/09).
2. http://walmartstores.com/Sustainability/9292.aspx (accessed 10/6/09).
3. Ibid.
4. ASTM International Committee E60 Bylaws, Adopted by Committee: March 3, 2009.
5. www.astm.org/COMMIT/sustain.html (accessed 02/23/10).
6. "Article 2, Section 2.4 Technical Regulations and Standards"; WTO - Technical Barriers to Trade.
7. OMB Circular A-119; Federal Participation in the Development and Use of Voluntary Consensus Standards and in Conformity Assessment Activities.
8. Product Category Rules (PCR) provide the apples-to-apples framework underpinning EPDs.
9. www.unep.org/Documents.Multilingual/Default.asp?DocumentID=78&ArticleID=1163 (accessed 6/14/07).

10. http://ec.europa.eu/dgs/health_consumer/library/pub/pub07_en.pdf (accessed 6/14/07).
11. www.municode.com/Resources/gateway.asp?pid=14134&sid=5 (accessed 6/14/07).
12. The flagship standard of the 14000 series is ISO 14001, Environmental Management Systems – Requirements with Guidance for Use. Environmental Management Systems (EMSs), particularly ISO 14001 registered EMSs, have become fundamental to the international market; in the USA, Executive Order 13423 requires federal agencies to implement EMSs and "ensure that contracts . . . for contractor operation of government-owned facilities . . . require the contractor to comply with provisions of this order . . ."

CHAPTER 6

How Does the Construction Process Work?

Worldwide, the building industry is beginning to recognize the shortcomings of its products and to discover that there are readily available, cost-effective remedies.

—David Malin Roodman and Nicholas Lenssen,
A Building Revolution: How Ecology and Health Concerns Are Transforming Construction

Every building construction project, green or not, goes through several phases, beginning with the planning phase and concluding with the postconstruction phase. The bidding and construction phases are where the rubber meets the road for the building's design professionals. By examining the process of bidding and construction, we can understand the actions required to ensure the successful incorporation of green building materials into a project.

Design and Construction Relationships

The Building Owner

The building owner is the person or company, either public or private, whose idea the building was in the first place. The owner is also responsible for funding the construction of the project and for operating it once it is complete. The owner is the one party who enters into separate contracts with both the design professional and the contractor. This creates a third-party relationship between the design professional and the contractor. For example, during construction, certain responsibilities of the design professional, acting on the owner's behalf, are included in the owner-design professional contract. They are also included in the owner-contractor contract.

The building owner rarely cites environmental concerns as a reason for building. The reason for building is to meet a specific need of the owner. The owner also rarely cites spending money as a reason for building. Spending money is viewed as an unfortunate consequence of meeting the identified need. Another necessary evil is the time required to transform the owner's need into a building.

The building owner may be a single person, several persons, or an organization. The organization, public or private, is probably represented by several key contacts (e.g., director of construction, facilities manager, marketing/sales manager, vice president in charge of construction, etc.), who may or may not have a clear understanding of the hierarchical relationships among themselves. However, to successfully incorporate green building materials into a project, it is as important to understand the relationships between the contacts within an organization as it is to understand the relationship of the owner to other parties on the project. Finding a champion of green materials within the organization is nice; finding the *right* champion is better.

With increasing frequency, building owners are including environmental concerns in their design requirements. The design professional must recognize that this does not imply that the owner's attitude about cost or time has changed. Nevertheless, more and more *Fortune* 500 companies are elevating environmental responsibility to higher levels within the corporate structure. It is not unusual for the director of environmental affairs to be a vice president or board member. According to a 2004 survey of Global 500 companies by Global Environmental Management Initiative (GEMI), approximately 81 percent rated environmental, health, and safety issues among the top 10 issues facing their business.[1]

The Construction Manager

The construction manager is either an individual or an entity hired by the owner to supplement the owner's role in a project. The construction manager may have a background as an architect, engineer, or contractor; however, most states do not require construction managers to be licensed. Construction managers can have different degrees of authority granted by the owner depending on how the project is organized. Construction managers are most likely to be found on projects with complex schedules or budgets, those that require extensive coordination between disciplines, and those where the owner has limited experience with design and construction projects.[2]

The construction manager provides professional management services. These may run for the duration of the project, from design through postconstruction, or for any portion thereof. Typically, one of the duties is to oversee the process of submittals. On a green project, this becomes an even more important role, since the accumulation of the proper documentation is one of the main factors enabling submittal of the project for certification. Another common duty is the coordination of the work of the various contractors. This is extremely important on green projects. For example, where commissioning is required for certification, the construction manager must ensure that the commissioning agent's requirements are met by all project members, that scheduled testing and demonstration is performed in a timely manner, and that closeout documentation (required for certification) is properly prepared and assembled for delivery to the architect and commissioning agent.

The Contractor

The contractor is the entity that enters into a contract with the building owner to build the project. The contractor, in turn, subcontracts with a multitude of subcontractors and suppliers to furnish and install specific portions of the work. The contractor, however, retains

responsibility for completing the project in accordance with the contract documents. For this reason, it is important that contractors incorporate provisions of their contract into the contracts with their subcontractors and suppliers.

Provisions of the contract documents that should be incorporated include submittal procedures and substitution request procedures. The subcontract or purchase order should reference the relevant drawings and specifications that pertain to the portion of the work being performed or building material being supplied.

When green building materials are included in a project, the contractor must deal with the additional demands of purchasing and installing unfamiliar materials. The contractor must ensure that the subcontractors and suppliers are aware of and follow the environmental requirements associated with these products. The contractor must also be familiar with substitution request procedures.

To avoid conflicts with both the owner and the design professional, the contractor should be aware of the owner's reasons for requiring the use of green building materials on a project and understand how flexible or not the contract documents are with respect to substituting nongreen materials for green ones.

The Design Professional

The design professional, who may be either an architect or engineer, is generally the primary consultant on a building project. Based on licensing laws and training, the primary design professional on a project is usually the architect. The architect typically subcontracts portions of the work to other design professionals, such as structural engineers, landscape architects, electrical engineers, civil engineers, mechanical engineers, and others as necessary. As the primary consultant, the architect usually has the most direct contact (and, theoretically) influence on the building owner. The architect is probably also involved in construction contract administration.

Many architects are interested in environmental issues. Some are concerned. Some do not place any priority on green at all. Others are actively attempting to improve the world to the extent they can. In short, architects are like everyone else.

When the actively committed design professional and the inspired green product manufacturer meet, the synergy can be tremendous. On average, though, the architect typically experiences more frustration than usual when searching for green building materials. Similarly, the manufacturer often feels frustrated trying to market a green product. This is true primarily for two reasons: Architects have extremely limited time in which to research new materials, and green building material manufacturers often lack a working knowledge of the building industry.

Many architects do not know where to go to get information on green building materials or know how to evaluate it once they have it. For a small firm, the time involved in researching these materials is prohibitive. Further, green building materials represent a rapidly changing segment of the industry that must be constantly monitored. Although a few small firms specialize in green architecture, many do not have the time or the expertise to follow the market changes regarding green. Larger firms can support more overhead activities. The green building material manufacturer would do well to identify those firms, large or small, that have indicated a commitment to green architecture, and market their products to them.

The Product Manufacturer

Green products are developed by two types of manufacturers: established manufacturers who produce a line or lines of green building materials, and the novice manufacturer who has a good idea and wonders why the rest of the world hasn't caught on yet. The most common difficulty facing the novice manufacturer is a lack of understanding of the target industry. A lack of basic understanding of the contractual relationships among the contractor, architect, and owner means that green product representatives may not know whom to contact, when, or how to get their product used on a project. They do not know what information must be conveyed, or why. They are not familiar with the standard procedures of the typical construction contract and contract documents.

The architect is frequently in the position of both student and teacher, learning about a new product or method while instructing the product manufacturer on the prerequisite testing and applicable building codes that pertain to the materials they are providing.

It is important that the manufacturer or supplier understand the design and construction process in order to effectively operate within it. Most new manufacturers—especially those addressing environmental issues—do not understand the process. They do not know how to get into it or how to follow it and to stay in it. Thus, even though they have a great idea and a great product, they go out of business almost as quickly as they got into it.

One of the primary actions that a green material manufacturer or supplier can take is to establish an efficient method for distribution of product information and product. For example, sustainably harvested wood, almost by definition, involves many small suppliers. It would be extremely useful for the small suppliers to organize through one or two brokerage agents, such as the nonprofit certifiers with whom they are already working, to bring their products to market.

An example of how this approach can work successfully is the use of Environ material, manufactured by Environ Biocomposites (formerly Phenix Biocomposites, Inc.), in two Walmarts. "The Environ material might have been one of those missed opportunities, except that in this case the manufacturer—Phenix Biocomposites, Inc.—was responsive to . . . [the architect's needs]. As a result, over 1,000 feet of Environ is now in place in [two] of Walmart's. . . environmental demonstration stores."[3]

The manufacturer realized it did not know how to enter certain markets of the construction industry. It was willing to work with design professionals to learn how to enter the market while continuing to develop its product:

> *When Environ first came out, it had so many possible uses that our marketing wasn't very focused. Everyone loved the look and liked the fact that it was recycled. We had people interested in using it for sushi bowls, rifle stocks, and our marketing staff was promoting every possible use. Technical support only got the calls when tough questions came up. For example, Environ isn't meant to be used for structural purposes, but some of our early sales staff weren't clear about that.*[4]

What was unusual for the product manufacturer was having more people involved in research than in sales. This permitted the company to readily offer technical information as required by the design professionals involved in the project. The technical information included results from its own testing, which was based on a version of ASTM standards.

Manufacturers of new products often focus their marketing efforts on a contractor working on a specific project. That doesn't usually work well. Contractors generally base their bids on past experience, and they may be reluctant to substitute a new, unfamiliar product for a more familiar one. It is rare that this substitution will not increase the budget or affect the schedule and, therefore, rare that the contractor will use the green building material on the project.

This brings up another stumbling block. The manufacturer who has successfully marketed to the architect must be ready to deal with the parties responsible for making decisions at different stages of the project. The manufacturer must be prepared to assist the contractor during construction and, perhaps, to convince the contractor and owner to stay with a product even after it is specified.

The Building Official

The building official is the chief code officer for the location at which the project is being constructed. Because the building official's primary responsibility is to ensure the health, safety, and welfare of the building's occupants after its completion, he or she takes a conservative approach to permitting new and unfamiliar building materials into projects.

Most building codes contain provisions governing the use of nontraditional and new materials in buildings. To avoid lengthy delays in the approval of these materials, providing the building official with extensive testing reports and, where available, engineering documentation, speeds the process of getting them approved for use on a project. Providing a list of projects where the material has already been used is also beneficial.

The building official is also burdened by an ever-increasing workload that limits the amount of time available to review nontraditional and new materials. An example of how difficult it is to get approval for nontraditional and new materials is the use of straw bale in a construction project. This material, which has been around for a long time, was not an approved material under the current building code. The code authorities required extensive testing and demonstration of its abilities to function as well as more traditional building materials, even though straw bale has been used to construct homes around the United States for many years.

The Building Occupant

The building occupant may or may not be the building owner. Broadly, the occupants of public facilities, commercial buildings, and private residences are the public. They are the ones who are directly and indirectly affected by design choices made for the building. If the only area for collecting trash is the leftover space under the kitchen sink, it is doubtful that even the most well-intentioned building occupant will separate materials for recycling or composting.

All of us are affected by the Urban Heat Island effect—the rise in temperatures in urban landscapes of 2 to 8 degrees as a result of the reflection of heat and light from solid surfaces (asphalt, concrete, etc.). The Urban Heat Island effect obligates the typical urban building occupant to use 1 to 2 percent more energy per degree rise in temperature than if the building were in a rural area or utilized alternative construction materials.[5]

The building occupant may or may not be in a position to directly influence the selection and implementation of a green building material. However, many building owners are taking note of the public's growing interest in the environment. For three years in a row, the *Times-Mirror Magazine* survey, conducted by the Roper Organization, found that most Americans (66 percent) believe that environmental protection and economic development go hand in hand. When obliged to choose between the two, six out of ten Americans stated that the environment is more important; nine out of ten feel they can personally help the environment; 48 percent are willing to pay an extra 25 cents for a gallon of gasoline if the money is used to help the environment.[6]

The Fabricator

The fabricator is a company that manufactures specific assemblies or products for incorporation into a project under a contract with the contractor. The assemblies or products may be fabricated from a combination of materials. It is important that the fabricator understand not only the special requirements for green building materials but also the standards that may govern the materials used in the assembly.

The design professional should include references to the applicable standards in the contract documents. Where compliance with the standards is critical to the success of the project, the design professional should also require that a copy of the standard be maintained on the construction job site.

On a green building project, the design professional also considers the environmental impact of the manufacturing process when evaluating which products and assemblies to include. In selecting materials for the Audubon House in New York City, the Croxton Collaborative, Architects, and the National Audubon Society team "looked at criteria such as embodied energy, the overall environmental policies of manufacturers, health and safety conditions at their factories, and even social responsibility."[7]

As in their contracts with subcontractors, contractors incorporate applicable provisions of their contract with the owner into their subcontracts or purchase orders. Fabricators not only manufacture but also install. This means they must be familiar with requirements for working at the job site, such as recycling, material and trash disposal, and air quality control. A fabricator's familiarity with the environmental issues involved in the fabrication of assemblies or products on a green building project makes its selection more likely.

The Subcontractor

The subcontractor is a company or individual that enters into an agreement with the contractor to perform a specific portion of the construction contract or to supply materials for a project.

As the use of subcontractors has grown, the need to ensure that provisions of the construction contract are included in subcontracts has increased correspondingly. Subcontractors are usually selected in much the same manner as contractors, through competitive bidding. In some instances, contractors may select subcontractors based on past experience rather than purely on price.

With subcontractors performing more and more of the work on a project, it is not only contractors who must be sensitized to special requirements of projects that include green building materials. Because subcontractors compete for work through variances in labor costs and by the use of competing materials and products, they, too, must clearly understand the limitations placed on them when green building materials are specified, because acceptable alternates for green materials may not always exist.

The Consultant

Much like subcontractors employed by a contractor, consultants are the design professional's subcontractors. Design professionals subcontract for the services of specialists such as civil engineers, acoustical consultants, and, with growing frequency, green building consultants.

With the introduction and growth of several green building rating systems since 2000, the role of the green building consultant has taken on greater importance and become more formalized. The LEED™ Green Building Rating System awards a point for using a LEED Accredited Professional on a project. Governmental requests for proposals (RFPs) and private industry solicitations regularly request green consultants as one of their requirements. Because many architecture/engineering (A/E) firms are not specifically dedicated to green building, they have to partner with or hire an independent green consultant who specializes in tracking the ever-changing spectrum of technical, political, and financial developments surrounding green buildings. Many large A/E firms have created internal green building consultancies—so-called green teams—to service their own projects. In response to the rising demand for green consultants, universities have started offering specialized degree programs in this area. The market for consultants with green expertise is expected to grow concurrently with the growth of green building programs.

Design professionals are responsible for providing their consultants with information about the project, including the owner's programmatic requirements, the special needs or requirements of the project, and conditions governing construction of the project. When the project is a green building, the design professional must relay special instructions regarding selection of green building materials, energy conservation, and waste management to the consultants so they can incorporate them into the contract documents.

The Design Team

Ideally, a green building material is designed into a building such that it can function optimally. Good communication and a focused understanding of the environmental goals for the project help the design team identify, specify, and utilize green building materials effectively.

The relationship between the architect and the manufacturer is the most important in terms of successfully implementing green building materials. They must work together. Neither can fully implement green building materials without the other. The architect relies on the manufacturer for applicable performance data, installation expertise, and product service. The manufacturer relies on the architect for product consideration at the critical first moments of design when the green product can be implemented most efficiently,

economically, and successfully. Together, they can support a growing market and have the satisfaction of knowing they have done the right thing.

The Bidding Phase

Using the construction documents prepared by the design professionals during the preceding phase, the owner solicits construction bids either by advertisement, in the case of public projects, or by invitation, in the case of private projects.

During the bidding phase, each bidder solicits bids from subcontractors for the portions of the work they are not going to perform with their own forces. The purpose of the competitive bidding process is to determine the lowest responsive and responsible bidder who will be able to construct the project with the funds the owner has available. In public projects, the owner generally must accept the lowest bid. In private projects, the owner usually selects the bidders in advance and is free to choose any of them.

Whether bids are solicited by competitive bid or negotiation, it is during the bidding phase that bidders review project specifications and drawings to determine which products and systems are included. When green building materials and systems are specified, the design professional has two important responsibilities during bidding: (1) educating bidding general contractors, subcontractors, suppliers, manufacturers' representatives, and others about green building materials and systems that may be relatively unknown to them; and (2) processing substitution requests for green building materials and systems.

Because many green building materials are manufactured by small or new companies, many bidders may not be familiar with them or do not know how to contact them. In addition to the contact information the design professional provides either in the specifications or on the drawings, the subject should be covered at the prebid conference. Another issue that must be dealt with at that time is the tendency on the part of contractors to use materials with which they are familiar. The fear of the new or untried is a powerful issue when the contractor is responsible for guaranteeing or warranting the entire building for a year.

The prebid conference, at which the design professionals, owner, and bidders are present, can be used to dispel some of these concerns. A full discussion should be conducted by the design professionals of the importance and reasons for using green building materials and systems on the project, along with a review of the materials and systems and how to contact the manufacturers. A discussion of alternates and substitution request procedures is also helpful. Bidders should be encouraged to raise questions or concerns they have about these products and systems at this time. Minutes of the prebid conference should be kept and distributed to all holders of bidding documents. Documenting information discussed during the conference is extremely important to prevent misunderstandings later in the project. Of course, clarifications of, revisions of, additions to, and deletions from the bidding documents should be incorporated in an addendum.

Another useful practice is to notify the manufacturers of the green building materials and systems when a building project that incorporates their products and systems is released for bidding, so they can contact the bidders directly. To further encourage the dialogue between bidders and green building material and system manufacturers, the design professional can provide a list of bidders to the manufacturers.

Alternates and Substitution Requests

Alternates are typically included in bidding documents to allow the bid price to be adjusted to fall within the limits of the funds available to construct the project. Another use for alternates is to identify the cost of specific materials and systems in comparison to alternate products and systems.

When green building materials and systems are specified, alternates can be used to compare the cost of green versus nongreen. When a project's budget is limited and the owner is concerned that using green will be more costly, alternates can establish the true cost, thereby allowing the owner to base a judgment on the cost of green over the life cycle of the building.

If alternates are used, reference to them should be included in several locations in the bidding documents, including:

- Invitation to Bid/Advertisement for Bids
- Instructions to Bidders
- Bid Form
- Agreement
- Specifications

The Invitation to Bid/Advertisement for Bids document should alert bidders to the inclusion of alternates on the project. A simple statement, like that shown in Figure 6.1, may be used.

The Instructions to Bidders should explain how bidders are to prepare alternates and how the alternates will be considered in evaluating bids. Figure 6.1 includes sample provisions that may be included in the Instructions to Bidders.

The Bid Form should include a list of alternates that matches the list in Section 01 23 00 (01230)—Alternates. To avoid confusion, the order of alternates on the Bid Form should be the same as they appear in Section 01 23 00 (01230). Each alternate on the Bid Form should be followed by a blank space where the bidders fill in their price. A sample alternate is given in Figure 6.1.

If a standard form of agreement, such as AIA Document A101 or EJCDC Document C-520, is not used, those alternates that have been accepted by the owner must be acknowledged within the Agreement. A sample is illustrated in Figure 6.1. When one of the standard forms is used, the accepted alternates should be listed in the space provided on the Agreement form.

To complete the series of bidding documents containing information about alternates, Section 01 23 00 (01230)—Alternates should be used to identify the alternates. Unlike the Bid Form, which contains only a title for each alternate, Section 01 23 00 (01230) includes a detailed description of each. This enables bidders to prepare accurate prices for them. Each alternate should reference the applicable technical specification sections as well as the drawings. The affected technical specification sections in Divisions 02 (2) through 49 (16) should have an article in Part 1—General, which refers to the provisions for alternates (see Figure 6.1). If design professionals wish to emphasize environmental considerations, they can use a special alternate section to do so.

Invitation to Bid/Advertisement for Bids

[The following text should be incorporated into the invitation to Bid/Advertisement for Bids.]

Bids shall be on a stipulated-sum basis for the lump-sum base bid, and indicate prices for alternates.

Instructions to Bidders

[The following text should be incorporated into the instructions to Bidders.]

Alternates are described in the specifications and are listed on the Bid Form.

The price bid for each alternate will be the amount added to or deducted from the Base Bid Price if the Owner selects the alternate.

The Owner may accept alternates in any order, regardless of the order in which they are listed, and determine lowest responsive and responsible bidder based on the sum of the base bid plus any selected alternates.

Bid Form

[The following is a sample alternate format for listing on the Bid Form.]

Alternate No. 1, Erosion Control Blankets (Note: Title of alternate should be derived from description in Section 01230 (01 23 00).

(ADD)/(DEDUCT)_____ Dollars ($_____)

(In words) (In numerals)

Agreement

[The following text should be incorporated into the Agreement between the owner and the contractor.]

The Contractor shall perform all work required by the Contract Documents for the Environmental Resource Center at 2332 Green Street, Paradise City, USA, including Alternates No. 1, 3, and 5 as described in Section 01230 (01 23 00), Alternates, of the Specifications.

Section 01230/01231 (01 23 00)/(01 23 10)

[The following is a sample alternate description which can be used in building a section of alternates in Division 1 (01) of the Project Manual.]

1.5 ALTERNATE NO. 1, EROSION CONTROL BLANKETS

A. Furnish and install degradable, natural-fiber erosion control blankets where indicated on the Drawings and as specified in Section 02370, Slope Protection and Erosion Control (31 25 13, Erosion Controls).

Section 02370 Slope Protection and Erosion Control (31 25 13 Erosion Controls)

[The following is a sample article referencing the Division 1 (01) section on alternates, which should be incorporated into the technical specification section.]

1.5 ALTERNATES

A. Refer to Section [01230/01 23 00] [01231/01 23 10], Alternates/ Environmental Alternates for description of work of this section affected by alternates.

FIGURE 6.1 Examples of Alternates in Bidding Documents

Alternates are used primarily to adjust the bid price prior to the signing of the agreement, whereas substitution requests are generally used by contractors, subcontractors, manufacturers, and suppliers to propose a different manufacturer, product, material, or system than that specified.

Depending on how the project requirements are written, substitutions may be requested only during the bidding phase, only during the construction phase, or during both phases.

It is important that the bidding/contract documents contain clearly defined procedures to control and manage substitution requests whenever they occur. Because of their special nature, this is especially true when green building materials and systems are specified on a project. It is fairly common to receive substitution requests to use nongreen materials instead of green building materials and systems. The inclusion of specific requirements regarding how substitution requests for green building materials and systems will be evaluated by the design professional will make the process clearer and perhaps prevent the submittal of frivolous substitution requests.

Substitution request provisions should appear in bidding/contract documents in much the same manner as alternates. To supplement and expand the provisions that appear in AIA Document A201, General Conditions of the Contract for Construction, and EJCDC Document 1910-8, Standard General Conditions of the Construction Contract, Section 01 25 13 (01630)—Product Substitution Procedures, should be included in the Project Manual. This section should include a standard form for use by bidders/contractors to submit substitutions.

To facilitate evaluation of substitutions and reporting the results, a standard form, similar to the one in Figure 6.2, should be used. The form provides a structured means of comparing the properties of the specified product or systems with the properties of the proposed substitution. It includes a column for the specified product or system and as many additional columns as are required to list proposed substitutions. The rows list properties to be compared and evaluated. In addition to properties such as size and content, the list should include green properties such as volatile organic compounds (VOC), recycled content, and distance of manufacturer from job site as required to define a product's compliance with a green building rating system or its sustainable features.

The Instructions to Bidders states when substitutions are permitted before bids are received, on which form they are to be submitted, who may submit a substitution request, and how notification of approval will be given to bidders. Once a substitution request is approved by the design professional during bidding, all bidders have the opportunity to use the substitute product or system. The benefit to the project's owner is that any savings realized by using the substitute product or system will be incorporated into the bid price.

The Division 01 (1)—General Requirements section cited above, which applies during both bidding and construction, outlines procedures governing substitutions. Once the construction contract is signed, substitutions can only be submitted by the contractor. During construction, the substitution request also must indicate any changes in the contract price and time. If the substitution request is approved, a change order must be issued to incorporate these changes into the contract.

The disadvantage to permitting substitution requests during bidding and construction is that there may not be enough time to properly research the proposed substitution. The design professional should not approve a substitution request if he or she is concerned about its level of quality or ability to perform as well as the specified product. When substitution

Item No.	Description	Specified Manufacturer	Substitute Manufacturer
1	Manufacturer's Name	Ceiling of Choice	Ceilings To Go
2	Product Name & Model No.	GreenTile Acoustical Panel No. XXX	JustasGreen Panel No. YYY
3	Nominal Size & Thickness	24 x 24 x 3/4 inches	24 x 24 x 3/4 inches
4	Material	Cast Mineral Fiber	Wet-formed Mineral Fiber
5	Edge Detail	Square	Square
6	Noise Reduction Coefficient (NRC)	0.7	0.65
7	Sound Transmission Class (STC)	Not Applicable	Not Applicable
8	Ceiling Attenuation Class (CAC)	35 Minimum	35
9	Light Reflectance (LR)	LR-1; Actual 0.79	LR-1; Actual 0.80
10	Surface Finish/Color	Not Specified/White	Factory-applied vinyl latex paint
11	Fire Resistance	Class A; Flame Spread-25	Class A; Flame Spread-25
12	Recycled Content Percentage	67	69
13	Recyclable	Yes	Yes
14	Reclamation Program?	Unknown	Yes
15	Sustainable Manufacturing Program	Unknown	Yes
16	Local/Regional Material?	Yes	No
17	Rapidly Renewable Material?	N/A	N/A
18	Certified Wood Material?	N/A	N/A
19			
20			

FIGURE 6.2 Product/System Sustainability Analysis

requests are proposed for green building materials and systems, the complexity and time required for review by the design professional is increased because of the properties that must be examined beyond those of nongreen materials. Because of these concerns, it is preferable to consider substitutions during the design and construction document phases of the project. In this way, the design professional can minimize the approval and use of unacceptable materials on the project.

The Construction Phase

The construction phase of the project usually begins when the bid award is made by the appropriate authority on a publicly financed project or when the contract is signed on other projects. If the contract documents require it, the contractor must submit a list of proposed products and a schedule of submittals to the design professional, usually within 30 days after the contract is signed. In some cases, the owner may require that the list be submitted at the same time the bids are submitted.

The list of proposed products, prepared by the contractor, is reviewed by the design professional and then forwarded to the owner for approval. The submittal of the list by the contractor to the design professional is a means of confirming that only specified products or approved substitutions are used. The preparation of the list also allows contractors to confirm that their suppliers and subcontractors are following the contract document requirements. The design professional must specify which products the contractor must include on the list, as the typical project includes a substantial number of products.

When green building materials are specified on a project, the submittal and review of the list takes on added significance. The design professional must clearly express in the contract documents that substitution requests cannot be proposed through the list of proposed products. If the list contains unapproved substitutions for specified green building materials, the design professional must quickly and clearly notify the contractor that the list is not in conformance with the contract documents. The contractor must revise and resubmit the list until it is acceptable to the design professional and the owner.

Once the list is found acceptable, the design professional distributes the approved list to the contractor, owner, and consultants. The contractor is responsible for distribution of the approved list to subcontractors and suppliers. The approved list serves as a checklist throughout the construction of the project to ensure that only specified green building materials and approved substitutions are incorporated into the completed building.

A schedule of submittals is another useful tool for the design professional to use to monitor the flow of information and tasks during the early stages of construction. The schedule of submittals is usually submitted in conjunction with the construction progress schedule. The design professional should review the schedule to confirm that the contractor has included all of the submittals required by the technical specification sections. Because the contractor must take into consideration many factors when preparing the schedule, the design professional should verify that the submittals are not scheduled simultaneously, that submittals for materials in an assembly are submitted together, and that the contractor has allowed adequate time prior to the need for materials on the project for preparation of submittals, review by the design professionals, and resubmittal in the event that the submittal is not acceptable the first time. The design professional should encourage the contractor to allow more time for submittals for green building materials because of the possibility that submittal information may be more difficult to obtain.

As mentioned earlier, many manufacturers of green building materials are either new or small or both and may require more time to assemble a submittal. With this understanding, the contractor and design professional can easily accommodate the green building material manufacturer's submittal time schedule.

The Submittal Process

Once the list of submittals is reviewed and approved, the contractor begins the submittal process. Submittals may include shop drawings, product data, samples, manufacturer's installation instructions, test reports, manufacturer's certificates, material safety data sheets, and other information as required by the individual technical specification sections.

The standard general conditions, either AIA Document A201 or EJCDC 1910-8, require that the contractor obtain the approval of the design professional for submittals required by the contract documents prior to ordering or incorporating those materials into the work.

The review and approval of submittals is an important part of the design professional's contract administration phase services. During the submittal review process, the design professional must be alert for unauthorized substitutions for specified materials. The design professional must also carefully compare the submittal to the requirements of the corresponding technical specification section to ensure it includes: (1) all of the submittal documentation required and (2) sufficient technical information to compare the submittal to the specification.

Green building material specification sections often contain requirements for special submittals such as toxicity test reports, data about material and recycled content, and installation environmental considerations. Because these submittals are not normally required for nongreen building materials, the contractor and the design professional must pay particular attention to these special requirements to ensure their timely submittal, review, and approval.

On projects that include the requirement for a preconstruction conference, a portion of the agenda should be set aside to review the substitution request process (if the contract documents permit such requests during construction) and the submittal process. Special submittals required for green building materials should be reviewed and clarified to avoid confusion regarding the requirements. It would also be appropriate at this conference to review the design professional's responsibilities regarding verification that materials delivered to the job site and installed in the project are those specified and submitted.

The contractor should clearly understand his or her responsibility for reviewing the submittal prior to forwarding it to the design professional and must ensure that the subcontractors and suppliers are knowledgeable about their responsibilities as well. The contractor should not forward incomplete or incorrect submittals to the design professional. The design professional, in turn, should refuse to review any submittal that does not comply with the specifications.

All members of the construction team should familiarize themselves with the provisions of the Division 01 (1) section that covers submittals prior to beginning the submittal process. This will shorten the time required for review and increase the likelihood that the design professional will approve the submittal the first time around.

Construction Administration Activities

The standard contract between the owner and the design professional requires that the design professional observe the work during construction. This is done periodically to keep the owner informed about the progress and quality of the work and to prevent defects and deficiencies. The observation is not meant to be exhaustive or to make the design professional responsible for the means and methods of construction, which is contractually the responsibility of the contractor.

The design professional's periodic visits to the job site help improve coordination between design and construction, improve communications between the design professional and contractor, and ensure conformance of the work to the contract documents. The design professional's responsibilities are normally coordinated with the general conditions of the contract for construction. To avoid conflicts, this is important to verify when nonstandard documents are used, as the design professional and contractor are not in contract with each other. The design professional's contract with the owner typically defines not only his or her role during construction but also how often he or she will visit the job site to observe. In some instances, the owner may hire the design professional to make more frequent visits to the job site or assign a part- or full-time individual on the job site when the project scope or complexity requires it.

Although the design professional is not required to make an exhaustive review of the work during periodic visits to the job site, it is beneficial to the project if he or she pays special attention to the incorporation of green building materials into the work, for two reasons: first, to verify that the specified materials are being used, and second, to verify that the manufacturer's installation instructions are being followed by the contractor. As mentioned earlier, this is important because of the relative unfamiliarity of contractors with these green building materials.

The design professional can also facilitate the participation of the green building material manufacturer in the construction process because of the relationship established during the design phase of the project. As a result, questions or concerns that arise during construction can be dealt with quickly and with the least disruption to the schedule.

Certification Activities

Each participant in the green building process has certain responsibilities. These responsibilities do not end with the start of construction. During the construction phase of a project, many important activities must be performed to ensure compliance with green building rating system requirements.

While in some cases the design professional has in-house capability to perform the activities associated with the certification process during construction, most design professionals choose to hire a green building consultant instead.

Chief among the activities that must be performed to ensure compliance during construction are:

- Reviewing documentation
- Monitoring compliance
- Commissioning

Reviewing Documentation

As part of the submittal process described earlier, the green building project requires additional submittals not normally associated with the administration of a building project. Review of these submittals is usually performed by the design professional. The submittals can include tracking the origin of materials (extraction, harvesting, fabrication), photographs of the indoor air quality ventilation protection, and construction waste management plans and documentation.

Western Connecticut State University
New Science Building
LEED® Green Building Rating System
Certification Status Report

Credit Category: Indoor Environmental Quality

Prerequisite 1: Minimum IAQ Performance:

Requirement: Meet the minimum requirements of ASHRAE 62-1999 using the Ventilation Rate Procedure.

Submittals: LEED Letter Template, signed by the mechanical engineer or responsible party, declaring that the project is fully compliant with ASHRAE 62-1999 and all published Addenda and describing the procedure employed in the IAQ analysis (Ventilation Rate Procedure).

Status: Certification Letter from mechanical engineer stating compliance is on file.

Credit 3.1: Construction IAQ Management Plan: During Construction

Requirements: Develop and implement an Indoor Air Quality (IAQ) Management Plan for the construction and preoccupancy phases of the building as follows:

- During construction meet or exceed the recommended Design Approaches of the Sheet Metal and Air Conditioning National Contractors Association (SMACNA) IAQ Guidelines for Occupied Buildings under Construction, 1995, Chapter 3.
- Protect stored on-site or installed absorptive materials from moisture damage.
- If air handlers must be used during construction, filtration media with a Minimum Efficiency Reporting Value (MERV) of eight must be used at each return air grill, as determined by ASHRAE 52.2-1999.
- Replace all filtration media immediately prior to occupancy. Filtration media shall have a Minimum Efficiency Reporting Value (MERV) of 13, as determined by ASHRAE 52.2-1999 for media installed at the end of construction.

Submittals:

☐ LEED Letter Template, signed by the general contractor or responsible party, declaring that a Construction IAQ Management Plan has been developed and implemented, and listing each air filter used during construction and at the end of construction. Include the MERV value, manufacturer name, and model number.

AND EITHER

☐ Provide 18 photographs—six photographs taken on three different occasions during construction—along with identification of the SMACNA approach featured by each photograph, in order to show consistent adherence to the credit requirements.

FIGURE 6.3 Sample LEED Status Report

OR

☐ Declare the five Design Approaches of SMACNA IAQ Guidelines for Occupied Buildings under Construction, 1995, Chapter 3, which were used during building construction. Include a brief description of some of the important design approaches employed.

Status: Need copy of Construction IAQ Management Plan, as accepted by Contractor, in order to prepare LEED Letter Template. Need photographs documenting compliance with SMACNA requirements.

Credit 3.2: Construction IAQ Management Plan: Before Occupancy

Requirements: Develop and implement an Indoor Air Quality (IAQ) Management Plan for preoccupancy phase as follows:

- After construction ends and prior to occupancy conduct a minimum two-week building flush-out with new Minimum Efficiency Reporting Value (MERV) 13 filtration media at 100% outside air. After the flush-out, replace the filtration media with new MERV 13 filtration media, except the filters solely processing outside air.

OR

- Conduct a baseline indoor air quality testing procedure consistent with the United States Environmental Protection Agency's current *Protocol for Environmental Requirements, Baseline IAQ and Materials, for the Research Triangle Park Campus, Section 01445*.

Submittals:

☐ LEED Letter Template signed by the architect, general contractor, or responsible party, describing the building flush-out procedures and dates.

OR

☐ LEED Letter Template, signed by the architect or responsible party, declaring that the referenced standard's IAQ testing protocol has been followed. Include a copy of the testing results.

Status: Need copy of Construction IAQ Management Plan, as accepted by Contractor, to verify that plan includes provision for preoccupancy building flush-out. Under this approach, indoor air quality testing procedure described above will *not* be required.

FIGURE 6.3 (*Continued*)

To facilitate tracking of the status of compliance with individual credits of a rating system, the design professional or green building consultant should set up a notebook or file system that organizes the documentation by credit for use at completion of the project. This documentation can be combined with a credit status report form that can be distributed to the contractor, owner, and other interested parties as the construction progresses (see Figure 6.3).

Monitor Compliance

The key to achieving certification after completion of construction is monitoring construction as it progresses. Monitoring is usually conducted by a green building consultant unless the design professional specializes in green building. During construction, the consultant oversees implementation of credits at the job site, conducts rating system credit review meetings with contractors and subcontractors at the job site, and records the work in progress as it relates to rating system credits. Not many guidelines exist for monitoring compliance during construction, but an effort is being made to fill the void. The Partnership for Achieving Construction Excellence at Pennsylvania State University in conjunction with the Pentagon Renovation and Construction Program Office has published the *Field Guide for Sustainable Construction*. The *Guide* provides "education and guidance for construction field workers, supervisors, and managers on construction methods and practices," with a goal of ensuring that sustainable requirements are attained on projects during construction.[8] Monitoring compliance, however, is just part of the process of commissioning of the project.

Commissioning

Commissioning is the process of ensuring that the owner's programmatic intent is carried out in both the design and construction of the project. The commissioning process is usually facilitated by an independent commissioning consultant or agent hired by the owner. Commissioning is usually provided as an additional service to the owner and is not a typical requirement.

The commissioning process starts with the development of a commissioning plan. The plan is created during the design process and concludes after the construction phase is complete.

During construction, the commissioning consultant reviews submittals for commissioned equipment, monitors installation of equipment at the job site, attends meetings with the contractor and subcontractors, makes sure all building systems are functioning at design performance levels and that the owner's designated personnel are trained to operate and maintain the building, makes sure adequate documentation for the building's materials and systems is provided, and reports observed deficiencies and variances in the construction to the owner, contractor, and design professionals. Members of the design team also receive and review the commissioning report and documentation assembled during project closeout procedures.

The Construction Phase as the Successful End to the Project

Many design professionals, after investing a great deal of their energy and talent in the design and specification of a building project using green building materials, are disappointed when the materials are changed during the bidding and construction phases without their agreement. By putting an equal amount of effort and care into the bidding and construction phases of the project, the design professional can ensure that the green building materials they selected and worked so hard to include in their project will actually

be incorporated in it. By working to make the contractor's job of using relatively unknown materials easier, the design professional can serve both the owner's needs and those of the environment.

Risk Management for Green Building Materials

We would be remiss if we left this chapter without a word about this subject. Building materials make up the environment in which we live, work, and play. That is a lot of exposure. As the percentage of green building materials utilized in buildings increases, so does their share of that exposure. From a risk management perspective, that should be a good thing. As stated earlier in this book, green building materials are those that use the Earth's resources in an environmentally responsible way. They are healthier for humans and for the planet.

Still, most green building materials are relatively new to the marketplace and do not have much empirical data supporting their claims. Add to this, the risk of using building materials that may have been "greenwashed" by material manufacturers trying to cash in on the surge in green buildings. The combination of newness, lack of field testing, and "greenwashing" present a risk potential for all members of the project team—product manufacturers who pledge their company's support of a new formulation or novel widget, the design professional who selects and specifies the untried product, the owner of the building in which the green building materials have been incorporated and will effectively be beta tested, and the insurer(s) of all of the above.

The risk potential for each member of the design and construction team is different and requires a different response. Clearly, it is in every participant's best interest to avoid or minimize risk wherever possible. Sometimes, that is interpreted to mean that it is better to avoid the risk. So, let's review the big picture risk. There is a real, and very substantive risk to ourselves and our world if we fail to develop, market, purchase, use, and reuse green materials. There is nobody who insures against that. Any consideration of risk must include consideration for the larger, shared risk.

Notes

1. "Clear Advantage: Building Shareholder Value," *Global Environmental Management Initiative* (February 2004).
2. The Construction Specifications Institute, *The Project Resource Manual* (New York: McGraw-Hill, 2005), pp. 3.23–3.26.
3. "Getting New Products into Buildings: An Interview with Architect and Manufacturer," *Environmental Building News* 5, no. 4 (July/August 1996): 8–9.
4. Ibid.
5. Environmental Protection Agency, *Cooling Our Communities: A Guidebook on Tree Planting and Light-Colored Surfacing* (1992), 22P-2001, 5–6.

6. "America and the Environment: The Sky Isn't Falling," *Skiing* (September 1994).
7. National Audubon Society, Croxton Collaborative, Architects, *Audubon House: Building the Environmentally Responsible Energy-Efficient Offices* (New York: John Wiley & Sons, 1994), 118.
8. The Partnership for Achieving Construction Excellence, *Field Guide for Sustainable Construction*, Pennsylvania State University, June 2004.

CHAPTER 7

Green Building Materials and Green Building Programs

Because many buildings stand for at least 50–100 years—and some last for centuries—it is essential to get them right the first time.

—State of the World 2004

Prior chapters have discussed the reasons you should use green building materials and how to select and specify them. A driving force behind the growth in availability of green building materials is the growth in the number of green building programs, smart growth initiatives, and related sustainable development legislation.

Green building programs come in a variety of shapes and sizes. They are local, regional, national, and international. They are holistic, addressing a range of environmental concerns; and, they are issue-specific, focusing on a single environmental aspect. They are checklist style, accessible by the general user, and they are Life Cycle Assessment style, necessitating a certain level of expertise. They are comprehensive, providing a one-size-fits-all approach to all building projects, and they are sector-specific, providing a more tailored approach for buildings of a certain type.

Regardless of the shape or size, they tend to share many of the same environmental goals—stewardship of energy, water, materials, site/landscape, and IEQ. Most green building rating programs outline objectives or intent as categorized according to these environmental goals. Most suggest a variety of ways to accomplish their stated objectives . . . but, they do not usually state THE way. Environmental issues are complex and interrelated. Thus, if any program were to specify THE way, it would be immediately suspect. Some flexibility is inherent in the concept.

As the market has matured, more and more consensus-based standards have been created (through ASTM, ISO, ASHRAE, FSC, SFI, etc.) that provide a firmer foundation for green building rating programs. Certainly, mainstream industry is familiar with the use of standards for other performance requirements—structural, fire resistance, fade resistance, etc. Incorporating standards allows the green building rating programs to more objectively implement their goals. It allows them to better communicate their design intent. It provides for better consistency in application, and it helps to integrate the administrative processes for green building programs into mainstream procedures. Today, most green building rating

programs reference a variety of green product and system standards. An understanding of the requirements of these programs will help the design professional deal more successfully with them and make the job of selecting and specifying green building materials much easier.

While by no means comprehensive, the following lists provide a sampling of the numerous programs created to further the efforts of cities, states, and countries that wish to have a more sustainable future.

Local Programs

Alameda County, California: The Green Building in Alameda County Program[1] covers home remodeling, new home construction, and multifamily housing. For construction of commercial and civic buildings, the program recommends the use of the LEED™ Rating System. The program includes a Green Points rating tool to evaluate how green a home is. A similar system is under development for multifamily housing. The AccessGreen Directory[2] lists products, suppliers, and service providers that correspond to the program's *Green Building Guidelines*. The *AccessGreen Directory* is searchable by product category, *Green Building Guidelines* reference, or keyword. The Green Points rating tool offers credits for materials with recycled content, materials that are recyclable, alternate lumber products, sustainable materials, and energy-efficient products.

Atlanta, Georgia: The EarthCraft House™ Green Building Program,[3] developed by the Southface Energy Institute with the assistance of government and construction industry leaders, is a program of the Greater Atlanta Home Builders Association. Originally available only in the Atlanta area, the program has expanded throughout the Southeast to other cities in Georgia, South Carolina, Alabama, and Virginia. It focuses on new homes, renovations, communities, multifamily housing, and affordable housing. This voluntary program encourages the construction of healthy, comfortable homes that reduce energy consumption and protect the environment. It encourages the use of resource-efficient building materials such as recycled and natural content materials and advanced products, as well as materials that exhibit durability. To date, over 4,000 EarthCraft single-family homes, over 1,500 EarthCraft multifamily dwelling units, and 6 EarthCraft Communities have been certified in the Greater Atlanta area. The pilot EarthCraft Light Commercial program recognizes sustainable design and construction of small-scale commercial buildings. The Atlanta Branch of the USGBC-Georgia Chapter, encourages use of LEED™ certification as the regional standard for sustainable communities and buildings.[4]

Austin, Texas: The Austin Energy Green Building Program,[5] the oldest local green building program in the United States, was founded in 1992. Its goal is to produce better, environmentally sound homes and workplaces. The program covers residential, commercial, and multifamily projects. Its *Sustainable Building Sourcebook* encourages the use of building materials manufactured from byproducts of another process, that avoid landfill disposal of materials through reuse or recycling, that minimize the embodied energy required to convert the product from raw material to finished product, that are rapidly renewable, recyclable, or have recycled content, that contain reused or salvaged materials, and that contain minimal or no volatile organic compounds (VOCs). The program's *Sustainable Building Sourcebook* includes Resourceful Specifications and is available for purchase for use by design professionals to incorporate

sustainability directly into their project specifications. In 2000, Austin adopted a resolution requiring that all municipal buildings achieve the USGBC's LEED™ silver-level certification.

Boulder, Colorado: Boulder's Community Planning & Sustainability Department supports the Green Building and Green Points Program,[6] which applies to all new residential construction as well as additions and remodeling projects larger than 500 square feet. The program encourages the use of cost-effective and sustainable remodeling and building methods. Applicants earn points by selecting green building measures in order to receive a building permit. The program offers points for recycling of construction debris, use of reclaimed lumber, use of materials with recycled content, use of engineered lumber products, use of energy-efficient materials, and use of low-VOC paint products. Commercial building projects are encouraged to use the USGBC's LEED™ Rating System. The City of Boulder is investigating the feasibility of updating its commercial building codes to require that all buildings constructed utilize and/or meet LEED requirements.

Chicago, Illinois: Chicago was one of the first cities in the country to incorporate environmentally friendly or "green" strategies and technologies into public buildings. In May 2002, the mayor inaugurated the Chicago Center for Green Technology.[7] The city adopted the Chicago Standard[8] in June 2004, which is based on selected points from the USGBC's LEED™ Rating System, for municipal projects and established a Green Homes for Chicago and Chicago Green Bungalow Initiative to apply green building principles to new and existing homes. The city has also initiated a Green Roof Improvement Fund for buildings in the Loop as well as a Green Roof Grant Program to help fund small and large green roof installations. Currently, more than 250 buildings are working toward LEED certification. To promote building design, construction, and renovation that provides healthier environments, reduces operating costs, and conserves energy and resources, the city has instituted a Green Permit Program.[9] The program provides developers and owners with an incentive to build green by streamlining the permit process timeline.

Chula Vista, California: Chula Vista's voluntary GreenStar Building Efficiency Program[10] offers builders and developers of residential projects the opportunity to meet the energy requirements of three building efficiency programs. The program also can be used to meet the city's requirements for air quality improvements. By encouraging the use of more energy-efficient windows and improved construction, residences are built to be 15 percent more energy efficient than those that adhere to California's Title 24 energy code. In November 2009, Municipal Code Ordinance 15.12 "Green Building Standards" went into effect, requiring that plans submitted on or after that time be designed to include the following green building measures: increased energy efficiency, water and resource conservation, reduction of construction project waste, provision of durable buildings that are efficient and economical to own and operate, and promoting the health and productivity of residents, workers, and visitors to the city.[11]

Denver, Colorado: Created by the Home Builder's Association (HBA) of Metropolitan Denver, the Governor's Office of Energy Management and Conservation, Xcel Energy, and E-Star Colorado in 1995, the Built Green® Colorado Program[12] is the largest in the nation, with members across the state. The voluntary program encourages

homebuilders to use products, practices, and technologies that will provide greater energy efficiency and reduce pollution, provide healthier indoor air, reduce water usage, preserve natural resources, and improve durability and reduce maintenance. The Built Green Checklist includes several Material Resource Efficiency categories covering foundation, framing, subfloor, roofing, insulation, windows and doors, exterior wall finishes, interior finish floor, cabinetry and trim, materials reduction and reuse, and waste reduction and recycling. For example, in the Foundation category, the Checklist offers points for using concrete containing a minimum of 15 percent western coal fly ash. In the Framing category, the Checklist awards points for the use of reinforced cementitious foam-formed walls (insulated concrete forms, or ICF). In March 2009, the HBA announced that Built Green Colorado would take an "intermission" in operations because of conditions in the housing market with the hope that at some point in the near future it would be able to resume serving the needs of the industry. Greenprint Denver, a network of businesses, universities, nonprofits, and government agencies, is pursuing regional interest in sustainable development and preparing a roadmap toward a sustainable city.[13] The City of Denver requires that all new city buildings and major renovations be built to the USGBC's LEED™ silver standard and achieve Energy Star® status.

Frisco, Texas: Frisco's Green Building Program[14] includes a commercial green building program, a public facility initiative, and a residential green building program. The commercial program gathers data for all non-single-family developments of greater than 10,000 square feet, while the public facilities initiative seeks to make public buildings more environmentally friendly. The residential program mandates the EPA's Energy Star™ requirements as the minimum building standard for new homes. The residential program also mandates water conservation, indoor air quality, and waste recycling standards for buildings constructed under the program. In 2006, Frisco adopted an ordinance establishing a Commercial Green Building Program. The program requires that commercial buildings and multifamily structures adhere to minimum standards in the following areas: energy conservation, mitigation of heat island effect and creation of a pedestrian environment, water conservation, and construction and demolition waste recycling. The public facilities initiative commits the city to using the LEED™ Rating System on future public buildings, with the goal of having all new municipal buildings attain a silver certification.

Grand Rapids, Michigan: The Home and Building Association of Greater Grand Rapids sponsors a Green Built Certified Program[15] that encourages the construction of new homes, apartments, townhouses, and condominiums that use materials and resources more efficiently and seek to get the most value out of the new homes being built today without more regulation. This voluntary program also promotes the use of new green building products such as reengineered lumber and recycled-content materials. The program recognizes new methods of dealing with old problems such as more efficient framing techniques and conservation techniques to increase recycling and thereby reduce hauling and tipping fees for construction waste. It is an outgrowth of efforts by the National Association of Home Builders (NAHB) to raise awareness on the part of their members of the economic and environmental benefits of green building. In January 2006, the city adopted a resolution outlining their sustainability policy for

public buildings. The policy requires city personnel to implement principles of the USGBC's LEED™ Rating System and EPA's Energy Star® program. All municipal construction and renovation projects involving buildings over 10,000 square feet and costs of $1 million or more must achieve LEED certification.[16]

Hudson Valley, New York: The Builders Association of the Hudson Valley, with funding from the New York State Energy Research and Development Authority (NYSERDA) and assistance from the NAHB Research Center, is developing a green building program that will apply to residential construction and renovation.[17] Much like similar programs in Austin and Denver, the Hudson Valley program will include the use of resource-efficient materials and environmentally friendly construction practices. The program will be the first of its kind in New York state.

Kansas City, Missouri: The voluntary Build Green Program[18] was developed by the Home Builders Association of Greater Kansas City to encourage a comprehensive approach to home building. The program offers participant builders four levels of achievement: platinum, gold, silver, and bronze. Participants must be members of the Build Green Council. Builders register each home they want to be designated as Built Green. This designation does not confer any certification or approval on the builders themselves or other homes they build. Each level of the program includes a checklist for the builder to complete, indicating the steps they have taken to achieve the level of greenness indicated. The checklist contains these categories: site, energy, material, indoor air quality, and recycling. The *Material Guidelines* include the use of one material with minimum 50 percent recycled content; engineered building products such as beams, joists, and headers; framing lumber certified by the Forest Stewardship Council (FSC), alternative building systems, such as structural insulated panels (SIPs) or straw bale; certified green content siding; gypsum board with recycled content; recycled-content attic insulation; natural material (domestic cotton or wool) or recycled-content carpet; and borate (ACQ) -treated lumber products in moisture-sensitive areas. Since 2004, the city has required that the design, construction, and operation of new facilities of any size and renovations in which the facility affected has at least 5,000 square feet of space, achieve a minimum of a silver certification under the USGBC's LEED® Rating System.[19]

Portland, Oregon: Portland's Bureau of Planning and Sustainability (BPS) manages the city's Green Building Program.[20] In 2001, the city became one of the first municipalities in the nation to adopt a green building policy for its own facilities containing strategies and performance thresholds for all new and remodeled city-owned facilities. In 2005 and again in 2009, the city approved updates to the policy that now requires LEED certification at the gold level plus additional local requirements as a minimum. The city's proposed High Performance Green Building Policy would provide incentives and resources to builders, developers, businesses, and homeowners to reduce total greenhouse gas emissions by 80 percent by 2050. For new commercial and multifamily construction, the policy would establish a "feebate," a market-based instrument that combines a fee for conventional construction, a waiver option for moderate green building improvements, and rewards for high-performance green building projects. For new single-family residential construction, the policy proposes a performance target for the percentage of homes that are built to green building standards. A performance rating system has also been proposed for existing commercial buildings.[21]

Santa Barbara, California: In 2007, the city adopted a resolution requiring that new building construction and major renovations for city-owned and- operated buildings be designed to exceed California Title 24 Energy Requirements by 20 percent. The resolution also required that new building construction and major renovation projects for city-owned and -operated buildings achieve a USGBC LEED silver certification or, where LEED is not applicable for the project, another green building program certification level contingent on the building type. Further the resolution requires that sustainable building materials and processes be used for modifications, improvements, and upgrades to existing city-owned and -operated buildings.[22]

San Francisco, California: San Francisco's Department of Environment offers several resources of interest to the design professional. In addition to a program covering less toxic pest management, the city also offers a Green Building Program.[23] Among the resources the city offers as part of the program is the *Green Building Resource Guide*, which assists interested parties in locating green building materials and services in the Bay Area. Materials listed in the *Guide* include wood products, cabinets and countertops, composite wood decking, insulation, siding and roofing, caulking and sealants, doors, adhesives, flooring, and paints and coatings. San Francisco also has the *Green Building Compliance Guide*, which applies to municipal buildings in San Francisco. The *Guide* was developed as a resource for design professionals working on city building projects. Because the city code requires that new municipal buildings and renovation projects of 5,000 square feet and over meet the requirements of the LEED™ program silver certification level, it also explains how to apply LEED™ in San Francisco. In 2008, San Francisco adopted a mandatory green building code, which establishes strict guidelines for residential and commercial buildings. Over time, small residential and midsized residential projects will have to be GreenPoint Rated; high-rise residential, midsized commercial and large commercial projects will have to achieve USGBC LEED certification at the silver level.[24]

Scottsdale, Arizona: Scottsdale's Green Building Program[25] rates building projects in several categories: site use, energy, indoor air quality, building materials, solid waste, and water. The program encourages the use of environmentally responsible materials and offers guidelines to selecting materials that are durable and appropriate for the city's desert climate, are manufactured locally to limit embodied energy, are recyclable, contain recycled content, and have low embodied energy. In addition, the program encourages the avoidance of materials that unduly deplete limited natural resources, are made from toxic or hazardous constituents, or generate pollution during manufacturing or use. The program uses a point rating system to qualify projects. On the residential side, the Green Home Rating Checklist uses a point system to qualify projects as green homes. Projects have to meet all mandatory measures and then can qualify for an entry level or advanced level rating.

Seattle, Washington: The city has developed several sustainable building design tools and strategies including the LEED™ Tools for Public Projects, Green Building for Neighborhood Fire Station Projects. The city promotes the use of several external green building programs, including: Built Green, Energy Star Homes, and LEED™ for Homes.[26] Once a type of building is selected, the user is presented with various tools to select from, including: an energy matrix, a water matrix, best practices, case

studies, links, and tips on how LEED™ applies to the type of building. The city adopted the LEED™ Green Building Rating System at the Silver level as the standard for all city-owned buildings and facilities with over 5,000 sq ft of occupied space. The city has also created the Seattle Supplements to the LEED™ program, which focus on local resources, contacts, and requirements. In 2006, the city also incorporated a LEED™ incentive into downtown zoning regulations. Projects that agree to achieve a LEED™ Silver rating, as well as contribute to affordable housing and other public amenities, are permitted to build to a greater height and/or greater maximum floor area for commercial and residential buildings. The Department of Planning and Development also offers a suite of green permitting options that supports the city's green building effort.[27]

The Master Builders Association of King and Snohomish Counties developed *Seattle Area Built Green*™ [28] as a nonprofit, residential building program whose goal is to provide homeowners with environmentally friendly homes. The program is similar to other Built Green™ in other areas of the country. The program uses a checklist and third-party verification to certify homes.

State Programs

California: In December 2004, the governor signed Executive Order S-20-04 regarding green buildings. It establishes the state's priority for energy and resource-efficient high-performance buildings. It sets a goal of reducing energy use in state-owned buildings by 20 percent by 2015 and encourages commercial sector buildings to set the same goal. The order also directs compliance with the Green Building Action Plan,[29] which covers public buildings, including state buildings and schools, as well as commercial and institutional buildings. The plan requires all existing state buildings over 50,000 square feet meet LEED-EB standards by no later than 2015 to the maximum extent cost-effective. The plan also requires that all new state buildings and major renovation projects of 10,000 square feet or larger and subject to Title 24 be designed and constructed to a LEED-NC Silver level or higher. The Executive Order and Green Building Action Plan together became known as the state's Green Building Initiative (GBI). In January 2008, the California Energy Commission submitted a "Green Building Report"[30] as required by Assembly Bill 2160 (AB 2160) reporting to the Governor's Green Action Team on several topics related to the 2004 GBI. Also in 2008, California became one of the first states in the nation to adopt a Green Building Standards Code,[31] which took effect in August 2009.

There is also the *California Green Builder Program* (*CGB*),[32] sponsored by the Building Industry Institute, which certifies both builders and residential developments. The program includes the following components: higher energy efficiency standards, outdoor air quality improvements, resource savings and waste diversion, and water conservation. The builder completes a worksheet consisting of four sections covering these components for each home plan in a community (subdivision) and submits the completed worksheet online. The CBG sends an inspector to the project site to inspect the first unit of each floor plan who in turn submits a completed inspection report to the HERS provider. Once reviews are complete and verification of compliance with program requirements are made, a California Green Builder project certificate is issued.

The builder can then display a CGB logo and designate the project as a California Green Builder subdivision or community.

Colorado: See the earlier listing for Denver for information on the joint program of the city of Denver and the state of Colorado.

Hawaii: Sponsored by the Building Industry Association, Hawaii, the Hawaii BuiltGreen™ Home Program[33] is modeled after the NAHB Model Green Home Building Program. The program's goals are to certify buildings that incorporate green features, including energy and water conservation, materials efficiency, site ecosystem protection, and improved indoor air quality and human safety; to globally market and brand the concept of green building and the benefits it provides to owners and the environment; and to provide educational and marketing tools for industry professionals. The program features a Home Builder Self-Certification Checklist that, upon completion, can qualify a project for a Hawaii BuiltGreen Star Rating™. There are three levels of ratings. A project must achieve an increasing number of points in order to attain a higher-level rating. The checklist is broken into several sections: protecting the site's features and functions, energy performance and comfort, health and indoor air quality, durability and materials conservation, and environmentally friendly home operations. The section on durability and materials conservation addresses design choices, termite details, framing, the foundation, the subfloor, windows and doors, insulation, interior walls, the finish floor, the cabinetry and trim, the roof, the exterior finish, outdoor features, and job site operations. To use the checklist, the builder checks off features included on a project and totals the points in each section. In 2006, Hawaii revised its Statutes to require each county agency that issues building, construction, or development-related permits to establish a procedure for priority processing of permit applications for construction projects that incorporate energy and environmental design building standards. These standards can be achieved by earning either a LEED Silver rating, a two Green Globes rating, or a comparable state-approved, nationally recognized, and consensus-based guideline, standard, or system.[34]

Illinois: In July 2009, the Illinois state legislature adopted Public Act 096-0073, entitled the "Green Building Act."[35] The act requires that all new state-funded building construction and major renovations of existing state-owned facilities seek LEED™, Green Globes, or equivalent certification. All construction and major renovation projects, regardless of size, must achieve the highest level of certification practical within the project budget. The Illinois Capital Development Board, the state agency responsible for building construction has issued "The Green Building Guidelines for State Construction" and a "Measurement & Verification Tool" to collect building and site characteristics data and building cost and performance metrics.[36]

Iowa: The state's *Sustainable Design Initiative*, which was initiated in 1999, encourages sustainable design in state-owned facilities. In the mid-1990s, the state Department of Natural Resources (DNR), working with the Department of Administrative Services and project architects, established "Sustainable Development Principles" as part of the Iowa Capitol Complex Master Plan. The concepts that are addressed in the Plan include: sustainable site planning, energy efficiency, water safeguarding, materials and resources conservation, indoor air quality, solid waste reduction, and environmental quality. The state also has a *Sustainable Design Guide* that covers sustainable design

principles. DNR evaluated several rating systems and chose the LEED™ Green Building Rating System as the one "that best represented the identified criteria."[37] In 2008, DNR's Energy Bureau developed "Life Cycle Cost Analysis Guidelines" to assist architects and engineers in completing the life cycle cost reports required by the Code of Iowa for public facilities.[38]

Maryland: The state's Environmental Design Program[39] seeks to advance the application of economically sound and environmentally sensitive building and site design techniques. The state recognizes LEED and Green Globes as green building standards. In 2004, the state legislature passed the Green Building Tax Credit, which provides developers with an 8 percent tax credit of construction costs if the facility meets LEED Silver certification. Efforts are currently underway to reestablish a sustainability body or office at the state level.

Michigan: Under Executive Directive No. 2005-4, entitled "Energy Efficiency in State Facilities and Operations"[40] and issued by the governor in April 2005, Michigan established an energy-efficiency savings target for all state buildings with the goal of attaining a 10 percent reduction in energy use by December 31, 2008, and a 20-percent reduction in grid-based energy purchases by December 31, 2015, when compared to energy use and purchases as of the year ending September 30, 2002. The state requires that all state-supported capital outlay projects, whether for state departments or agencies, universities, or community colleges, costing over $1 million use the LEED™ Green Building Rating System in their design and construction. The directive requires that all new construction and major renovation projects of state-owned facilities, including all capital outlay projects, score a minimum of 26 points on the LEED™ Rating System. It also requires that the LEED™ Rating System be applied to state-leased facilities to the extent feasible. Green Built Michigan encourages the construction of sustainable, superior-quality homes. Green Built Michigan is a valuable resource for home buyers, providing residential certification through a third-party verification system and the use of the NAHB Model Green Home Guidelines.[41]

Nevada: In June 2005, the governor signed a bill that creates new incentives and standards for green building in the state. A part of Assembly Bill 3 requires that most state-funded public buildings meet the minimum requirements of the USGBC's LEED™ Green Building Rating System Silver level or an equivalent standard. The law also requires that the state select two state-owned buildings to serve as demonstration projects for LEED™ certification. In addition, the law provides that any privately constructed buildings that meet the standard will earn a tax credit and the products and materials used in the building will be exempt from state sales tax. The bill also requires the adoption of guidelines for the use of resource-efficient materials. As of June 2007, nearly 63 million square feet of development space in the state had applied for LEED™ certification. Because of budgetary constraints and lost tax revenue, the legislature reduced the amount of the property tax abatement in June 2007.[42]

New York: Through the New York State Energy Research and Development Authority[43] (also known as NYSERDA), the state provides green building services to building design teams. These services include computer modeling, design charrette coordination, assistance in obtaining LEED™ certification, New York State Green Buildings Tax Credit assistance, green materials recommendations, and commissioning and life

cycle costing analysis. They apply to new and rehabilitated commercial, industrial, and institutional buildings. Beginning in 1996, "NYSERDA has given more than $3.9 million in federal and state funds to provide assistance for projects affecting more than 22 million square feet of building space"[44] in New York State. The state supports the use of the LEED™ Green Building Rating System. In the area of green materials, New York's Green Building Program seeks to improve indoor air quality through the use of low-emitting materials. In addition, Executive Order No. 111, issued on June 10, 2001, directs state agencies, authorities, and other affected entities to be more energy efficient and environmentally aware. In 2000, the State enacted a Green Building Tax Credit for business and personal income taxpayers. The incentive applies to owners and tenants of buildings and spaces that meet standards that increase energy efficiency, improve indoor air quality, and reduce the environmental impacts of large commercial and residential buildings in the state.[45]

North Carolina: The NC HealthyBuilt Homes Program[46] is a voluntary, statewide green building certification program supported by the North Carolina Solar Center, the State Energy Office, Home Builder Associations, and other professional building organizations. Checklist guidelines were developed by a task force of green building experts from around the state and organized by the North Carolina Solar Center. The program offers participants four rating levels for their project, starting with "certified" at the low end and ending with "gold certified" at the high end. It covers the following areas: site, water, building envelope energy opportunities, comfort systems energy opportunities, appliances and renewable energy opportunities, indoor air quality, and materials. Similar to other residential green building programs, the materials section of the checklist awards points for the use of fly ash in concrete, recycled concrete or glass cullet for aggregate, use of non-solvent-based damp proofing, wood from third-party certified sustainably harvested sources, recycled-content or HCFC-free rigid foam insulation, regionally obtained salvaged materials, natural cork or 100 percent recycled or recovered content underlayment, natural fiber carpet or linoleum, and paints or finishes with recycled content.

Oregon: The state, through Oregon Housing and Community Services (OHCS), promotes green building practices in the residential marketplace and encourages the use of recycled building materials in multifamily projects. To further green building awareness, OHCS published the *Green Building Source Guide*[47] in 2002. This guide goes beyond the typical green building guideline manual by offering links to other guidebooks as well as program descriptions, product directories, and technical and educational material from other sources. The *Guide* includes a listing of green products and technology websites as well. The state adopted a policy for sustainable facilities that requires new and occupied buildings to be built or renovated to meet the requirements of the USGBC's LEED™ Silver certification.[48]

Pennsylvania: The state claims to have the most LEED™-certified buildings in the country (although California and Oregon might take issue). Pennsylvania's *Guidelines for Creating High-Performance Green Buildings*, available through the Governor's Green Governmental Council (GGGC)[49], defines *high-performance green building* under the guidelines. Such a building includes materials that have taken into account the life cycle costs of its manufacture, operation, maintenance, and disposal; uses resources

efficiently; maximizes use of local building materials; and incorporates products that minimize waste in their production or disposal. The "Guidelines" section dealing with materials includes guidance on the selection of materials based not only on first cost but also on life cycle costs. The section also recommends the use of recycled building materials and environmentally friendly materials.

Vermont: The Vermont Green Homes Alliance Program[50] is a residential program that differs from others in that it does not exclusively depend on representatives of the building industry as its source. The program, an initiative of Building for Social Responsibility (BSR), certifies residential buildings constructed to sustainable criteria, including siting and land use, building design, quality and durability, energy use, resource impacts, occupant health and indoor air quality, and keeping it green occupant education and Operation & Management (O&M). The Quality/Durability category awards points for choosing high-quality materials and details for minimum maintenance requirement, while the Resource Impacts category awards points for using resource-efficient and environmentally responsible materials or local or regional materials; reducing, reusing, and recycling waste materials during construction; encouraging diversion of waste during occupancy; and water efficiency. The Occupant Health/Indoor Air Quality category awards points for minimizing sources of pollutants, including using urea formaldehyde-free interior panel products, flooring materials that do not contain petroleum-based products, and low-VOC adhesives.

Washington: During the 2005 regular session, the Washington state legislature passed Substitute SB5509[51] relating to high-performance green buildings. The legislation requires that state-funded buildings, including offices, schools, universities, and justice facilities be built according to the U.S. Green Building Council's LEED™ Green Building Program and attain a minimum Silver-level rating. The bill applies to any new construction of more than 5,000 square feet and any remodeling project that exceeds 5,000 square feet when the cost is greater than 50 percent of the assessed value. State-funded affordable housing projects must adopt a system for measuring building performance as well. The bill further requires that school projects be designed and constructed to the Washington Sustainable Schools Protocol (WSSP) or LEED™ Silver level. It includes a unique section that indemnifies members of the design and construction team if a project fails to meet the LEED™ Silver rating standard "as long as a good faith effort was made to achieve the LEED™ standard set for the project."[52] SB 5854, approved in 2009, requires the Department of Community, Trade, and Economic Development to conduct a study on tax incentives to encourage green building in commercial, residential, and public buildings. It also sets the goal for zero fossil-fuel greenhouse gas emission homes and buildings by 2031.

Wisconsin: The state's residential green building program, Green Built Home™,[53] is a voluntary program that reviews and certifies homes that meet sustainable building and energy standards. The program was initiated by the Madison Area Builders Association in cooperation with other builders' associations, utilities, and organizations that promote green building. To qualify, a home must earn a minimum of 60 points by meeting the specified criteria. Each home that is certified receives a GreenGuide Label that provides the home buyer with information on the number of points earned from the program's checklist. The checklist section that deals with materials selection

covers exterior, below grade, structural frame, envelope, insulation, roof, subfloor, finish floor, and doors, cabinetry, and trim. Program requirements in this section are similar to those of the residential programs discussed elsewhere in this chapter.

U.S. Governmental Agency Programs

Environmental Protection Agency (EPA): Many EPA programs advocate green product design and manufacturing. "One of EPA's strategic goals is to improve environmental protection and encourage government, business, and the public to conserve natural resources by adopting pollution prevention strategies and sustainable practices."[54] Through its Greening EPA Program,[55] the EPA is seeking to walk its talk. The agency has a goal of making its facilities, both old and new, serve as models for a healthy workplace with minimal environmental impacts. The EPA is committed to design, construct, operate, and maintain its buildings in a sustainable manner. Because the EPA leases most of its major office buildings, it works to improve the environmental performance of these facilities through green lease specifications and riders. The EPA also requires that all major new building construction projects achieve at least a LEED™ Silver certification. The EPA also encourages the use of environmentally friendly building materials through its Environmentally Preferable Purchasing Program.[56]

General Services Administration (GSA): The GSA, the nation's largest landlord, has long supported green buildings and has embraced the USGBC's LEED™ Green Building Rating System. The GSA's Public Building Service has an environmental goal of eliminating "all damage to the environment resulting from its operations."[57] Working in collaboration with the Sustainable Design and Energy Programs, the Environmental Program is working toward this goal. The GSA, through the Sustainable Design Program, "is committed to incorporating principles of sustainable design and energy efficiency into all of its building projects."[58] The GSA uses the LEED™ Green Building Rating System as a goal in design criteria to help apply principles of sustainable design and development to its facilities projects. "Since fiscal year 2000, GSA has mandated that all of its new construction and major modernization projects attain, at minimum, a LEED™ Certified rating, while striving for LEED™ Silver."[59] Beginning in fiscal year 2003, all new GSA building projects must meet criteria for basic LEED™ certification. By December 2009, 181 GSA projects had been registered under the LEED™ program and 45 projects had been LEED™ certified.[60]

National Park Service (NPS): The NPS, the agency responsible for maintaining and operating the nation's park system, through the Denver Service Center (DSC) maintains the Service's publication, *Guiding Principles of Sustainable Design*.[61] The *Guiding Principles* chapter on building design includes a section on environmentally sensitive building materials. This section discusses the concept of a cradle-to-grave analysis of building materials to assist in their selection for a project. The primary selection priority is materials found in nature. The secondary priority is materials made from recycled products, and the tertiary priority is man-made materials with varying degrees of environmental impact. In the past, the DSC did not use sustainable design criteria to evaluate design contracts. Currently, all solicitations issued by DSC stress the

importance of integrated and coordinated designs, as well as sustainable design practices, by using these as specific evaluation criteria.

Sustainable Project Rating Tool (SPiRiT)[62]*:* Beginning in fiscal year (FY) 2002, projects were required to adopt sustainable principles to guide their development. The SPiRiT Program "provides guidance to support the consideration of sustainable design and development principles in Army installation planning decisions and infrastructure projects."[63] SPiRiT was developed by the U.S. Army Engineer Research and Development Center (ERDC) for the Corps of Engineers. SPiRiT is based on the USGBC's LEED™ Green Building Rating System Version 2.0. Beginning in FY2006 all Army military construction projects are required to achieve a SPiRiT Gold rating. At the same time the Construction Engineering Research Laboratory (CERL) conducted a research project to assist in the move from SPiRiT to the LEED™ Rating System.

National (U.S.) Programs

Energy Star®: The Energy Star[64] program is a voluntary government and industry partnership that seeks to make it easy for businesses and consumers to save money and protect the environment. It is administered by the EPA in conjunction with the Department of Energy (DOE). The labeling program was launched in 1992 to identify energy-efficient products. In 1996, the label was expanded to include new homes, commercial and institutional buildings, residential heating and cooling equipment, major appliances, office equipment, lighting, and consumer electronics. The Energy Star® Program for Buildings awards a plaque to buildings that achieve a rating of 75 or higher and have been professionally verified to meet current indoor environmental standards. By using the program's benchmarking tool, a building's performance on a scale of 1 to 100 relative to similar buildings nationwide is obtained. The types of building that are eligible, representing over 50 percent of U.S. commercial floor space, include:

- Offices (general offices, financial centers, bank branches, and courthouses)
- K–12 schools
- Hospitals (acute care and children's)
- Hotels and motels
- Medical offices
- Supermarkets
- Residence halls
- Warehouses (refrigerated and nonrefrigerated)

Building for Environmental and Economic Sustainability (BEES): The BEES[65] software facilitates selection of cost-effective, environmentally preferable building products. The software was developed by the National Institute of Standards and Technology's (NIST) Building and Fire Research Laboratory with support from the EPA's Environmentally Preferable Purchasing Program. Designed for use by designers, builders, and product manufacturers, the software includes actual environmental and economic performance data for almost 200 building products. "BEES measures the environmental performance of building products by using the life-cycle assessment approach

specified in ISO 14000 standards."[66] BEES is available for downloading at no charge from the NIST website.

Good Cents: Utility-sponsored programs to improve energy efficiency are the oldest green building programs in the United States. The Good Cents program was developed in 1976 to encourage the construction of energy-efficient homes. To date, more than 750,000 Good Cents homes have been built across the country with another 60,000 added annually.[67]

Green Globes-Building Environmental Assessments[68]*:* Developed by the Green Building Initiative originally for use in Canada, Green Globes™ is an interactive, Web-based, commercial green building assessment protocol that guides the integration of green principles into a building's design. Green Globes rates seven areas: project management, site, energy, water, resources, emissions and effluents, and indoor environment. Green Globes rates a project's sustainability by awarding "Green Globes" for levels of point achievement, much like the USGBC's LEED™ program. The program assesses a project's level of achievement at three points during the design and construction process, at the end of schematic design, at the end of construction documents, and at the completion of construction. The rating award is not made until a project has completed the third check and it has been verified.

Home Energy Ratings Systems (HERS) Ratings: "A HERS rating is an evaluation of the energy efficiency of a home, compared to a computer-simulated reference house of identical size and shape as the rated home that meets minimum requirements of the Model Energy Code (MEC). The HERS rating results in a score between 0 and 100, with the reference house assigned a score of 80. From this point, each 5 percent reduction in energy usage (compared to the reference house) results in a one-point increase in the HERS score. Thus, an Energy Star qualified new home, required to be significantly more energy-efficient than the reference house, must achieve a HERS score of at least 86."[69] Third-party raters conduct the evaluation. The evaluation process includes an analysis of a home's construction plans and an on-site inspection of the home. Local HERS programs exist throughout the country.

Leadership in Energy and Environmental Design Green Building Rating System[70] *(LEED™):* LEED is the U.S. Green Building Council's voluntary, consensus-based national standard for developing high-performance, sustainable buildings. LEED rating systems are currently available or under development for new commercial construction and major renovations (NC), existing building operations (EB), commercial interiors (CI), core and shell projects (CS), homes (H), and neighborhood developments (ND). LEED provides a complete framework for assessing building performance and meeting sustainability goals. Based on well-founded scientific standards, LEED emphasizes state-of-the-art strategies for sustainable site development, water savings, energy efficiency, materials selection, and indoor environmental quality. LEED recognizes achievements and promotes expertise in green building through a comprehensive system offering project certification, professional accreditation, training, and practical resources. The rating system includes a materials and resources category offering credits for using recycled-content materials, local and regional materials, rapidly renewable materials, and certified wood. The indoor environmental quality category requires the use of low-emitting materials.

National Programs (Other Countries)

Australia: The Green Star Environmental Rating System for Buildings[71] was created to set a standard of measurement for green buildings in Australia. The rating system is a voluntary national program that evaluates the environmental performance of buildings. Green Star Rating Systems have been developed for office design, office as built, office interiors, education, healthcare, multi-unit residential, and retail centers. Each of the rating systems includes the following categories: management, indoor environmental quality, energy, transport, water, materials, land use, site selection and ecology, and emissions. Each category contains credits awarded based on achieving the required level in the building. Credits in the materials category are awarded for providing storage for recycling waste, reuse of façade, reuse of structure, shell, and core, recycled content of concrete, recycled content of steel, PVC minimization, and use of sustainable timber.

Canada: Building Environmental Performance Assessment Criteria (BEPAC) was originally designed for new and existing office buildings in British Columbia, although regional variants have subsequently been developed for Ontario and Atlantic Canada. BEPAC evaluates two main categories, the base building and tenant buildout. Each category is assessed according to five criteria: ozone layer protection, environmental impact of energy use, indoor environmental quality, resource conservation, and site and transportation. Each of the criteria is assessed within a 10-point scale. BEPAC weights the points to reflect the relative importance of aspects within each of the criteria, but not between criteria. BEPAC is no longer used but remains of academic interest.

The Built Green™ Society of Canada offers builders a voluntary program called Built Green™ Canada.[72] The program was launched in October 2003 and is modeled after the R-2000 training program and the EnerGuide for New Houses program administered by Natural Resources Canada. The focus of the program is on: energy efficiency, indoor air quality, resource use (including waste management), and overall environmental impact. The program mirrors the requirements of other builder programs both in Canada and the United States. To qualify for a bronze, silver, or gold level rating, the builder completes a checklist, provides the required documentation, and submits the completed package for verification. In 2010, Built Green will be releasing a standard for renovations.

The Canada Green Building Council (CaGBC) offers a version of the USGBC's LEED™ Green Building Rating System. The *LEED® Canada-NC Version 1.0 for New Construction and Major Renovations*[73] is derived from the U.S. version of LEED™. The Canadian version provides a set of equivalent Canadian LEED prerequisite and credit requirements and references to relevant Canadian standards and resource materials. It also provides a starting point for any jurisdiction in Canada that wishes to further refine the rating system for their area. In March 2007, CaGBC issued an Addendum to the LEED-NC Rating System. CaGBC has also issued other rating systems including: LEED Canada for Commercial Interiors, LEED Canada for Core and Shell, LEED® Canada for Existing Buildings: Operations and Maintenance, and LEED Canada for Homes. They hope to release the LEED Canada for Neighbourhood Development Rating System sometime during 2010.

China: The National Resource Defense Council (NRDC), through its China Clean Energy Project,[74] has been working with the Chinese government to minimize the environmental impact of its building program. NRDC has worked to develop energy efficiency standards for residential buildings, provide assistance on national energy standards for government and commercial buildings, and translate and adapt the LEED™ Green Building Rating System for application in China. China's first LEED™ project achieved Gold level certification. In 2005, China adopted its first green building standard. NRDC is also working with several Chinese municipalities to develop green building programs. The China Clean Energy Program,[75] in partnership with NRDC, is working on developing energy-efficient building codes and equipment standards, and green building standards and documents. For the 2008 Olympic Games in Beijing, NRDC worked with Olympic officials to make the 42 buildings in the 160-acre village a model of green construction. The Olympic Village was awarded LEED™ for Neighborhood Development Gold-level certification.

Hong Kong: The HK-BEAM Society created the Hong Kong Building Environmental Assessment Method (BEAM),[76] a voluntary system to measure, improve, and label the environmental performance of buildings. The system has been used on over 200 buildings to date. The system applies to both new and existing buildings. In the category of materials topics such as: the efficient use of materials (building reuse, modular and standardized design, off-site fabrication, adaptability and deconstruction, and envelope durability), selection of materials (rapidly renewable, sustainable forest, recycled, ozone depleting), and waste management (demolition and construction waste, waste recycling facilities, and waste management).

Japan: The Japan Sustainable Building Consortium (JSBC) is developing the Comprehensive Assessment System for Building Environmental Efficiency (CASBEE).[77] The system is a cooperative development of academic, industrial, and governmental agencies. The system's assessment tools include a predesign assessment tool, a Design for Environment (DfE) tool, an eco-labeling tool, and a sustainable operation and renovation tool.

Korea: The Green Building Council Korea[78] has released the Green Building Rating System (GBRS) to measure the environmental performance of buildings. The system applies a whole building perspective over a building's life cycle. The system is based on the Green Building Challenge assessment framework. Criteria evaluated by the system includes: resource consumption, environmental loadings, quality of indoor environmental air quality, longevity, process, and contextual factors.

International Programs

ATHENA™ Environmental Impact Estimator: Created by the Canada-based ATHENA™ Sustainable Materials Institute,[79] this LCA software tool assesses the environmental implications of industrial, institutional, office, and both multi-unit and single-family residential designs throughout their life cycle. Where relevant, it also distinguishes between owner-occupied and rental facilities. A companion LCI Database Reports CD contains a series of life cycle inventory (LCI) and related reports that

support the software. ATHENA has also released the ATHENA® EcoCalculator for Assemblies, providing architects, engineers and others with access to instant LCA results for hundreds of common building assemblies.

The Building Research Establishment Environmental Assessment Method (BREEAM)[80]*:* This Building Research Establishment (BRE) Program was created over a decade ago in England to assess the environmental performance of both new and existing buildings. BREEAM is a tool that allows the owners, users and designers of buildings to review and improve environmental performance throughout the life of a building. BREEAM assesses performance of buildings in the areas of: management, energy use, health and well-being, pollution, transport, land use, ecology, materials, and water. Credits are awarded in each area based upon performance. Buildings are rated: Pass, Good, Very Good, and Excellent. BREEAM can be applied to: offices, homes (EcoHomes), industrial units, retail units, and schools. BRE also publishes *The Green Guide to Specification*, which provides a method for easily assessing the environmental performance of over 250 construction specifications. The *Guide* also includes an explanation of the background of green procurement, Life Cycle Analysis, and environmental issues.

Eco-indicator99[81]*:* Eco-indicator 99 is a state-of-the-art impact assessment method for LCA, with many conceptual breakthroughs. The method is also the basis for the calculation of eco-indicator scores for materials and processes. These scores can then be used as a design for the environment tool by designers and product managers to improve products. The impact assessment method is now widely used by Life Cycle Assessment practitioners around the world.

Sustainable Building Challenge (SBC): The SBC is a continuation of the Green Building Challenge process that began in 1996 and that has engaged over 75 teams in project assessments. It is an "international collaborative effort to develop a building environmental assessment tool that displays and addresses controversial aspects of building performance and from which the participating countries can selectively draw ideas to either incorporate into or modify their own tools."[82] Over 20 countries have participated in the development of the assessment tool (known as SBTool 07). The 2007 version permits comparisons with the LEED and Green Globes programs. Categories include site selection, project planning and development, energy and resource consumption, environmental loadings, indoor environmental quality, functionality and controllability of building systems, long-term performance, and social and economic aspects.

The Nordic Ecolabel[83]*:* This program covers products in Denmark, Finland, Iceland, Norway, and Sweden. Items that display the Nordic label have taken into consideration the product's impact on the environment from raw material to disposal, met criteria regarding quality and performance, and offer features that are at least as good as other similar products.

While this chapter just touches on the growing number of green building programs available at the local, state, national, and international levels, the variety is intended to give the design professional a good grounding in the differences among such programs. The future will certainly witness continuing growth in the number and sophistication of programs that will help define and encourage green building materials and buildings.

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CHAPTER 8

Conclusion

The Congress, recognizing the profound impact of man's activity on the interrelations of all components of the natural environment, particularly the profound influences of population growth, high-density urbanization, industrial expansion, resource exploitation, and new and expanding technological advances, and recognizing further the critical importance of restoring and maintaining environmental quality to the overall welfare and development of man, declares that it is the continuing policy of the Federal Government, in cooperation with State and local governments, and other concerned public and private organizations, to use all practicable means and measures, including financial and technical assistance, in a manner calculated to foster and promote the general welfare, to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans.

—The National Environmental Policy Act[1]

The first generation of green building projects was not particularly representative of the majority of the building industry. Some projects involved high-end facilities (private residences or high-end services) that had the accompanying high-end budget. Other projects were sponsored and subsidized by interested nonprofit groups or governmental agencies and had flexible schedules and even more flexible allowances. Then, there were the projects developed by people who live "off the grid" and built their own residences rather cheaply, and without benefit of a building inspector, using old tires, bottles, straw bales, wind or solar power, and various unique collectibles.

More recent projects have brought environmental issues—and possible solutions—within reach of mainstream design and construction. They introduce green building products that are affordable, functional, and beautiful. They clearly demarcate a new direction in architecture.

The world's green building market is expected to grow approximately 5 percent annually to reach $571 billion by 2013, up from $455 billion in 2008, according to a report by New-York based NextGen Research.[2] Annual growth for the U.S. market alone was 30–40% from 2004 to 2007, reaching an estimated $45 billion, based on LEED certification data, total construction data, and interviews and surveys of practitioners and experts.[3]

Drivers of growth include: shifting attitudes among builders and consumers, government mandates, and the higher prices that green buildings often receive when on the market.

History of Green Building Materials

Out of necessity, building design by early civilizations was heavily influenced by natural elements. Structures were oriented toward available daylight and desirable breezes. Roofs were pitched to shed water. Walls were thickened to insulate against the cold. Consequently, buildings in hot, arid regions looked distinctly different from those in cold, wet climates.

Material selection was limited to the regionally available natural resources and the use of materials was molded by regional climate patterns. Depending on the prevalent ecosystem, building materials included: thatch, adobe, sod, straw, stone, timber, brick, wattle and daub (the precursor to lath and plaster), and fabric. Homes were constructed on raised platforms in warm, wet, flood-prone areas of the tropics. Homes were constructed from collapsible frames and lightweight breathable fabric (that swelled when wet to shed water) by desert nomads. Northern regions consistently produced thicker, denser walls to defend against the cold. In every location, people built their own buildings with materials that they acquired locally.

Ironically, today, indigenous building materials, materials that evolved in harmony with the land and the people over hundreds of years, are deemed "alternative" materials. Where there are exceptions, such as stone and wood, it is largely because commercial interests privatized the acquisition of natural resources and have promoted the market value of that resource. Natural materials are largely unrecognized in building codes. Alternative materials are, by their very nature, nontoxic. Most comply with basic performance requirements for fire resistance. Most can be detailed to meet seismic and lateral load requirements as well. Still, "original" building materials are considered to be "alternative." They have been replaced with modern building products, synthetic materials, and composites.

Modern civilization's mastery of an array of scientific principles has enabled us to create artificial environments unimaginable in previous eras. A flick of the thermostat provides almost instantaneous comfort. Point-of-use water heaters provide a seemingly endless supply of hot water. Appliances in the kitchen offer relentless conveniences. With a push of a button or turn of a dial, we adapt the parameters of our built environment to suit the whim of the moment. Our buildings reflect these new technology-driven expectations. As a result, an office building in New York is likely to resemble one in New Mexico. Worse, a company can design a prototype (a fast food restaurant or retail space) and build it almost anywhere with little modification. Twenty-first-century architecture is much more homogenous than any previous period. Differences in building design and choice of building material that were once the result of the influence of nature's elements are now primarily a factor of aesthetics and budget.

The turning point was the dawn of the Industrial Revolution, marked architecturally by the Crystal Palace in the mid-nineteenth century. The Crystal Palace epitomized the Industrial Revolution, a grand vision constructed with new materials in repetitive, standardized sizes. Today, it is a staple in history of architecture courses, lauded and immortalized over the years. Very few histories relate the rest of the story, however. Unfortunately, the difference in thermal expansion between the glass and the metal frame was ill-considered, the

glass sheets were prone to popping out, and the building leaked like a sieve. The analogy is plain. Society embraced the promises of the Industrial Revolution as it did the image of the Crystal Palace—and it tolerated similar oversights. Society failed to acknowledge the new problems that accompanied the new solutions. Nothing is free. There are always trade-offs, whether we recognize them or not.

The Industrial Revolution ushered in a fabulously exciting time of new and improved products for buildings—steel, sheet glass, reinforced concrete, elevators, and curtain walls. It thrived on standardization and mass production, which helped make all these technological wonders affordable to an eager public. It permitted the construction of taller buildings. It allowed construction at a faster pace than ever before. More and bigger and "better" buildings changed the fabric of our cities. Many of the deplorably polluted conditions of older cities were improved. Indoor plumbing alone can be credited with mitigating many of the diseases pervasive in urban areas. But, it was a trade-off. This we failed to realize. The new technologies replaced older forms of pollution with new ones. While we no longer fear treading in the deposits left by horse-drawn carriages, we have no way of avoiding the air pollution caused by some 600 million passenger cars (plus and additional 78 million commercial vehicles such as heavy trucks and buses) on the road today. The sooty fog caused by coal combustion has been replaced by ozone (smog) and worse. Fires, always a hazard for dense urban areas, may be relatively less frequent because of improvements in building materials and systems, but they now present the added component of toxic smoke from the burning of myriad plastics and synthetic chemicals.

The Industrial Revolution was followed closely by a Scientific Revolution. Post–World War II society expects technological marvels in daily life that even the pioneers of the Industrial Revolution did not envision. The Scientific Revolution heralded a period of chemical discovery that paralleled the physical discovery of the Industrial Revolution. It fostered new attitudes towards materials, dissecting matter into atoms, neutrons, and quarks. The building industry witnessed mass production of new products from previously unknown substances. We now take for granted the benefits of stain-resistant carpet and fiber-optic communications. As did our forebears, we overlooked the new problems that accompanied the new solutions, the wonder materials. We are just beginning to acknowledge these new problems—the toxins, carcinogens, and mutagens. We are gaining a better, fuller perspective of the impact on our natural resources and on urban congestion and quality of life.

Both the Industrial Revolution and the Scientific Revolution altered the business of building as well. The process of building came to mirror the process of standardized manufacturing. We design to standard sizes with standard products, tested and qualified by industry-recognized standards, and contracted on standard industry-recognized forms. The craftsman era is largely gone. Where it survives, it is extremely expensive. In many ways, this makes innovation more difficult than it was before the Industrial Revolution. Innovation requires a certain freedom from prescriptive standards in order to find better ways to meet basic performance requirements. Innovation is exactly what we need to solve the problems overlooked by the Industrial Revolution and Scientific Revolution. And that is exactly what green building is. It is a recognition of the benefits as well as the problems presented by these revolutions. It combines the affordability and convenience of standardization with the quality and thoughtfulness of craftsmanship.

Our society has developed many conveniences and made many improvements in the quality of life. However, wisdom from history should not be discarded. The benefits

associated with designing buildings in response to nature have been largely forgotten over the years. Green building design and green building products are rediscovering these benefits. A building design that takes climatic conditions into consideration requires less energy to operate, while providing improved lighting, better indoor air quality, and healthier places to live and work.

The Future of Green Building Materials

The architecture of the Industrial Revolution and the Scientific Revolution expresses the values and world views of society at that time. Future "revolutions" are likely to impact the building industry as much as those preceding. New fields of scientific investigation, such as holographic philosophy, virtual reality, and chaos theory, may alter our perspective dramatically—and so our buildings. The information revolution of the computer age might alter our working relationships and daily interactions and the corresponding need for certain types of buildings. Space exploration may give birth to new technologies, new needs, and a new world (or worlds) view. Collapsing economies and dwindling natural resources may salute an energy revolution, impacting building design and promoting new markets for renewable energy products.

The design of buildings individually and collectively (urban design) reflects our culture, our consistently shifting attitudes about issues beyond the simple need for shelter. It also reflects very real and very significant economic and environmental factors. Any one of the possible future revolutions just cited will have social, economic, and environmental components. The difference from previous eras, however, is that we are more likely to recognize them as they occur.

The capacity for gathering, processing, and communicating information now allows society an unprecedented ability to observe itself. We have substantive means for simultaneous micro- and macro-examination of events as they occur. We can identify trends as they develop. We can text, blog, and tweet. We can access satellite imagery and analyze it with powerful databases. If we are also fortunate enough to keep up with all of the possible information, perhaps we can get ahead of the curve. A thoughtful review of key events and trends can help us identify the opportunities and challenges facing us.

We offer the following for consideration. Please take a moment to play "what if" with each of these. It is our opinion that in future hindsight, one or more of these may be seen as a turning point for sustainability in general and green building in particular.

Emerging Pollutants

"Emerging pollutants," sometimes referred to as "emerging contaminants" or "materials of concern," can be defined as pollutants that currently are not included in routine monitoring programs and that may be candidates for future regulation, depending on research on their (eco)toxicity, potential health effects and public perception. There are two major categories of emerging pollutants:

- Chemicals/technologies known to industry and commerce but previously unrecognized as pollutants
- Chemicals/technologies new (or developing) to industry and commerce

It is important to realize that emerging pollutants are not necessarily new chemicals. Often, they are substances that have long been in use but whose presence and significance only now are being explored. Data for emerging pollutants tends to be scarce. If it wasn't marked as a problem, it hasn't been tracked, and, moreover, there may be a range of economic interests vested in keeping the status quo. This makes it difficult to initiate research and represents a major difficulty for regulatory bodies in their decision making.

Emerging pollutants are composed of a wide spectrum of compounds. Examples of potential emerging pollutants include: pharmaceuticals, nanotechnologies, and biotechnologies. Extensive and expanding characterization lists and acceptable ranges of newly identified compounds are being developed by various entities including: the World Health Organization, the European Union, and the U.S. Environmental Protection Agency (EPA).

In December 2009, the U.S. EPA announced actions to address "chemicals of concern," including phthalates. "The American people are understandably concerned about the chemicals making their way into our products, our environment and our bodies," said EPA Administrator Lisa P. Jackson. "We will continue to use our authority under existing law to protect Americans from exposure to harmful chemicals and to highlight chemicals we believe warrant concern. At the same time, I will continue to fight for comprehensive reform of the nation's outdated chemical management laws that ensures a full assessment of the safety of chemicals on the market today and effective actions to reduce risks where chemicals do not meet the safety standard."[4] When the Toxic Substances Control Act (TSCA) was passed in 1976, there were 60,000 chemicals on the inventory of existing chemicals. From 1976 to 2009, the EPA only successfully restricted or banned five existing chemicals and only required testing on another two hundred existing chemicals. An additional 20,000 chemicals have entered the marketplace for a total of more than 80,000 chemicals on the TSCA inventory.[5]

The U.S. Geological Survey (USGS) sponsors the Emerging Contaminants Project[6] to provide information on these substances for evaluation of their potential threat to environmental and human health. The goals of the project are to: (1) develop analytical methods to measure chemicals and microorganisms or their genes in a variety of matrices (e.g., water, sediment, and waste) down to trace levels, (2) determine the environmental occurrence of these potential contaminants, (3) characterize the myriad of sources and source pathways that determine contaminant release to the environment, (4) define and quantify processes that determine their transport and fate through the environment, and (5) identify potential ecologic effects from exposure to these chemicals or microorganisms.

The NORMAN network[7] started its activities in September 2005 with the financial support of the European Commission,[8] and it is now established as a permanent self-sustaining network of reference laboratories, research centers, and related organizations for the monitoring and biomonitoring of emerging pollutants. NORMAN has identified a list of the most frequently discussed emerging pollutants. These include: surfactants, plasticizers, flame retardants, nanotechnologies, and biotechnologies as follows:

Plasticizers

Phthalates

- Benzylbutylphthalate (BBP)
- Diethylphthalate (DEP)

- Dimetylphthalate (DMP)
- Di-n-butylphthalate (DBP)
- Di-n-octylphthalate (DOP)

Other

- Bisphenol A
- Triphenyl phosphate

Benzophenone derivatives

- 2,4-Dihydroxybenzophenone

Flame Retardants

Brominated Flame Retardants

- 1,2,5,6,9,10-Hexabromocyclododecane (HBCD)
- Tetrabromo bisphenol A (TBBPA)
- Tetrabromo bisphenol A bis (2,3 dibromopropylether)
- Hexabromocyclododecane (isomers)
- Decabromodiphenyl ethane

Polybrominated Diphenylethers

- 2,2\′,3,4,4\′,5\′,6-Heptabromodiphenyl ether (BDE-183)
- 2,2\′,4,4\′,5,5\′-Hexabromodiphenyl ether (BDE-153)
- 2,2\′,4,4\′,5,6\′-Hexabromodiphenyl ether (BDE-154)
- 2,2\′,4,4\′,5-Pentabromodiphenyl ether (BDE-99)
- 2,2\′,4,4\′,6-Pentabromodiphenyl ether (BDE-100)
- 2,2\′,4,4\′-Tetrabromodiphenyl ether (BDE-47)
- 2,2′,3,3′,4,4′,5,5′,6,6′-Decabromodiphenyl ether (BDE-209)
- Technical Decabromodiphenyl ether
- Technical Octabromodiphenyl ether
- Technical Pentabromodiphenyl ether

Organophosphates

- Tri-(dichlorisopropyl)phosphate
- Triethylphosphate
- Tri-n-butylphosphate
- Triphenylphosphate
- Tris(2-chloroethyl)phosphate

Chlorinated Paraffins

- Long-chain PCAs (lPCAs, C > 17)
- Medium-chain PCAs (mPCAs, C14–17)
- Technical PCA products

Nanoparticles

Carbon Fullerenes

- Buckyballs (Fullerene C-60)

Carbon Nanotubes

- Carbon nanotubes, single-wall
- Carbon nanotubes, multi-wall
- Carbon nanotubes, coated

Carbon Black

- Carbon black

Silicon-Based

- Silicon carbide
- Silica

Titanium Dioxyde

- Titanium dioxyde

Aluminum Oxide

- Aluminum oxide (powder)
- Aluminum oxide (fiber)

Biocides

- Triclosan
- Methyltriclosan
- Chlorophene

Anticorrosives

Benzotriazoles, Methylbenzotriazoles (MBT)

- 4-Methyl-1H-benzotriazole
- 5-Methyl-1H-benzotriazole
- 5,6-Dimethyl-1-H-benzotriazole

Tolyltriazoles (TT)

- Tolyltriazole
- 4-/5-Tolyltriazole (TTri)

Wood Preservatives

Phenols

- Para-Cresol

Emerging pollutants are coming under increased scrutiny. While investors fall over themselves trying to capitalize on new opportunities, a plethora of nonprofits and international organizations are assembling to ensure that developers assess risks adequately.

Nanotechnology, for example, has exploded. Demand for domestic nanomaterials in 2002 has been estimated at $200 million and is projected to grow an astonishing 33 percent a year; the National Science Foundation has estimated that nanotechnology applications may be valued at more than $1 trillion in the global economy by 2015. Nanotechnology is the science and technology of controlling matter at the nanoscale—the scale of a billionth of a meter—1/100,000 the width of a human hair, or 10 times the diameter of a hydrogen atom. A billionth of a meter is called a nanometer. Already, nanoscale zinc oxides are used in sunscreen lotions and scratch-resistant glass. Nanoscale fibers are used in stain-resistant fabrics. Digital camera displays, high resolution printer inks, and high-capacity computer hard drives have benefited from nanoscience and nanoengineering. The potential impacts on the market extend to nearly every conceivable product and service. For example, the solution to looming water scarcity, one of the world's leading environmental problems, may be found in nanotechnology.[9] The Nanotechnology Clean Water Initiative is applying nanotechnology to water management. The Israeli National Nanotechnology Initiative (INNI) has invested about $150 million in nanotechnology with an annual operating budget of around $25 million. The first fruits of the initiative are expected to come from three areas: pure membrane technology, integration of energy and membrane components, and development of nanosensors. French utility company Generale Des Eaux has also developed its own nanofiltration technology in collaboration with Dow Chemical subsidiary Filmtec. One significant application of nanotechnology in water filtration is its ability to obviate the need for large industrial size purification plants. Argonide Corporation, a Miami-based group that produces aluminum oxide nanofibers, has developed a filtration system for NASA, which will enable large amounts of water to be filtered without the need for large high-pressure pumps.

The Project on Emerging Nanotechnologies was established in 2005 as a partnership between the Woodrow Wilson International Center for Scholars and the Pew Charitable Trusts. The project is dedicated to helping ensure that, as nanotechnologies advance, possible risks are minimized, public and consumer engagement remains strong, and the potential benefits of these new technologies are realized.

Nanotechnology offers amazing possibilities by harnessing nanoscale particles. Nobody really knows how nanoscale particles will behave. Nobody really knows what precautions are necessary and what, if any, alarms should be raised. All that is certain is that the technology is developing much, much faster than applicable legislation or regulatory

controls. The biggest objection that observers raise at this point is the clandestine operations of manufacturers embracing nanotechnology.

Manufacturers are reluctant to disclose use of nanotechnology. In its first report of session 2009–2010 on nanotechnology and food, the UK House of Lords Science and Technology Committee criticized the food industry for "failing to be transparent about its research into the uses of nanotechnologies and nanomaterials."[10] The report calls on the UK Food Standards Agency to maintain a publicly available register of food and food packaging containing nanomaterials. Also, it highlights the "severe shortfalls" in risk research and assessment of nanomaterials in food, especially research on the behavior of nanomaterials within the body and gut. According to the Project on Emerging Nanotechnologies, 90 percent of Americans think that the public should be better informed about the development of cutting-edge technologies.[11]

The European Commission opened a public consultation on the strategic nanotechnology action plan for 2010–2015. In 2011, the Commission intends to publish information related to types and uses of nanomaterials, including safety aspects, to provide a "better and more accurate overview" of nanomaterials in the EU market.

The U.S. Nanoscale Materials Stewardship Program (NMSP) concludes in early 2010 at which point the EPA is expected to issue new rules. The EPA has already stated that environmental health and safety data gaps exist in nanotechnology and that EPA is considering how best to use its authorities under TSCA Sections 4 and 8(a) to address the "1data gaps on existing chemical nanoscale material production, uses and exposures."[12]

"What ifs" play in multiple directions for emerging pollutants. What if nanotechnology discovers the cure for cancer (or something similarly desirable)? There are a lot of fascinating prospects for nanoscale materials. That's why so many people are racing to market. But, what if nanotechnology opens a Pandora's Box? If they prove problematic, it will be virtually impossible to contain nanoscale materials.

Future Generations Are Here!

Sustainability is about managing the earth's resources for our children and for our children's children. Future generations are primary stakeholders. They will live with the consequences of our actions today. So, who speaks for them? They do.

More and more, students from grade school through university are speaking up. They articulate their concerns extremely well, and, largely because of the Internet, they are empowered as never before to advance their position. Given how difficult it is for parents to avoid the sugar-loaded cereal or latest toy at the demand of their young, it bears watching to see what a new kind of parental pressure might forge.

One of the best examples of the student perspective is the MBA Oath.[13] In 2009, in the wake of the global financial crisis, students at Harvard expressed their concern with the unsustainability of the world economy. They questioned the approach of business leaders. They worried about the future, and they envisioned a better way. With an initial goal of convincing 100 Harvard students to commit to a new, better way, they launched a campaign that subsequently spread around the world. It not only captured the attention of students, but also the public. Numerous media outlets, including: *The Economist*, National Public Radio (NPR), *The New York Times*, BBC World Service, *Newsweek*, and CNN, ran with the story. The press coverage expanded the outreach, which increased student signatories for

the oath, which fed the growth of the website (complete with Twitter and Facebook links), which triggered additional media coverage . . . and, we have a new trend.

It remains to be seen if the future generations maintain their conviction as they transform into the present generation. Their goals are laudable. They seek to enhance community value, quality of life, and accountability of business leaders. With the MBA Oath, they pledge to practice social, economic, and environmental ethics in their careers. What if they do?

THE MBA OATH

As a manager, my purpose is to serve the greater good by bringing people and resources together to create value that no single individual can create alone. Therefore I will seek a course that enhances the value my enterprise can create for society over the long term. I recognize my decisions can have far-reaching consequences that affect the well-being of individuals inside and outside my enterprise, today and in the future. As I reconcile the interests of different constituencies, I will face choices that are not easy for me and others.

Therefore I promise:

- **I will** act with utmost integrity and pursue my work in an ethical manner.
- **I will** safeguard the interests of my shareholders, co-workers, customers and the society in which we operate.
- **I will** manage my enterprise in good faith, guarding against decisions and behavior that advance my own narrow ambitions but harm the enterprise and the societies it serves.
- **I will** understand and uphold, both in letter and in spirit, the laws and contracts governing my own conduct and that of my enterprise.
- **I will** take responsibility for my actions, and I will represent the performance and risks of my enterprise accurately and honestly.
- **I will** develop both myself and other managers under my supervision so that the profession continues to grow and contribute to the well-being of society.
- **I will** strive to create sustainable economic, social, and environmental prosperity worldwide.
- **I will** be accountable to my peers and they will be accountable to me for living by this oath.

This oath I make freely, and upon my honor.

The MBA Oath is intended for individuals who have an MBA or who are about to graduate with an MBA. What if other students follow suit and create sector-specific oaths, challenging (and inspiring) business as usual? Even if only a fraction of graduates maintained such commitment, the world would be much changed.

In consideration of the future generations who have a vested interest in the world they will inherit, ASTM Committee E60 (the Sustainability Committee) established a Subcommittee on Student Liaison and Affairs. This is unique in the standards development world and worth highlighting. It gives students their own forum within ASTM. It gives a voice for future generations in the sustainability committee. Already, the student committee

has international participation and has forwarded topics of concern and draft language to the full committee for consideration.

What if students become leaders in development of sustainability standards? Would this cause a shift in focus from immediate impacts to future impacts?

Future Generations Outnumber Us

Previously, we highlighted the impacts of a growing global population. This remains a critical issue and an important trend. The world population grew from an estimated 6 billion in 2000 to an estimated 7 billion in 2010. It is anticipated to exceed 9 billion by 2050. But, it is not growing uniformly. The greatest growth is in developing countries and areas that are gaining affluence. The possible impacts are many. Increase in resource extraction and pollution. Changes in balance of power. Changes in cultural perceptions regarding what is desirable, what is "cool." A prime example is the incredible impact of China.

Clearly, all markets, including the building industry, are dominated by the prospect of China's impacts. Some organizations salivate at the thought of the sheer number of people acquiring disposable income and providing new markets to serve. Others see nothing but environmental doom for the planet as another two billion plus people start consuming. These observations are overly simplistic and imagine China's impacts in western terms. The Chinese culture is quite different from western culture, especially American culture. For example, Chinese are grounded in tradition. They have a long, respected history and tend to view events that happened generations ago as currently relevant. Americans rarely remember events from the previous administration and pride themselves on a rampantly carpe diem approach to life. The result is that political and economic decisions that China embraces will likely have relevance and meaning from a Chinese perspective that Americans may not understand. The size and determination of China is such that a lack of American understanding may result in a radical shift in global superpowers. Indeed, the demographics of global commerce may alter such that Mandarin (the primary language of nearly a quarter of the world's population) becomes a fundamental prerequisite for success. Chinese culture may establish the global mean.

China's expanding markets represents a massive environmental stressor. China has over 1.3 billion people and over 350 million households (with the next census planned for 2010). Compare this to the approximately 310 million people in the United States and 115 million households (with the next census planned for 2010). The math is pretty straightforward. As of 2009, the average household is smaller in the United States than in China. According to the U.S. Census Bureau, in 2007 there were 37 million nonfamily households in the United States, representing one-third of all U.S. households. Of these nonfamily households, 31 million consisted of one person living alone.[14] If China followed a U.S. pattern (with an average of three people per household), it would have about 433 million households. Nearly four times the number of U.S. households. Increase the numbers to account for growing populations.

The number of potential consuming households is staggering. Each will contribute exponentially to environmental impacts such as CO2 emissions. According to the Carbon Dioxide Information Analysis Center, the primary climate-change data and information analysis center of the U.S. Department of Energy, coal production and use in China has increased tenfold since the early 1960s. As a result, Chinese fossil-fuel CO_2 emissions have

grown a remarkable 79.2 percent since 2000 alone. At 1.66 billion metric tons of carbon in 2006, the People's Republic of China has surpassed the United States as the world's largest emitter of CO_2. This is due primarily to fossil-fuel use and cement production.[15] In contrast, the U.S. released 1.57 billion metric tons of carbon in 2006.

What if all of the households in China (not to mention India) become sufficiently affluent to own one car, one computer, one television, and one single-family home?

Economic Disparity

Unfortunately, another prominent trend is the increasing gap between rich and poor. This gap is widening both globally and nationally and indicates increasing political and economic instability. The United States does not fair well in the global comparisons. While the average work day in the United States has increased, other industrialized countries have experienced a decrease. Furthermore, the relative purchasing power of the U.S. dollar is decreasing. The average American citizen is working harder and earning less in real dollars.

The economic disparity between rich and poor may generate a variety of repercussions—depending upon the interplay of other variables. Political upheaval is one possibility. This may be localized. Given the globalization of society, a local event could trigger a severe domino effect. Because our economic structure has been transformed, many things previously unimaginable are quite possible. Where we once had the centuries-old, secretive but well-established, bank-driven model (wherein banks are the primary source of finance and central banking systems the primary control mechanism), we now have a relatively new and unpredictable market-driven model (wherein nonbank mechanisms, such as stocks, mortgage houses, credit companies, and investment brokers, provide a plethora of funding sources and central banking systems control only the banking processes). Individual consumers can directly invest on credit obtained without benefit of a bank. More importantly, they can invest based on real-time, readily accessible information. Never before in human history has society been in such a position. The financial herd can raise companies larger than many countries, and, they can crush them in the blink of an eye. Individual investors can—and do—demand that companies alter behavior to be more socially and environmentally correct. This has become so common that it has earned a title, "shareholder activism." Thus, one possible result of the widening gap between rich and poor is a focused shareholder activism that forces corporations towards a more benevolent behavior. Shareholder activism often mandates corporate responsibilities that, in other circumstances, might have been assumed by the government through either regulatory controls or welfare benefits.

The gap between rich and poor is a social stressor. What if that growing demand of an increasingly affluent population collides with the economic disparity between rich and poor?

The New Economy

One of the greatest challenges facing society today is how to maintain economic growth without depleting or degrading the earth's limited resources. As the United States emerges from the worst recession in 80 years, a New Economy is forming both domestically and internationally. Forecasters from conservative and liberal organizations alike concur about some of the basic characteristics of the New Economy. The trend is towards an economy

in which we consume less, save more, and become greener. What does that mean for the United States? What does it mean for the global economy?

Already, we are starting to observe changing patterns in urban development. Ideas are the most valuable commodity. Service is the growth sector. In Houston, the Texas Medical Center encompasses an array of restaurants, shops, and hotels, and employs 100,000 people. It is a self-contained complex, poised to become the seventh largest downtown in the United States—all by itself. In Fort Collins, a green zone has been designated to generate as much electricity as it consumes. It is a showcase for clean energy. Across the country, university budgets are reviewed with an emphasis on corporate value. No longer is it adequate to produce PhDs; rather, it is necessary to generate patents and commercial ventures.

Already, we are measuring value in new ways. Our crystal ball was working reasonably well in the first and second editions of *Green Building Materials: A Guide to Product Selection and Specification*. In those we identified a trend towards a new field of accounting called *environmental accounting,* supported by many economists and politicians, including Former Vice President Al Gore. Basically, environmental accounting revises the financial systems in this country, (taxes, prices, GNP evaluations, etc.) to reflect the value of forests, minerals, clean air and water, erosion of soils, and so forth. The theory requires a complete restructuring of global economic systems. Obviously, without a magic wand, such a wholesale restructuring is unlikely. Nevertheless, piecemeal applications of environmental accounting are becoming more numerous. Piecemeal applications directly impacting the building industry include the sun rights, sewer rights, and pollution rights instituted at the local levels in cities such as New York, Houston, and Los Angeles. While direct taxation of environmental "sins" still seems at most a remote possibility, the prospect of trading credits is gaining momentum. Developments in greenhouse gas (GHG) accounting or "carbon footprinting" are penetrating into all industry sectors.

The International Geosphere-Biosphere Programme (IGBP), a research program that studies climate change, has developed the Climate-Change Index. The IGBP Climate-Change Index distills the complexity of the Earth's climate down to one number, in the same way that the Dow Jones Index condenses volumes of data into a single figure. The Index brings together key indicators of global climate change: carbon dioxide, temperature, sea level, and sea ice. The Index has risen steadily since 1980—the earliest date the index was calculated.[16]

Socially Responsible Investing (SRI) parallels these new metrics. SRI continues to grow. A 70-foot-high billboard near New York's Madison Square Garden features a carbon counter that lets viewers track greenhouse gas emissions. The billboard is on the Deutsch Bank—a clear (and very large) sign of dominance of climate change. The launch of the carbon counter in June 2009 included the traditional unveiling as well as massive twittering. The carbon counter can even be downloaded for those who want to track greenhouse gases from their computer.[17]

Other investment houses also embrace the new metrics, each developing their own proprietary economic variation of the IGBP Climate-Change Index. HSBC Corporate, Investment Banking and Markets (CIBM) launched the HSBC Global Climate Change Benchmark Index in 2007. Their index tracks the stock market performance of key companies considered to be best placed to profit from the challenges presented by climate change.[18] The FTSE KLD Global Climate 100 Index is another specialty index. It promotes investment in 100 public companies believed to demonstrate strong potential for

mitigating immediate and long-term causes of climate change. KLD, in partnership with the Global Energy Network Institute (GENI), created the index in response to growing demand from institutional investors and individuals for investment strategies that address global climate change.[19]

The New Economy, however, is likely to involve a lot more than factoring in a few more variables. The New Economy is likely to be radically different.

The current economic model is linear. We take stuff, use it, and dispose of it. At some point, there is no more stuff at the start. Obviously, a problem for a linear model. It is even more disastrous for an economic model that assumes an infinite capacity for growth. The supply-and-demand economic model is time-honored. It is also worn out. When the trends are examined in relation to each other, it is clear that the social pressures and environmental pressures of our expanding, changing global population cannot sustain the current economic model. If the economy collapses under such pressures, it is likely to be catastrophic.

Closing-the-loop is not just an environmental concept; it is an economic one as well. Stuff, and money, need to cycle or our global economy will break down.

The most significant economic sectors account for 70–80 percent of all life cycle environmental impacts in society. In order of environmental impact, these are:

- Transportation
- Food
- Residential development (building, energy use, consumer products)

In the United States, total material consumption increased from 1975 to 2000 by 57 percent to 6.5 billion metric tons. Per capita consumption increased by 23 percent. Over 40 percent of material consumption, approximately 2.7 billion metric tons, was returned to the environment as waste in 2000. Waste has increased by 26 percent since 1975. The most environmentally harmful waste materials—synthetic and persistent organic chemicals, radioactive compounds, and heavy metals—increased by 24 percent to 16 million metric tons.[20]

The New Economy must close the loop. There is only one way to do that and simultaneously accommodate the rising affluence of an expanding population. It will be necessary to separate wealth from stuff. Separation will allow each to cycle at different rates. Wealth can move quickly and grow infinitely. Stuff can move more slowly and cycle as necessary. Separating the value from the stuff means that what is sold or exchanged will be the service, not the thing. We will purchase "heat" not HVAC equipment. We will buy the security service, not the security equipment. That is the future. In the near-term, we may see more and more product-service systems.

For years, economists have discussed product-service systems (PSSs) as a potential cure for a growth economy that is outpacing its resource base.[21] With a PSS, you are selling (or buying) the performance of the product. PSSs are not a new idea. Businesses have been providing products bundled with various services for years—car rentals, lawn care services, air conditioning maintenance programs, extended warranties on electronics, lending libraries—each is a PSS.

What if people began to buy and sell PSSs instead of stuff?

A design student at London's Royal College of Art (Chiyu Chen) has conceived of a new urban bike-sharing program.[22] As in typical urban bike-sharing programs, users would

check out publicly provided bikes as needed. They only want the service of riding a bike, not the ownership of the bike. In Mr. Chen's vision, however, the borrowed bikes would be equipped with a "Hybrake" regenerative-braking module, a mechanism similar to the braking system on the Toyota Prius, only miniaturized, to store kinetic energy generated from braking. When the riders bring back the bikes and lock them into the station, the energy would be transferred. There is a service exchange, transportation for energy generation. And, clean energy at that. While only a concept now, it signals the direction in which our next generation is heading.

Within the building industry, an excellent example of a PSS is performance contracting. Performance contracting rewards excellence and encourages a "race to the top" (from an environmental perspective) rather than a "race to the bottom." U.S. federal agencies use Energy Savings Performance Contracts (ESPCs) to accomplish energy savings projects without upfront capital costs and without special Congressional appropriations. The contractor conducts a comprehensive energy audit for the federal facility and identifies improvements to save energy. The contractor funds and implements the improvements. Utility payments go to the over the term of the contract (up to 25 years). After the contract ends, all additional cost savings accrue to the agency. As of 2010:[23]

- More than 460 ESPC projects have been awarded by 19 different federal agencies in 47 states.
- Approximately $2.3 billion has been invested in federal facilities through ESPCs, saving more than 18 trillion Btu annually—equivalent to the energy used by a city of more than 500,000 people.
- Energy cost savings of $7.1 billion for the federal government ($5.7 billion goes to finance project investments) have been achieved. Net savings to the Federal government are $1.4 billion.

What if performance contracts become the norm? Instead of the lowest bid to provide the lowest-quality acceptable materials, the market might evolve to expect the best pricing for best practices.

Final Thoughts

The range of green building products that are currently available has grown exponentially in response to the growth in green building rating systems on the local, state, national, and international level. They offer a range of aesthetic options. They perform well. They are cost-competitive. Many mainstream manufacturers have jumped on the bandwagon in response to the growth in demand and the realization that green building materials are not a fad that is soon going to fade away. It is not only possible to incorporate green building products into our design and construction practices; it is imperative.

It is our sincere and earnest hope that this book contributes to the redevelopment of our economic and political infrastructure in the support of sustainable approaches to green building. By promoting the use of green building products, we better serve our clients and the public. We provide a more efficient, less toxic building that respects the health,

safety, and welfare of the building occupants and the community in general. And we help to change the business of building in a positive way, one that helps to safeguard the "the social, economic, and other requirements of present and future generations of Americans."[24]

Notes

1. Section 101 [42 USC § 4331], Title 1, The National Environmental Policy Act.
2. www.abiresearch.com/research/1004656-Green+Building+Materials (accessed March 1, 2010).
3. www.climatechangebusiness.com/Green_Building_Markets (accessed March 1, 2010).
4. "EPA Announces Actions to Address Chemicals of Concern, Including Phthalates"; Environmental Protection Agency Press Release, December 30, 2009.
5. www.epa.gov/oppt/existingchemicals/ (accessed March 1, 2010).
6. toxics.usgs.gov/regional/emc/ (accessed October 22, 2009).
7. www.norman-network.net/index_php.php (accessed October 22, 2009).
8. NORMAN project - 6th Framework Programme – Priority 6.3 - Contract N° 018486.
9. Sagman, Uri. "Canadian scientist/entrepreneur, founds Nanotechnology Clean Water Initiative." London, November 18, 2003.
10. www.parliament.uk/hlscience/ (accessed March 1, 2010).
11. "Nanotechnology, Synthetic Biology, & Public Opinion: A Report of Findings Based on a National Survey Among Adults; Conducted on Behalf of: Project on Emerging Nanotechnologies - The Woodrow Wilson International Center For Scholars"; Hart Research Associates, September 22, 2009, www.nanotechproject.org/publications/archive/8286/ (accessed March 1, 2010).
12. According to an item in EPA's December 7, 2009, Regulatory Agenda, EPA believes that a TSCA Section 4(a) test rule "may be needed to determine the health effects of certain multi-wall carbon nanotubes and nanosized clays and alumina."
13. http://mbaoath.org/ (accessed March 1, 2010).
14. U.S. Census Bureau; America's Families and Living Arrangements: 2007; issued September 2009.
15. http://cdiac.ornl.gov/trends/emis/tre_prc.html (accessed March 1, 2010).
16. www.igbp.net/page.php?pid=100 (accessed March 1, 2010).
17. www.dbcca.com/dbcca/EN/what-you-can-do/downloadable_widget.jsp (accessed March 1, 2010).
18. www.hsbcnet.com/solutions/news/corporate/cc_bmark.html (accessed March 1, 2010).
19. www.kld.com/indexes/gc100/index.html (accessed March 1, 2010).
20. Rogich, Donald, Amy Cassara, Iddo Wernick, and Marta Miranda. "World Resources Institute Materials Flows Database 2005; Material Flows in the United States: A Physical Accounting of the U.S. Industrial Economy; Washington, DC, 2008.

21. 2005–2008, the EU funded "Sustainable Consumption Research Exchanges (SCORE!)" in support of the UN's framework of programs on sustainable consumption and production. The premise is that the future of the world depends on humanity's ability to provide a high quality of life for nine billion people without damaging the Earth's resources. www.oslodeclaration.org (accessed March 1, 2010).
22. *The Christian Science Monitor*. "Horizons: Frontiers of Science and Technology," August 2, 2009.
23. www.1.eere.energy.gov/femp/financing/espcs.html (accessed March 1, 2010).
24. Section 101 [42USC . . .]

APPENDIX A

Sources of Further Information

To assist readers in learning more, this appendix lists sources of additional information about green building materials and green buildings.

ABS Consulting Training Services
16855 Northchase Drive
Houston, TX 77060-6006
(800) 769-1199; fax (281) 673-2931
email: info@absconsulting.com;
www.absconsulting.com/svc_training.cfm

ABS Consulting Training Services provides continuing education and practical information to help businesses and individuals meet the unique challenges of new regulations, international standards, and technologies.

Resources: Practical books and references, including all of the U.S. *Code of Federal Regulations* (CFRs), in print, electronic, and online versions; *Federal Register* notification service

Alliance for Sustainability (AFS)
Hillel Center, University of Minnesota
1521 University Avenue SE
Minneapolis, MN 55414-2021
(612) 331-1099; fax (612) 379-9004
email: iasa@mtn.org;
http://allianceforsustainability.net/

The mission of the Alliance is to bring about personal, organizational, and planetary sustainability through support of projects that are ecologically sound, economically viable, socially just, and humane. The Alliance for Sustainability is a Minnesota-based, tax-deductible nonprofit supporting model sustainability projects on the local, national, and international levels.

Resources: *Manna* (e-newsletter)

Alliance to Save Energy
1850 M Street NW, Suite 600
Washington, DC 20036-5817
(202) 857-0666; fax (202) 331-9588
email: info@ase.org; www.ase.org

The Alliance focuses on improving energy efficiency in new and existing buildings. It promotes energy-efficient housing through energy rating systems, assesses the effects of federal and state fiscal policies, and identifies energy-efficient products and services nationwide.

Resources: e-FFICIENCY NEWS (e-newsletter)

AMEE Inc.
UK — London Office:
1st Floor, Moo Studios
100 City Road
London EC1Y 3DD
USA — San Francisco Office:
1 Lombard Street, Suite 303

San Francisco, CA 94111-1130
(202) 507-4000; fax (202) 429-2248
email: aceeeinfo@aceee.org; www.aceee.org

AMEE finds, verifies, and makes accessible the best carbon-related data in the world: emissions factors and the algorithms for using them. AMEE's API is used to access and embed best-practice carbon models into carbon accounting systems, carbon calculators, and many other applications.

Resources: Case studies; data updates; *AMEE Explorer* search engine; *AMEE Developer Centre* (energy consumption measurement tool)

American Council for an Energy-Efficient Economy (ACEEE)

529 14th Street NW, Suite 600
Washington, DC 20045-1000
(202) 507-4000; fax (202) 429-2248
email: aceeeinfo@aceee.org; www.aceee.org

ACEEE explores the links between energy efficiency, economic prosperity, a cleaner environment, and other aspects of national and global concern. It conducts technical and policy assessments, advises governments and utilities, works collaboratively with businesses, and organizes conferences.

Resources: Grapevine Online (online newsletter); technical reports and books on various energy-efficiency topics; commercial building performance resources (website)

American Environmental Health Foundation (AEHF)

8345 Walnut Hill Lane, Suite 225
Dallas, TX 75231-4209
(800) 428-2343, (214) 361-9515; fax (214) 361-2534
email: aehf@aehf.com; www.aehf.com

AEHF was founded in 1975 to research chemical sensitivity and to educate the public about it. The Foundation Store carries almost 1,500 environmentally safe products for the home and office. These products are designed for both the chemically sensitive individual and the environmentally aware person.

Resources: Catalog of environmentally safe products (website); articles on chemical sensitivity, indoor and outdoor air quality, and organic gardening

American Institute of Architects (AIA)

1735 New York Avenue NW
Washington, DC 20006-5292
(800) AIA-3837, (202) 626-7300; fax (202) 626-7547
email: infocentral@aia.org; www.aia.org

The AIA's Committee on the Environment (COTE) works to sustain and improve the environment by advancing and disseminating environmental knowledge and values and by advocating the best design practices to integrate built and natural systems to the profession, industry, and public.

Resources: *AIA Environmental Resource Guide*; Back-of-the-Envelope Calculator; *Assessing Green Building Performance* (a post-occupancy evaluation of 12 GSA buildings); COTE Measure of Sustainable Design; COTEnotes (e-newsletter)

American Public Media Sustainability Coverage

480 Cedar Street
St. Paul, MN 55101-2217
(800) 562-8440
http://sustainability.publicradio.org/

American Public Radio provides coverage of sustainability topics in a variety of media. The website showcases sustainability stories broadcast on a variety of radio programs, including Marketplace®, Weekend America®, Speaking of Faith®, and American RadioWorks®.

Resources: *The Greenwash Brigade*; various web-based resources

American Rivers

1101 14th Street NW, Suite 1400
Washington, DC 20005-5637
(202) 347-7550; fax (202) 347-9240
email: outreach@amrivers.org; www.americanrivers.org

American Rivers works toward achieving healthy rivers, abundant fish and wildlife, and thriving river communities. Its emphasis is on

water quality, water scarcity, and sprawl solutions.

Resources: Toolkits on a variety of subjects; publications on subjects such as sprawl, community watersheds, and clean water

American Solar Energy Society, Inc. (ASES)

2400 Central Avenue, Suite A
Boulder, CO 80301-2843
(303) 443-3130; fax (303) 443-3212
email: ASES@ASES.org; www.ases.org

ASES is a national organization dedicated to advancing the use of solar energy for the benefit of U.S. citizens and the global environment. ASES promotes the widespread near- and long-term use of solar energy. ASES Technical Divisions include: Solar Electric, Solar Buildings, Sustainability, Solar Thermal, Renewable Fuels and Sustainable Transportation, Resource Applications, Clean Energy and Water, Small Wind, and Concentrating Solar Power.

Resources: *Solar Today* (magazine); divisional online newsletters; ASES reports

Architects, Designers, and Planners for Social Responsibility (ADPSR)

P.O. Box 9126
Berkeley, CA 94709-0126
(510) 845-1000
email: forum@adpsr.org; www.adpsr.org

ADPSR works for peace, environmental protection, ecological building, social justice, and the development of healthy communities.

Resources: New Village Press books; *Architectural Resource Guide (ARG)* by Northern California chapter

Associated Air Balance Council (AABC)

1518 K Street NW, Suite 503
Washington, DC 20005-1203
(202) 737-0202; fax (202) 638-4833
email: info@aabc.com; www.aabc.com

AABC is a professional organization for consultants and contractors in the HVAC and mechanical professions that works to promote state-of-the-art TAB procedures and services through technical papers and other publications, such as the AABC National Standards, the industry's first comprehensive standards for field measurement and instrumentation.

Resources: *TAB Journal; TAB Specifications;* commissioning guidelines; sample specifications

Associated Air Balance Council (AABC) Commissioning Group (ACG)

1518 K Street NW, Suite 503
Washington, DC 20005-1203
(202) 737-0202; fax (202) 638-4833
email: info@aabc.com; www.aabc.com

AABC Commissioning Group is a nonprofit association of certified commissioning authorities dedicated to providing professional, independent commissioning services ACG offers certification exams to test the knowledge and technical expertise of eligible commissioning providers.

Resources: *ACG Commissioning Guideline; Cx Journal* (e-newsletter)

Association for Environmental Health and Sciences (AEHS)

150 Fearing Street
Amherst, MA 01002-1941
(413) 549-5170; fax (413) 549-0579
email: info@AEHS.com; www.aehs.com

AEHS is a clearinghouse for technical and regulatory information on soil issues, including chemistry, geology, hydrogeology, engineering, modeling, toxicology, regulatory science, and the law.

Resources: *Soil and Sediment Contamination* (journal); *International Journal of Phytoremediation; Human & Ecological Risk Assessment* (Journal); *Environmental Forensics Journal*

Alliance of Foam Packaging Recyclers (AFPR)

1298 Cronson Boulevard, Suite 201
Crofton, MD 21114-2305

(410) 451-8340; fax (410) 451-8343
email: info@epscentral.org;
www.epspackaging.org

Formed in 1991 by over 80 companies representing every major manufacturer of EPS protective foam packaging, their raw material suppliers and equipment manufacturers work to facilitate EPS recycling between EPS manufacturers. The Alliance has more than 200 plant locations nationwide to serve as central collection points and help produce foam packaging made with recycled content. Emphasis is on encouraging the reuse of loose-fill foam packaging and the recycling and reprocessing of molded foam packaging.

Resources: Annual EPS Recycling Rate Report; EPS Technical Information

ASID Sustainable Design Information Center

608 Massachusetts Avenue NE
Washington, DC 20002-6006
(202) 546-3480; fax: (202) 546-3240
www.asid.org/designknowledge/sustain/

This website offers general information on sustainability and green design and multiple links to resources available online. The Sustainable Design Council, composed of seven professional members, supervises this section of the website and oversees the ASID sustainable design strategic initiative.

Resources: ASID Research Series on Sustainability: Interior Design and Global Impacts (White Papers)

Athena Sustainable Materials Institute

629 St. Lawrence St.
P.O. Box 189
Merrickville, Ontario, Canada, K0G 1N0
(613) 269-3795; fax: (613)269-3796
email: info@athenaSMI.ca;
www.athenasmi.org

The Institute works to facilitate the use of LCA in green building rating and assessment systems such as LEED and Green Globes. Researches the development, verification, and updating of databases supporting environmental impact estimator software.

Resources: *Athena Impact Estimator for Buildings* (environmental impact estimator); *Athena EcoCalculator for Assemblies* (product life cycle inventory studies)

Best Practices Benchmarking for Energy Efficiency Programs

Rafael Friedman, PG&E Project Manager
(415) 972-5799
Mike Rufo, Itron Project Manager
(510) 844-2881
email: consult@itron.com;
www.eebestpractices.com/index.asp

The project works to develop and communicate excellent practices nationwide in order to enhance the design, implementation, and evaluation of energy efficiency programs. The project uses a benchmarking methodology to identify best practices for a wide variety of program types.

Resources: Best Practices Program Area Reports; *Portfolio Best Practices Report*; Best Practices Self-Benchmarking Tool

Bioenergy Feedstock Information Network (BFIN)

Environmental Sciences Division
Oak Ridge National Laboratory
P.O. Box 2008
Oak Ridge, TN 37831-6186
(865) 576-8057; fax: (865) 576-7572
email: eere@ornl.gov; www.ornl.gov/sci/eere

This DOE-funded project organizes renewable energy outreach activities, focusing on domestic production, recovery, and conversion of energy crops (fast-growing trees and grasses) and residues to economically priced, environmentally beneficial fuels and power generation.

Biomass Program

Energy Efficiency and Renewable Energy
U.S. Department of Energy
1000 Independence Avenue SW, EE-2E, 5H-021
Washington, DC 20585-0001
(202) 586-5188; fax (202) 586-1640
email: eere_biomass@ee.doe.gov;
www.eere.energy.gov/biomass/

The DOE Office of the Biomass Program (OBP) partners with U.S. industry to foster research and development on advanced technologies that will transform the abundant biomass resources of the United States into clean, affordable, and domestically produced biofuels, biopower, and high-value bioproducts. The Biomass Program is the combination of several previously separate programs: the Biofuels Program, the Biopower Program, and the biomass-related elements of research formerly sponsored by the Office of Industrial Technologies (OIT).

Resources: Biomass document database; Biomass Project fact sheets

Bonneville Environmental Foundation (BFE)

240 SW First Avenue
Portland, OR 97204-3503
(866) 233-8247; fax: (503) 248-1908
email: info@b-e-f.org; www.b-e-f.org

The foundation supports watershed restoration programs and the development of new sources of renewable energy while empowering people to shrink their carbon footprint. BEF markets green power products to public utilities, businesses, government agencies, and individuals. Their BEF Carbon Offsets enable organizations and individuals to dedicate funds to the development of renewable energy sources like solar power and wind farms.

Resources: Quarterly electronic newsletter, *Carbon Calculator*; White Papers

BSI America

BSI Management Systems
12110 Sunset Hills Road, Suite 200
Reston, VA 20190-5902
(800) 862-4977; fax: (703) 435-9001
email: inquiry@bsiamerica.com;
www.bsiamerica.com/en-us/

BSI is a third-party agency that offers ISO 14001 registration and greenhouse gas emissions verification.

Resources: International Environmental Systems Update; guidance documents about ISO 14001; "Carbon Footprint" white paper

BuildingGreen, LLC

122 Birge Street, Suite 30
Brattleboro, VT 05301-6703
(802) 257-7300; fax: (802) 257-7304
email: info@buildinggreen.com;
www.buildinggreen.com

This organization provides articles, reviews, and news on energy-efficient, resource-efficient, and healthy building practices and products.

Resources: *BuildingGreen* Suite; *Environmental Building News (EBN); GreenSpec Directory; Green Building Products Directory*

Business for Social Responsibility (BSR)

111 Sutter Street, 12th Floor
San Francisco, CA 94104-4507
(415) 984-3200; fax (415) 984-3201
email: connect@bsr.org; www.bsr.org

BSR is a global organization that helps member companies achieve success in ways that respect ethical values, people, communities, and the environment. BSR provides information, tools, training, and advisory services to make corporate social responsibility an integral part of business operations and strategies. A nonprofit organization, BSR promotes cross-sector collaboration and contributes to global efforts to advance the field of corporate social responsibility. Environmental programs utilized by BSR members include green design, green product design, waste reduction, and energy efficiency.

Resources: Environmental Issue Reports

Canadian Institute of Chartered Accountants

277 Wellington Street West
Toronto ON M5V 3H2
Canada
(416) 977-3222; fax: (416) 977-8585
www.cica.ca

This group prepared the Environmental Performance and Shareholder Value Creation Survey, which identified a number of opportunities for companies in all industries to

implement more effective environmental performance measurement and management systems that support long-term shareholder value creation.

Center for Economic and Environmental Partnership (CEEP)

P.O. Box 2829
Malta, NY 12020-8829
(518) 229-7851
www.ceepinc.org

CEEP funds and sponsors programs promoting development of an effective and competitive environmental industry in New York state and advances development of sound environmental business policies and programs in New York state and elsewhere. Emphasis is on high-performance buildings; alternative, distributed, and renewable energy (ADRE); and solid waste and recycling (SWR).

Center for Maximum Potential Building Systems, Inc. (CMPBS)

8604 FM 969
Austin, TX 78724-6200
(512) 928-4786; fax (512) 926-4418
email: center@cmpbs.org; www.cmpbs.org

CMPBS works with public entities, professional organizations, community groups, universities, and individuals to develop sustainable building policies and practices that cover individual buildings to entire regions.

Resources: Reports and compendia

Center for Plant Conservation

Missouri Botanical Garden
P.O. Box 299
St. Louis, MO 63166-0299
(314) 577-9450; fax (314) 577-9465
email: CPC@MOBOT.org;
www.centerforplantconservation.org

The center focuses on conserving rare and endangered native plants through research, cultivation, and education at botanical gardens and arboreta in the United States. Emphasis is on five priority regions: Hawaii, Florida, California, Texas, and Puerto Rico.

Resources: *Ex Situ Plant Conservation; 2008 Plant Conservation Directory; Genetics and Conservation of Rare Plants; America's Vanishing Flora; Restoring Diversity: Strategies for Reintroduction of Endangered Plants*

Center for Health, Environment, and Justice (CHEJ)

P.O. Box 6806
Falls Church, VA 22040-6806
(703) 237-2249; fax (703) 237-8389
email: chej@chej.org; www.chej.org

CHEJ assists communities in combating environmental threats. Emphasis is on a contaminated sites campaign, including convicting the EPA for child abuse for not cleaning up these sites. CHEJ advocates responsible corporate behavior in replacing outdated chemicals with safe, affordable alternatives.

Resources: Campaign reports; *Everyone's Backyard (EBY)* quarterly membership magazine

Chemical Injury Information Network (CIIN)

P.O. Box 301
White Sulphur Springs, MT 59645-0301
(406) 547-2255; fax (406) 547-3455
email: chemicalinjury@ciin.org; www.ciin.org

CIIN is a support and advocacy organization dealing with multiple chemical sensitivities (MCS). It is run by the chemically injured for the benefit of the chemically injured and focuses primarily on education, credible research into MCS, and the empowerment of the chemically injured.

Resources: *Our Toxic Times; Environmental Directory; Nontoxic Buying Guide*

City Bikes

2501 Champlain Street NW
Washington, DC 20009-2807
(202) 265-1564; fax (202) 462-7020
www.citybikes.com

City Bikes supports local, regional, and national bicycle and other nonmotorized transportation advocacy groups and events, maintains a comprehensive recycling program,

and provides support for cycling awareness and safety programs for children.

Clean Water Action

1010 Vermont Avenue NW, Suite 1100
Washington, DC 20005-4918
(202) 895-0420; fax (202) 895-0438
email: cwa@cleanwater.org;
www.cleanwateraction.org

This national citizens' organization works for clean, safe, and affordable water and to prevent health-threatening pollution, create environmentally safe jobs and businesses, and empower people to make democracy work. Emphasis is on citizen organizing and education.

Resources: *Clean Water Currents* (e-newsletter)*;* fact sheets and reports

Climate, Community, and Biodiversity Alliance (CCBA)

2011 Crystal Drive, Suite 500
Arlington, VA 22202-3787
(703) 341-2461; fax (202) 912-1047
email: info@climate-standards.org;
www.climate-standards.org

CCBA is a global alliance promoting integrated solutions to land management. It designs triple-benefit voluntary standards to identify land management projects that simultaneously minimize climate change, support sustainable development, and combat loss of biodiversity.

Resources: Project design standards

Climate Solutions

219 Legion Way SW, Suite 201
Olympia, WA 98501
(360) 352-1763; fax (360) 943-4977
email: info@climatesolutions.org;
www.climatesolutions.org

Climate Solutions works to accelerate practical and profitable solutions to global warming by galvanizing leadership, growing investment and bridging divides. *New Energy Cities* program seeks to accelerate the transition to a clean, renewable, super-efficient energy system in cities using a comprehensive systems approach that integrates: smart power grids, green intelligent buildings, plug-in electric vehicles and energy storage, and renewable power sources such as wind, solar, geothermal, and biomass.

Resources: *CS Journal*; *CS Bulletin*; email updates

The Cohousing Association of the United States

Coho/US, #1445
22833 Bothell-Everett Highway, Suite 110
Bothell, WA 98021-9366
(812) 618-2646
www.cohousing.org

The Cohousing Association of the United States (Coho/US) is dedicated to promoting and encouraging the cohousing concept, supporting both individuals and groups in creating communities, providing assistance to completed groups for improving their systems for living together in community, and creating networking opportunities for those involved or interested in cohousing.

Resources: *Cohousing Magazine* (e-zine)

Collaborative for High-Performance Schools (CHPS)

142 Minna Street, Second Floor
San Francisco, CA 94105-4125
(877) 642-CHPS; fax: (415) 957-1381
email: info@chps.net; www.chps.net

The Collaborative facilitates the design of high-performance schools—that is, environments that are not only energy efficient but also healthy, comfortable, well lit, and containing the amenities needed for a quality education by providing information to school districts and designers.

Resources: *Low-Emitting Materials List; High Performance Products Database; Best Practices Manual; Materials Specification; CHPS E-Bulletin;* fact sheets on commissioning, IAQ, and acoustics

Construction Industry Compliance Association (CICA)

National Center for Manufacturing Services
3025 Boardwalk
Ann Arbor, MI 48108-3230

(800) 222-6267; fax (734) 995-4004
www.CICAcenter.org

CICA is a source for plain-language explanations of environmental rules for the construction industry. This information is provided free by the National Center for Manufacturing Sciences with the assistance of: Associated General Contractors of America and National Association of Home Builders. Emphasis is on laws in the areas of: stormwater, C&D debris, hazardous/toxic waste, air, wetlands, endangered species, green buildings, and safety and health.

Construction Materials Recycling Association (CMRA)

P.O. Box 122
Eola, IL 60519-0122
(630) 585-7530; fax (630) 585-7593
email: info@cdrecycling.org;
www.cdrecycling.org

CMRA is devoted exclusively to the needs of the rapidly expanding North American construction waste and demolition debris processing and recycling industry. It promotes the acceptance and use of recycled construction materials, including concrete, asphalt, wood, and gypsum.

Resources: Materials websites; recycler search website

Consumer Product Safety Commission (CPSC)

4330 East-West Highway
Bethesda, Maryland 20814-4408
(800) 638-CPSC; fax (301) 504-0124
email: info@cpsc.gov; www.cpsc.gov

The CPSC is charged with protecting the public from unreasonable risks of serious injury or death from thousands of consumer products under the agency's jurisdiction. It is committed to protecting consumers and families from products that pose fire, electrical, chemical, or mechanical hazard or can injure children, and it issues product safety alerts and recalls.

Resources: Publications on a wide variety of consumer safety issues

Cool Roof Rating Council (CRRC)

1610 Harrison Street
Oakland, CA 94612-3308
(866) 465-2523; fax (510) 485-7175
email: info@coolroofs.org;
www.coolroofs.org

CRRC provides building code bodies, energy service providers, architects and specifiers, property owners and community planners with accurate radiative property data on roof surfaces that may improve the energy efficiency of buildings while positively impacting the environment. CRRC administers a strict rating program under which companies can label various roof surface products with radiative property values.

Resources: *Rated Products Directory*

Conservation International

2011 Crystal Drive, Suite 500
Arlington, VA 22202-3787
(800) 429-5660
www.conservation.org

Conservation International focuses on the conservation of ecosystems and the preservation of biological diversity. It emphasizes working with partner organizations and locals in tropical and temperate countries to develop and implement ecosystem conservation projects.

Resources: *Team Earth* (digital magazine); *eNews Update*

Database of State Incentives for Renewables & Efficency (DSIRE)

North Carolina State University
College of Engineering
North Carolina Solar Center
Campus Box 7401
Raleigh, NC 27695-7401
(919) 515-3480 (800) 33-NCSUN; fax: (919) 515-5778
email: ncsun@ ncsu.edu; http://dsireusa.org/

DSIRE is an online database that includes listings of state and utility company grants, rebates, and tax incentives.

Resources: Glossary; database; maps and tables

Defenders of Wildlife

1130 Seventeenth Street NW
Washington, DC 20036-4611
(800) 385-9712; fax (202) 682-1331
email: defenders@mail.defenders.org;
www.defenders.org

Defenders of Wildlife protects native wild animals and plants in their natural communities. Programs focus on what scientists consider two of the most serious environmental threats to the planet: the accelerating rate of extinction of species and the associated loss of biological diversity, and habitat alteration and destruction.

Resources: *Defenders* (quarterly magazine); electronic newsletters; reports

Designing and Building Healthy Places

Centers for Disease Control and Prevention (CDC)
1600 Clifton Road
Atlanta, GA 30329-4018
(800) 232-4636
email: cdcinfo@cdc.gov;
www.cdc.gov/healthyplaces

CDC studies the interaction between people and their environments, natural as well as human-made, as they relate to public health. Emphasis is on health issues related to land use.

Resources: Fact sheets; publications and manuscripts; podcasts; *Healthy Community Design News* listserv

Development Center for Appropriate Technology (DCAT)

P.O. Box 27513
Tucson, AZ 85726-7513
(520) 624-6628; fax (520) 798-3701
www.dcat.net

DCAT works to enhance the health of the planet and communities by promoting a shift to sustainable construction and development through leadership, strategic relationships, and education. DCAT's primary program is called Building Sustainability into the Codes. It explores approaches to creating a sustainable context for building codes, working with national regulatory and green building organizations.

Resources: *Building Codes for a Small Planet DVD; Code, Regulatory and Systemic Barriers Affecting Living Building Projects* white paper

Earth Island Institute

2150 Allston Way, Suite 460
Berkeley, CA 94704-1375
(510) 859-9100; fax (510) 859-9091
www.earthisland.org

The Institute develops innovative projects for the conservation, preservation, and restoration of the global environment. Earth Island's Project Network consists of more than 30 projects worldwide, education, and activist campaigns, to address many of the most pressing social and environmental issues.

Resources: *Earth Island Journal; IslandWire;* multimedia and videos

Earth 911.com

1375 N. Scottsdale Rd, Suite 360
Scottsdale, AZ 85257-3449
(800) CLEANUP
http://earth911.com/

This organization works to empower the public with community-specific resources for improving quality of life. It is a public-private partnership that effectuates prevention ideals and offers community-specific information about recycling centers, green shopping, energy conservation, household hazardous waste, kids/environmental information, and composting, among other topics.

Resources: Electronic newsletter; searchable database for recyclable materials

Earthwatch Institute

3 Clock Tower Place, Suite 100, Box 75
Maynard, MA 01754-0075
(800) 776-0188; fax (978) 461-2332
email: info@earthwatch.org;
www.earthwatch.org

Earthwatch Institute engages people worldwide in scientific field research and education to promote the understanding and action necessary for a sustainable

environment. It accomplishes this through three primary objectives: education, research, and conservation.

Resources: E-newsletter; Treehugger blog

Ecological Building Network (EBNet)

11 Mark Drive
San Rafael, CA 94903
www.ecobuildnetwork.org/index.htm

EBNet is an international association of builders, engineers, architects, academics, and developers committed to promoting intelligent building methods and materials for a sustainable future. The current (and primary) project of EBNet is the development of modernized earthen building standards.

Resources: white papers and test reports for indigenous construction, including straw, adobe, and rammed earth

Ecospecifier

PO Box 311
Cannon Hill, QLD 4170
Australia
61 7 3890 5752; fax 61 7 3890 8765
email: admin@ecospecifier.org;
www.ecospecifier.org

Ecospecifier is a guide to eco-preferable products and materials for the construction industry, specifically targeted at the needs of decision makers and specifiers. It responds to the need for greater clarity about what is and is not green, for the desire to specify products that will lead to better indoor air quality and well-being, and for the growing body of public- and private-sector clients who want to save energy and water and to use sustainable resources.

Resources: *Environmentally Preferable Products* (database); e-newsletter; technical guides

Energy Crossroads

E. O. Lawrence Berkeley National Laboratory (LBL)
Environmental Energy Technologies Division
1 Cyclotron Road
Berkeley, CA 94720-8099
(510) 486-6784; fax: (510) 486-5394
email: EETDinfo@lbl.gov;
http://eetd.lbl.gov/EnergyCrossroads

This is Lawrence Berkeley National Laboratory's contribution to organizing a wide array of pointers to energy-efficient resources on the Internet.

Resources: Links to nearly 700 websites

Energy & Environmental Building Alliance (EEBA)

6520 Edenvale Boulevard, Suite 112
Eden Prairie, MN 55346-2564
(952) 881-1098; fax (952) 881-3048
email: inquiry@eeba.org; www.eeba.org

EEBA provides education and resources to transform the residential design, development, construction, and remodeling industries to profitably deliver energy efficient and environmentally responsible buildings and communities.

Resources: *Builder Guides; Houses That Work*

Energy Efficiency and Renewable Energy Program

Oak Ridge National Laboratory (ORNL)
P.O. Box 2008
Oak Ridge, TN 37831-6186
(865) 241-5756; fax (865) 576-7572
email: eere@ornl.gov; www.ornl.gov/sci/eere/

ORNL's Energy Efficiency and Renewable Energy Program develops sustainable energy technologies that foster a cleaner environment, a stronger economy, and a more secure future for the nation. The program conducts research in distributed energy, buildings, weatherization, federal energy management, and renewables.

Resources: *ORNL Review*

Energy Experts

Washington State University Extension Energy Program
P.O. Box 43165, Building #3
Olympia, WA 98504-3165
(360) 956-2129
www.energyexperts.org

This website includes a selection of objective and timely information on energy efficiency in all building types for building owners, operators, and occupants. It provides information on technologies and best practices for programs and businesses that work to design or retrofit buildings.

Resources: Energy Solutions Database; calculators and tools, *Energy Experts eNews* (monthly electronic newsletter)

The Energy Grid

14 Veterans Rd, #22
Amherst, NH 03031-2737
(603) 413-0322
email: mark.robinson@TheEnergyGrid.com; http://pvwatts.org/

This website offers several decision-making tools to aid the designer in learning about and using energy-efficient and solar electric technologies and products.

Resources: PVWatts Solar Calculator; Clean Power Estimator

Energy Outreach Center (EOC)

Climate Solutions
219 Legion Way SW, Suite 201
Olympia, WA 98501-1097
(360) 352-1763; fax (360) 943-4977
email: info@climatesolutions.org; www.climatesolutions.org

The EOC provides information to the public about home energy conservation and renewable energy. Emphasis is on home energy analysis service, residential heat loss calculations, classes and workshops, information center, newsletters, and research.

Resources: Downloadable fact sheets

Energy Star Programs

U.S. Environmental Protection Agency
Climate Protection Partnerships Division
1200 Pennsylvania Avenue NW, MS-6202J
Washington, DC 20460-0002
(888) STAR-YES
www.energystar.gov

Energy Star is a government-backed program helping businesses and individuals protect the environment through superior energy efficiency. Energy Star includes the Green Lights program. Program provides tools for designing commercial building projects to save money and energy, prevent carbon emissions, and fight global warming.

Resources: *Target Finder* database; product specifications; product and manufacturer lists; podcasts

Environmental Careers Organization (ECO)

(480) 515-2525
email: admin@eco.org; www.eco.org

ECO's mission is to protect and enhance the environment through the development of diverse leaders, the promotion of careers, and the inspiration of individual action. ECO accomplishes this through internships, career advice, publications and research. Founded in 1972, ECO has placed more than 8,450 college and graduate students and recent graduates in environmental internships in the public, private, and nonprofit sectors. ECO is a leader in workforce diversity and mentorship, sponsoring 1,850 associates from over 200 colleges through its groundbreaking diversity initiative, which began in 1992.

Resources: *The ECO Guide to Careers That Make a Difference: Environmental Work for a Sustainable Future; The Complete Guide to Environmental Careers in the 21st Century; Increasing Diversity in the Environmental Field: The Report from the National Roundtable on Diversity in the Environment*

Environmental Council of Concrete Organizations (ECCO)

5420 Old Orchard Road
Skokie, IL 60077-1083
email: jzuchman@ecco.org; www.ecco.org

ECCO communicates the environmental aspects of using concrete products on behalf of its members.

Resources: Searchable reference library; ECCO bulletins

Environmental Defense Fund (EDF)

257 Park Avenue S
New York, NY 10010-7304
(212) 505-2100; fax (212) 505-2375
www.environmentaldefense.org

Through its program areas, Environmental Defense brings together experts in science, law, and economics to tackle complex environmental issues and develop sound solutions. Emphasis is on urgent issues such as climate and air, ecosystem restoration, environmental health, living cities, and health.

Resources: Fact sheets on environmental topics; print and e-newsletters; blogs, podcasts and RSS

Environmental Law Institute (ELI)

2000 L Street NW, Suite 620
Washington, DC 20036-4919
(202) 939-3800; fax (202) 328-3868
email: law@eli.org; www.eli.org

ELI provides information services, training courses and seminars, research programs, and policy recommendations to environmental professionals in government, industry, the private bar, public interest groups, and academia.

Resources: Publications catalog offering monographs, deskbooks, and reports; *The Environmental Forum, The Environmental Law Reporter, National Wetlands Newsletter*

Environmental Product Declarations (EPD)

International EPD Consortium (IEC)
Vasagatan 15-17
SE-111 20 Stockholm
Sweden
46 8 700 66 90; fax: 46 8 700 66 99
email:joakim@envirodec.com;
www.environdec.com

EPDs provide science-based, verified, and comparable environmental information for various products and services to support continuous improvements based on flexible in-company product development processes. Developed by the Swedish Environmental Management Council, EPDs are applicable worldwide for all interested companies and organizations. Currently, companies and organizations in seven countries have participated in the creation of EPDs in various stages. The intent of an EPD is to provide a basis for fair comparison of environmental performance of products.

Resources: Searchable database of EPDs; e-newsletter

Environmental Sustainability Index (ESI)

Center for International Earth Science Information Network (CIESIN)
Columbia University
P.O. Box 1000, 61 Route 9W
Palisades, NY 10964-8000
(845) 365-8988; (845) 365-8922
email: ciesin.info@ciesin.columbia.edu;
http://sedac.ciesin.columbia.edu/en/esi/

The Yale Center for Environmental Law and Policy

205 Prospect Street
New Haven, CT 06511-2106
(203) 432-3123; (203) 432-6597
email: esi@yale.edu; www.yale.edu/esi

The ESI is a composite index tracking a diverse set of socioeconomic, environmental, and institutional indicators that characterize and influence environmental sustainability at the national scale. An environmental performance index focusing on assessing key environmental policy outcomes using trend analysis and performance targets is under development.

Resources: *2005 Environmental Sustainability Index; 2010 Environmental Performance Index*

Environmental Yellow Pages (EYP)

P.O. Box 771375
Coral Springs, FL 33077-1375
(800) 451-1458; fax (954) 970-447
www.enviroyellowpages.com

EYP provides information on the latest education, reference, health, environmental products, and professional services in the environmental industry for consumers and professionals worldwide. Coverage includes environmental bids, employment, and environmental services.

Resources: Searchable online database; hardcopy directories available in California,

Delaware, Florida, Georgia, New Jersey, New York, Pennsylvania, and Texas

Envirofacts Data Warehouse

EPA Office of Research and Development
www.epa.gov/enviro/

This portion of the EPA's website is a one-stop repository for select U.S. EPA environmental data on activities that may affect air, water, and land anywhere in the United States. The website provides access to several EPA databases. Information in *Envirofacts* is accessible in a variety of ways from the website's home page.

Resources: Environmental databases

FacilitiesNet

email: facilitiesnet@tradepress.com; www.facilitiesnet.com

This website is sponsored by Autodesk, Inc., BASF Corp., BOMI Institute, Butler Mfg., Marvin Windows and Doors, and Mpulse Maintenance Software. It provides several energy-related links for products, organizations, state-specific lists of power organizations, legislative updates, and other energy information.

Resources: *Buyer's Guide; Building Operating Management* (magazine)

Forest Stewardship Council—U.S. (FSC-US)

212 Third Avenue North, Suite 280
Minneapolis, MN 55401-1442
(612) 353-4511; fax (612) 208-1565
email: info@fscus.org; www.fscus.org

FSC sets forth principles, criteria, and standards that span economic, social, and environmental concerns for guiding forest management toward sustainable outcomes. Emphasis is on standards for forest management.

Resources: *Retailer Database; International Database; FSC-US Newsletter; Fact Sheets*

Friends of the Earth (FOE)

1717 Massachusetts Avenue NW, Suite 600
Washington, DC 20036-2008
(877) 843-8687; fax (202) 783-0444
email: foe@foe.org; www.foe.org

This advocacy group focuses on ozone depletion, agricultural biotechnology, toxic chemical safety, groundwater protection, nuclear weapons production wastes, tropical deforestation, and international projects.

Resources: *Friends of the Earth* (quarterly newsmagazine)

Global Environment Management Initiative (GEMI)

1155 15th Street, NW, Suite 500
Washington, DC 20005-2725
(202) 296-7449; fax (202) 296-7442
email: info@gemi.org; www.gemi.org

GEMI is an organization of leading companies dedicated to fostering global environmental, health, and safety (EHS) excellence through the sharing of tools and information. Through the collaborative efforts of its members, GEMI also promotes a worldwide business ethic for EHS management and sustainable development through example and leadership.

Resources: *Clear Advantage: Building Shareholder Value/Environment: Value to the Investor; Exploring Pathways to a Sustainable Enterprise: SD Planner*™

Global Village: The Institute for Appropriate Technology

184 Schoolhouse Ridge Road
P.O. Box 90
Summertown, TN 38483-0090
(931) 964-2200; fax (931) 964-2200
email: ecovillage@thefarm.org; www.i4at.org

Global Village is a nonprofit organization founded for the purpose of researching promising new technologies that can benefit humanity in environmentally friendly ways. The philosophy of the Institute is that emerging technologies that link the world together are not ethically neutral but often have long-term implications for viability of natural systems, human rights, and our common future.

Resources: Online reports covering topics including buildings, solar devices, and water systems

Green America (formerly Co-op America)

1612 K Street NW, Suite 600
Washington, DC 20006-2810
(800) 58-GREEN; (202) 872-5307;
fax (202) 331-8166
email: info@greenamericatoday.org;
www.greenamericatoday.org

Green America provides economic strategies, organizing power, and practical tools for businesses and individuals addressing social and environmental problems. It focuses on educating and empowering people and businesses to make significant improvements through the economic system.

Resources: *National Green Pages; Real Green* (bimonthly e-newsletter); *Green American; Guide to Socially Responsible Investing*

GreenBlue

600 East Water Street, Suite C
Charlottesville, Virginia 22902-5361
(434) 817-1424; fax (434) 817-1425
email: info@greenblue.org;
www.greenblue.org

GreenBlue is a nonprofit institute that stimulates the creative redesign of industry by focusing the expertise of professional communities to create practical solutions, resources, and opportunities for implementing sustainability. GreenBlue is staffed by scientists, engineers, design professionals, and business strategists who ask, "How can we design, prototype, and realize better products and systems?" GreenBlue was founded in 2002 and its project, the Sustainable Packaging Coalition, was founded in 2004. In late 2006, GreenBlue launched the project CleanGredients and in 2009, GreenBlue acquired the nonprofit organization Metafore.

Resources: *Sustainable Packaging Indicators and Metrics Framework,* various project profiles

The Green Building Initiative (GBI)

2104 SE Morrison Street
Portland, Oregon 97214-2825
(877) GBI-GBI1; fax (503) 961-8991
email: info@thegbi.org; www.thegbi.org

The GBI is a nonprofit organization supported by a broad cross-section of groups and individuals interested in promoting energy-efficient and environmentally sustainable practices in residential and commercial construction. Working closely with the National Association of Home Builders (NAHB) and local home builder associations (HBAs), the GBI provides information on green building approaches that, in addition to being environmentally progressive, are practical and affordable, and Web-based support, such as model guidelines, case studies and online technical assistance, promotional and marketing support for local green building programs, educational seminars for builders and other stakeholders in the building industry, and market research regarding evolving consumer trends and attitudes.

Resources: *Green Globes Assessment Tool; GBI Insight* (e-newsletter)

GreenClips Sustainable Building Design News Digest

Sustainable Design Resources
1395 Lyon Street #7
San Francisco, CA 94115-3333
(415) 928-7941
www.greenclips.com

GreenClips is a summary of news on sustainable building design and related government and business issues. Although GreenClips ceased publication in 2006 the archive of past issues remains available for access on the Internet.

Green Collar Association, Canada

710 Granville Street
PO Box 18532
Vancouver BC, V6Z 1E0
(866) 262-5735

Green Collar Association, USA

PO Box 2093
Washington, DC 20013-2093
(202) 684-3411
email: info@greencollar.org;
www.greencollar.org

Green Collar's mission is to advance the socially responsible economy and promote green collar jobs by aligning the interests of companies, educational institutions, and members of the workforce—including professionals and skilled workers. The Green Collar Association is focused on: building bridges, cross-pollination, creating a fair playing ground, developing next generation leadership, and stimulating profitability.

Resources: *Green Expectations* (email newsletter); digital collection of intellectual output, including journal articles, conference presentations, poster presentations, datasets, bibliographical data, theses and dissertations, teaching materials, white papers, book chapters, and more.

Green Corps

44 Winter Street, 4th Floor
Boston, MA 02108-4765
(617) 426-8506; fax: (617) 292-8057
email: info@greencorps.org;
www.greencorps.org

Green Corps teaches the next generation of environmental leaders the strategies and skills needed to win tomorrow's environmental battles while providing critical field support for today's pressing environmental problems.

Green Depot

LIVE Store
222 Bowery
New York, NY 10012-4216
(800) 538-2008
email: contactus@greendepot.com;
www.greendepot.com

Green Depot supplies environmentally friendly and sustainable building products, services and home solutions. Their mission is to make green building products and services readily accessible so that green building can be easily adopted into standard construction operations.

Green-e Program, Center for Resource Solutions

P.O. Box 29512
San Francisco, CA 94129-0512
(415) 561-2100; fax: (415) 561-2105
email: info@green-e.org; www.green-e.org

Green-e provides an easy way for consumers to quickly identify environmentally superior electricity products in competitive markets. Green-e certifies renewable electricity products that meet the environmental and consumer protection standards established by the program.

Resources: *Green-e Dictionary*; Green-e Renewable Energy Certification Program; Green-e Climate Certification Program

Green Globes Building Environmental Assessments

2104 SE Morrison Street
Portland, Oregon 97214-2825
(877) GBI-GBI1; fax (503) 961-8991
email: info@thegbi.org;
www.greenglobes.com

Green Globes™, originally developed for use in Canada, is an interactive, Web-based, commercial green building assessment protocol that guides the integration of green principles into a building's design. Green Globes™ rates seven areas: project management, site, energy, water, resources, emissions and effluents, and indoor environment.

Resources: Online building self-assessment tool; user guides; case studies

Green Lights/Energy Star Buildings Programs

U.S. Environmental Protection Agency
Energy Star Hotline (6202J)
1200 Pennsylvania Avenue NW
Washington, DC 20460-0001
(202) 775-6650; fax (202) 775-6680
www.energystar.gov

Managed by the Atmospheric Pollution Prevention Division of the EPA, the Green Lights and Energy Star Buildings programs seek to work cooperatively with companies, governments, and other institutions to encourage the use of energy-efficient lighting and other building technologies, including air conditioning and air distribution systems. The

Green Lights program was merged with the Energy Star Program in 1995.

Resources: Several publications

Greenpeace USA

702 H Street NW, Suite 300
Washington, DC 20001-3876
(800) 326-0959; fax (202) 462-4507
email: info@wdc.greenpeace.org;
www.greenpeaceusa.org

Greenpeace is an independent campaigning organization that uses nonviolent direct action and creative communication to expose global environmental problems and to promote solutions that are essential to a green and peaceful future. Emphasis is on campaigns to save ancient forests, stop global warming, expose toxic pollutants, protect the oceans, eliminate the threat of genetic engineering, and end the nuclear age.

Resources: Reports on forests, global warming and energy, toxics, and other topics; *Greenpeace Update* newsletter

Green Plants for Green Buildings (GPGB)

493 S. Highland Avenue
Ukiah, CA 95482-4633
(800) 347-9014
email: info@gpgb.org;
www.greenplantsforgreenbuildings.org/

GPGB is dedicated to bridging the gap between those involved in the development of the LEED rating system and the considerable body of convincing evidence pointing to plants as a naturally green solution to several serious indoor environmental quality concerns.

Resources: LEED Credit Portfolio; indoor plant research library

Green Products

221 East Rocbaar Drive
Romeoville, IL 60446-1163
(877) 474-7481; fax (815) 407-0906
email: info@greenproducts.net;
www.greenproducts.net

Green Products works to bring biobased product innovations from the fields of the farm to the lab and, ultimately, to a building. Emphasis is on developing products for roofing, masonry, and metal. Developer of Environmental Liquid Membrane Systems (ELMS 50 and ELMS Platinum) and a biobased urethane foam adhesive (Naturalock).

The Green Products Association (GPA)

The Green Roundtable/nexus
38 Chauncy Street, 7th Floor
Boston, MA 02111-2321
(617) 374-3740; fax (617) 457-7839
www.nexusboston.org

The GPA connects architects and specifiers with green products and acts as the go-to place for education, training, and networking. They partner with international trade, industry, and media constituents to create a broader platform for manufacturers and distributors to promote their products. The GPA is leading an industry-wide market transformation so that all construction and building operation products meet a continuously increasing level of sustainability throughout their life cycle.

Green Roofs for Healthy Cities (GRHC)

406 King Street East
Toronto, Ontario M5A 1L4
Canada
(416) 971-4494; fax (416) 971-9844
www.greenroofs.org

GRHC works to create a market for green roof products and services in cities throughout North America. It collects and publishes technical data on green roof performance, project, and policy developments.

Resources: *Green Roofs Living Architecture Monitor* (quarterly electronic publication); *Green Roof Professional (GRP) Accreditation Program; The Green Roof Tree of Knowledge* (research and policy database)

Green Seal

1001 Connecticut Avenue NW, Suite 827
Washington, DC 20036-5525
(202) 872-6400; fax (202) 872-4324
email: greenseal@greenseal.org;
www.greenseal.org

Green Seal is a nonprofit organization dedicated to protecting the environment by promoting the manufacture and sale of

environmentally responsible consumer products (including doors, windows, and appliances). It develops environmental standards and awards a Green Seal of Approval to products that cause less harm to the environment than the conventional products they replace.

Resources: Several publications, including standards for environmental consumer products. The website defines standards for environmentally responsible products and provides general information on health concerns, energy efficiency, and so on. A list of products with Green Seal certifications is also provided.

GreenWare Environmental Systems, Inc.

469 King Street West, Suite 200
Toronto, Ontario, M5V 1K4
Canada
(416) 867-9504; fax (416) 367-2653
2425B Channing Way, Suite 590
Berkeley, CA 94704-2209
(800) 474-0627; fax (416) 367-2653
email: greeninfo@greenware.com;
www.greenware.ca, www.greenware.com

GreenWare is a provider of environmental software and professional services to companies and governments worldwide. Their expertise in environmental management systems and auditing, environmental science and technology, business management, and environmental regulation, coupled with technical strengths in information technology, allows them to create powerful software applications for implementing comprehensive environmental management, auditing, and reporting information systems.

Resources: Software: ISO 14000 EMS Series, Perform Series, GreenWare Auditor, GreenWare Environmental Information System (EIS)

Greenwire

E&E Publishing, LLC
122 C Street, NW, Suite 722
Washington, DC 20001-2109
(202) 628-6500; fax (202) 737-5299
www.eenews.net/gw/

Greenwire provides comprehensive daily coverage of environmental and energy politics and policy by subscription.

Healthy Building Network (HBN)

2001 S Street NW, Suite 570
Washington, DC 20009-1176
(877) 974-2767 or (202) 741-5717; fax (202) 898-1612
email: info@healthybuilding.net;
www.healthybuilding.net

The Healthy Building Network prioritizes green building strategies that are closely linked to the goals of the environmental health movement. HBN brings the perspectives of people directly affected by the source, production, use, and disposal of building materials to green building professionals: architects, planners, designers, specifiers, builders, and manufacturers. HBN identifies common interests, advocates careful material selection as a means of improving the quality of life throughout the material life cycle, and coordinates coalitions and campaigns to accelerate the transition to healthier building materials.

Resources: Semi-monthly email newsletter

Holistic Management International (HMI)

101 Tijeras Ave, NW
Albuquerque, NM 87102-2910
(505) 842-5525; fax (505) 843-7900
email: hmi@holisticmanagement.org;
www.holisticmanagement.org

HMI provides, promotes, and teaches holistic land management, which works in concert with natural processes. Holistic management can restore damaged grasslands to health and sustainability and increase the productivity and profitability of ranches and farms. HMI facilitates scientific research on grasslands from around the world.

Resources: *In Practice* (email newsletter)

Human Dimensions of Urban Forestry and Urban Greening

School of Forest Resources, College of the Environment
University of Washington

Box 352100
Seattle, WA 98195-2100
(206) 616-5758; fax (206) 685-0790
email: kwolf@u.washington.edu;
www.naturewithin.info

This project researches peoples' perceptions of and behaviors with respect to nature in cities. Areas of research include nature and consumer environments, trees and transportation, civic ecology, and urban forestry and human benefits.

Resources: Fact sheets, professional publications, and scholarly publications

Idaho National Laboratory (INL) BioEnergy Program

P.O. Box 1625
Idaho Falls, ID 83415-0001
(208) 526-0111
https://inlportal.inl.gov/portal/server.pt?open=512&objID=421&parentname=CommunityPage&parented=4&mode=2

This program, funded by the U.S. Department of Energy (DOE) Office of Energy Efficiency & Renewable Energy's Biomass Program, conducts research into using entire crops, including the grain and traditionally discarded plant biomass, to product food, feed, fiber, and energy.

Resources: Biomass reports, fact sheets, and articles

The Institute for Earth Education

Cedar Cove
Greenville, WV 24945
(304) 832-6404; fax (304) 832-6077
email: IEE1@aol.com;
www.eartheducation.org

The Institute is a nonprofit, volunteer organization made up of an international network of individuals and member organizations that develops and disseminates educational programs to promote harmony with the Earth. Emphasis is on Earth education program development and support for teachers and leaders.

Resources: *The Earth Education Sourcebook*

Institute for Local Self-Reliance (ILSR)

2001 S Street NW, Suite 570
Washington, DC 20009-1176 (202) 898-1610
email: info@ilsr.org; www.ilsr.org

ILSR works with nonprofit organizations, businesses, and government toward self-reliance through resource management. It offers technical assistance, organizes conferences, conducts research, analyzes public policy issues, and disseminates information.

Resources: Numerous publications

Institute of Scrap Recycling Industries, Inc. (ISRI)

1650 L Street NW, Suite 600
Washington, DC 20036-5610
(202) 662-8500; fax (202) 626-0900
email: isri@isri.org; www.isri.org

This trade association represents processors, brokers, and consumers of scrap commodities, including metals, paper, plastics, glass, and textiles, as well as suppliers of equipment and services to the industry.

Resources: *SCRAP* (bimonthly magazine)

Institute for Bau-Biologie and Ecology (IBE)

P.O. Box 738
Lyles, TN 37098-0738
(866) 960-0333; fax (727) 441-4373
email: infopod@buildingbiology.net;
http://buildingbiology.net/

The Institute focuses on the education of the building industry and the public regarding healthy houses. Emphasis is on electromagnetic radiation and the offgassing of building materials.

Resources: Online and correspondence courses on indoor climate, electrosmog, and building

International Institute for Sustainable Development (IISD)

75 Albert Street, Suite 903
Ottawa, Ontario K1P 5E7
Canada
(613) 238-2296; fax (613) 238-8515
email: info@iisd.org; www.iisd.org

IISD promotes sustainable development in decision making within government, business, and the daily lives of individuals. Emphasis is on policy research, international trade, business strategy, and national budgets.

Resources: Publications

Interstate Renewable Energy Council (IREC)

P.O. Box 1156
Latham, NY 12110-1156
(518) 458-6059; fax (518) 458-6059
email: info@irecusa.org; www.irecusa.org

The IREC's mission is to accelerate the sustainable utilization of renewable energy sources and technologies in and through state and local government and community activities. IREC's programs include the Going Solar/PV4You program, Connecting to the Grid Project, the Schools Going Solar Information Clearinghouse, community outreach, *Small Wind Energy News*, and Annual Renewable Energy Recognition Awards.

Resources: Database of State Incentives for Renewable Energy (DSIRE); *Small Wind Energy* (newsletter); publications and reports

Investor Responsibility Research Center Institute (IRRCi) 44th Fl

New York, NY 10005-1427
fax (646) 778-4192
www.irrcinstitute.org/

IRRCi is the leading source of high-quality, impartial information on corporate governance and social responsibility. Founded in 2006, IRRCi provides proxy research and analysis, benchmarking products, and proxy voting services to more than 500 institutional investors, corporations, law firms, foundations, academics, and organizations.

Journal of Industrial Ecology

Published by Wiley-Blackwell Journals
350 Main Street
Malden, MA 02148-5020
(800) 835-6770; fax (617) 258-6779
email: cs-journals@wiley.com;
/www.wiley.com/bw/journal.asp?ref=1088-1980&site=1

An international, peer-reviewed, multidisciplinary quarterly designed to foster both understanding and practice in the emerging field of industrial ecology. The journal addresses a series of related topics: material and energy flows studies ("industrial metabolism"); dematerialization and decarbonization; life cycle planning, design and assessment; design for the environment; extended producer responsibility ("product stewardship"); eco-industrial parks ("industrial symbiosis"); product-oriented environmental policy; and eco-efficiency.

Keep America Beautiful, Inc. (KAB)

1010 Washington Boulevard
Stamford, CT 06901-2202
(203) 659-3000; fax (203) 659-3001
email: info@kab.org; www.kab.org

KAB is dedicated to litter and graffiti prevention, beautification, waste minimization, and community improvement. It is a national organization with over 1000 local affiliates and organizations.

Resources: *Bin Buzz* (quarterly newsletter); annual reviews; *Great American Cleanup Report*; *Community Matters* (e-newsletter)

Lady Bird Johnson Wildflower Center

The University of Texas at Austin
4801 La Crosse Avenue
Austin, TX 78739-1702
(512) 232-0100; fax (512) 232-0156
www.wildflower.org

The center is dedicated to native plants. Their vision for the future is to preserve and restore the natural beauty and biological richness of North America by inspiring people to love the land. They encourage people to think differently about the plants around them. They want people to understand the role of native plants in a healthy ecosystem, to value the beauty and health of the natural landscape that defines their heritage, and to take action to protect, conserve, and restore the natural landscapes of North America.

Resources: *Wildflower* (quarterly magazine); The *Wildflower Wire* (monthly email newsletter); Native Plant Information Network (searchable database)

The Land Institute
2440 East Water Well Road
Salina, KS 67401-9051
(785) 823-5376; fax (785) 823-8728
email: info@landinstitute.org;
www.landinstitute.org

The Institute has worked for over 30 years on the problem of agriculture. Its purpose is to develop an agricultural system with the ecological stability of the prairie and a grain yield comparable to that of annual crops. The institute is working to establish Natural Systems Agriculture as a new paradigm for food production, where nature is mimicked rather than subdued and ignored.

Resources: Publications

Land Trust Alliance (LTA)
1660 L Street, NW, Suite 1100
Washington, DC 20036-5635
(202) 638-4725; fax (202) 638-4730
email: info@lta.org;
www.landtrustalliance.org/

The alliance provides technical assistance for land trusts and other land conservation professionals, fosters public policies supportive of land conservation, and builds public awareness of land trusts and their goals.

Resources: *Saving Land (*quarterly magazine); Searchable Online Directory of Land Trusts; various publications

League of Conservation Voters (LCV)
1920 L Street NW, Suite 800
Washington, DC 20036-5045
(202) 785-8683; fax (202) 835-0491
email: feedback@lcv.org; www.lcv.org

The league is a national, nonpartisan organization that seeks to have pro-environmental issues better represented in the U.S. Congress. Emphasis is on endorsing and supporting candidates for election to the U.S. House and Senate.

Resources: *LCV Insider* (electronic newsletter)

Local Power Inc.
35 Grove Street, #118
San Francisco, CA 94102-4741
(510) 451-1727; fax (415) 358-5760
www.local.org

Local Power Inc. is an energy service bureau that helps cities adopt, implement and manage Community Choice Aggregation (CCA) energy networks. LPI's founders created CCA, Solar Bonds, and other major tools for green cities.

National Aeronautics and Space Administration (NASA)
Langley Research Center
Atmospheric Science Data Center (ASDC)
Hampton, VA 23681-2199
(757) 864-8656
email: larc@eos.nasa.gov;
http://eosweb.larc.nasa.gov/

The ASDC is responsible for processing, archiving, and distributing NASA's earth science data in the areas of radiation budget, clouds, aerosols, and tropospheric chemistry. The Data Center specializes in atmospheric data important to understanding the causes and processes of global climate change and the consequences of human activities on the climate.

Resources: Various publicly-accessible databases relating to the climate

The National Arbor Day Foundation
100 Arbor Avenue
Nebraska City, NE 68410-1067
(888) 448-7337; fax (402) 474-0820
www.arborday.org

The foundation is dedicated to tree planting and environmental stewardship. Emphasis is on community programs such as Trees for America and the National Arbor Day Program.

Resources: *Arbor Day*

National Association of Conservation Districts (NACD)
509 Capitol Court NE
Washington, DC 20002-4946
(202) 547-6223; fax (202) 547-6450
www.nacdnet.org

The association promotes conservation, management, and orderly development of the natural resources of the United States.

Resources: *Forestry Notes*

National Association of Regulatory Utility Commissioners (NARUC)

1101 Vermont NW, Suite 200
Washington, DC 20005-3504
(202) 898-2200; fax (202) 898-2213
email: admin@naruc.org; www.naruc.org

The Association provides links to state public utility commissions and other industry and association sites. It also features news items on regulatory issues.

National Audubon Society

225 Varick Street
New York, NY 10014-4396
(212) 979-3000; fax (212) 979-3188
www.audubon.org

The society focuses on protecting wildlife and its habitats through research, lobbying, litigation, and citizen action. Emphasis is on ancient forests, wetlands, endangered species, Arctic National Wildlife Refuge, Platte River, the Everglades, and the Adirondack Park.

Resources: *Audubon* (magazine)

The National Center for Appropriate Technology (NCAT)

P.O. Box 3838
Butte, MT 59702
(800) ASK-NCAT; fax (406) 494-2905
email: moreinfo@ncat.org; www.ncat.org

The center helps people and communities adopt technologies that save energy and resources. Offers information on energy services, sustainable energy, sustainable food/agriculture, farm energy, and climate change.

Resources: *NCAT Action* (e-newsletter); other e-newsletters on various topics; presentations on various topics

The National Coalition Against the Misuse of Pesticides (Beyond Pesticides)

701 E Street SE, Suite 200
Washington, DC 20003-2803
(202) 543-5450; fax (202) 543-4791
email: info@beyondpesticides.org;
www.beyondpesticides.org

The coalition works to protect public health and the environment by leading a transition to a world free of toxic pesticides. The coalition identifies the risks of conventional pest management practices and promotes nonchemical and least hazardous management alternatives.

Resources: Several publications; fact sheets; searchable pesticides database

National Energy Information Center (NEIC)

EI 30, 1000 Independence Avenue SW
Washington, DC 20585-0001
(202) 586-8800; fax (202) 586-0114
email: infoctr@eia.doe.gov; www.eia.doe.gov

EIC is an office within the Energy Information Administration (EIA), responsible for the dissemination of information related to all types of energy sources. The EIA, created by Congress in 1977, is a statistical agency of the U.S. Department of Energy. The center provides policy-independent data, forecasts, and analyses to promote sound policymaking, efficient markets, and public understanding regarding energy and its interaction with the economy and the environment.

Resources: Several publications

National Environmental Balancing Bureau (NEBB)

8575 Grovemont Circle
Gaithersburg, MD 20877-4121
(301) 977-3698; fax (301) 977-9589
www.nebb.org

NEBB is a professional organization of consultants and contractors in the HVAC and mechanical profession. Many provide commissioning services.

Resources: Several publications

National GroundWater Association (NGWA)

601 Dempsey Road
Westerville, OH 43081-8978
(800) 551-7379, (614) 898-7791;
fax (614) 898-7786
email: ngwa@ngwa.org; www.ngwa.org

NGWA is a nonprofit international professional society for the groundwater industry. It provides leadership and guidance for sound, scientific, and economic management of underground resources.

Resources: *Water Well Journal; GroundWater Monitoring and Remediation; GroundWater*

National Lead Information Center (NLIC)

422 South Clinton Avenue
Rochester, NY 14620-1103
(800) 424-LEAD, fax: (585) 232-3111
www.epa.gov/lead/nlic.htm

The NLIC provides the general public and professionals with information about lead hazards and their prevention.

Resources: Several online publications

National Pesticide Information Network (NPTN)

Oregon State University
333 Weniger Hall
Corvallis, OR 97331-6502
(800) 858-PEST; fax (541) 737-0761
email: npic@ace.orst.edu;
http://npic.orst.edu/index.html

The network provides information about pesticides and how to recognize and respond to poisonings.

Resources: *Pesticide Fact Sheets* (available on website); *Hot Topics* (available on website); *Medical Case Profiles* (available on website); *NPIC InfoBase Search* (searchable database libraries)

National Pollution Prevention Roundtable (NPPR)

11 Dupont Circle NW, Suite 201
Washington, DC 20036-1217
(202) 299-9701; fax (202) 299-9704
email: staff@p2.org; www.p2.org

The NPPR is the largest membership organization in the United States devoted solely to pollution prevention (P2). NPPR acts as a window on the P2 community. Its mission is to provide a national forum for promoting the development, implementation, and evaluation of efforts to avoid, eliminate, or reduce pollution at the source (i.e., source reduction instead of traditional end-of-pipe methods). NPPR's members include the country's preeminent P2 experts from regional resource centers, state and local government programs, small business assistance networks, nonprofit groups, industry associations, and federal agencies.

Resources: *National Programs Directory* (online tool for locating pollution prevention business assistance and services)

The National Safety Council's Environmental Health & Safety (NSC)

1025 Connecticut Avenue NW, Suite 1200
Washington, DC 20036-5415
(800) 505-2270; fax (202) 293-0032
www.nsc.org/safety_home/Resources/Pages/EnvironmentalHealthandSafety.aspx

The NSC fosters improved public understanding of significant health risks and challenges facing modern society. Topics include radon, lead poisoning, sun safety, and radiation.

Resources: Fact sheets, buyer's guide, NSC list servs

National Solid Wastes Management Association (NSWMA)

4301 Connecticut Avenue NW, Suite 300
Washington, DC 20008-2304
(202) 244-4700; fax (202) 966-4824
email: membership@nswma.org;
www.nswma.org

NSWMA is a trade association representing for-profit companies in North America that provide solid, hazardous, and medical waste collection, recycling and disposal services, and companies that provide professional and consulting services to the waste services industry.

Resources: *Waste Age* (monthly magazine); *Waste News* (biweekly newspaper and Web publication); *Waste Age* fact sheets about items in the waste stream

National Trust for Historic Preservation

1785 Massachusetts Avenue NW
Washington, DC 20036-2117
(800) 944-6847; fax (202) 588-6038
www.preservationnation.org/

The Trust fosters an appreciation of the diverse character and meaning of the U.S. cultural heritage and preserves and revitalizes the livability of communities by saving America's historic environments. The Trust is a privately funded nonprofit organization that provides leadership, education, advocacy, and resources to save diverse historic places and revitalize communities.

Resources: *Historic Preservation* (bimonthly magazine); *Forum Journal* (quarterly journal); *Preservation Atlas, Forum News* (bimonthly newsletter)*; Preservation Policy* newsletter; *Legal Defense Fund* newsletter; books and brochures

National Wildlife Federation (NWF)

11100 Wildlife Center Drive
Reston, VA 20190-5362
(800) 822-9919; fax (703) 790-4040
www.nwf.org

The NWF promotes conservation, responsible use of natural resources, and protection of the global environment. It distributes education materials, sponsors nature programs, lobbies Congress, and litigates environmental disputes. Emphasis is on endangered species, forests, wetlands and water resources, grazing and mining reform, biotechnology, toxic pollution sunsetting, and backyard habitat programs.

Resources: *National Wildlife* (bimonthly magazine); *Wildlife Online* (monthly e-newsletter)

Native Seeds/SEARCH

3061 N. Campbell Avenue
Tucson, AZ 85719-2816
(520) 622-5561; fax (520) 622-5591
email: info@nativeseedsorg;
www.nativeseeds.org

Native Seeds/SEARCH is a nonprofit conservation organization that works to conserve, distribute, and document the adapted and diverse varieties of agricultural seed, their wild relatives, and the role these seeds play in cultures of the American Southwest and northwest Mexico.

Resources: *Native Seed/SEARCH Seed Listing; Seedhead News* (quarterly newsletter); *e-lert* updates

Natural Resources Defense Council (NRDC)

40 West Twentieth Street
New York, NY 10011-4217
(212) 727-2700; fax (212) 727-1773
email: nrdcinfo@nrdc.org; www.nrdc.org

This organization protects U.S. natural resources through legal action, scientific research, and citizen education. Emphasis is on energy policy and nuclear safety, air and water pollution, urban transportation issues, pesticides and toxic substances, forest protection, global warming, and the international environment. Website features a page on green business that includes green business guides and green building.

NRDC Building Green Website

(www.nrdc.org/buildinggreen/default.asp)

This part of the NRDC website is devoted to high-performance buildings.

Resources: *Unearth* (quarterly magazine); *Nature's Voice* (bimonthly bulletin); *NRDC Reports*; email bulletins

The Natural Step (TNS)

SW 2nd Ave, Suite 302
Portland, OR 97204-3526
(503) 241-1140; fax (503) 546-6825
email: info@thenaturalstep.org;
www.thenaturalstep.org/usa

TNS is an educational organization that uses consensus building to help guide businesses, communities, governmental agencies, and individuals toward sustainability.

Resources: *The Natural Step for Communities*; *Stepping* Stones newsletter; case studies, other publications

The Nature Conservancy

4245 North Fairfax Drive, Suite 100
Arlington, VA 22203-1606
(703) 841-5300; fax (703) 841-1283
email: comment@tnc.org; www.nature.org/

This organization works to conserve plants, animals, and natural communities that represent the diversity of life on Earth by protecting the habitats they need to survive. It manages a system of more than 1,300 nature sanctuaries in all 50 states. Emphasis is on demonstrating that biodiversity protection can also accommodate human economic and cultural needs.

Resources: *Nature Conservancy* (magazine); *Great Places* (e-newsletter)

New Buildings Institute (NBI)

P.O. Box 2349
142 East Jewett Boulevard
White Salmon, WA 98672-2349
(509) 493-4468; fax (509) 493-4078
email: info@newbuildings.org;
www.newbuildings.org

The Institute promotes energy efficiency in buildings through policy development, research, guidelines, and codes.

Resources: *Advanced Lighting Guidelines; Skylight and Light Well Photometrics; LEED Energy Performance Study;* reports; e-newsletter

New Rules Project, Institute for Local Self-Reliance

1313 Fifth Street SE, Suite 303
Minneapolis, MN 55414-4513
(612) 379-3815; fax (612) 379-3920
email: bailey@ilsr.org; www.newrules.org

This organization works to establish new rules at the local level to build community by supporting humanly scaled politics and economics and to begin viewing communities and regions as places that nurture active and informed citizens. Topics covered include the environment and energy.

Resources: Reports and publications

Northeast Recycling Council (NERC)

139 Main Street, Suite 401
Brattleboro, VT 05301-2800
(802) 254-3636; fax (802) 254-5870
email: info@nerc.org; www.nerc.org/

NERC provides information on regional recycling issues and state programs.

Resources: *Environmental Benefits Calculator; NERC Email Bulletin; Reuse Marketplace* multi-state materials exchange network

Northeast Sustainable Energy Association (NESEA)

50 Miles Street
Greenfield, MA 01301-3241
(413) 774-6051; fax (413) 774-6053
email: nesea@nesea.org; www.nesea.org

NESEA promotes energy efficiency, sustainable energy design, and the use of renewable energy. It sponsors annual conferences on green building. NESEA offices are in the Northeast Sustainability Center, an evolving project that will serve as a renewable energy design model.

Resources: *Northeast Sun* (quarterly magazine); *Sustainable Green Pages Directory*; Resource Library for Professionals

Nuclear Information and Resource Service (NIRS)

6930 Carroll Avenue, Suite 340
Takoma Park, MD 20912-4446
(301) 270-6477; fax (301) 270-4291
email: nirsnet@nirs.org; www.nirs.org

NIRS serves as a networking information clearinghouse for environmental activists concerned with nuclear power and waste issues. Emphasis is on challenging radioactive waste policy, publication of energy audit manual for towns and universities, and preventing new nuclear reactors.

Resources: *The Nuclear Monitor* (monthly newsletter); fact sheets

The Ocean Conservancy

1300 19th Street NW, 8th Floor
Washington, DC 20036-1653
(800) 519-1541, (202) 429-5609;
fax (202) 872-0619
email: info@oceanconservancy.org;
www.oceanconservancy.org

The Ocean Conservancy promotes healthy and diverse ocean ecosystems and opposes practices that threaten ocean life and human life. Through research, education, and science-based advocacy, the conservancy informs, inspires, and empowers people to speak and act on behalf of the oceans.

Resources: Monthly e-newsletter; *Ocean Conservancy (*quarterly magazine)

Oikos Green Building Source

Published by Iris Communications, Inc.
P.O. Box 6498
Bend, OR 97708-6498
(541) 647-2449; fax (541) 647-2469
email: info@oikos.com; http://oikos.com

This website is dedicated to sustainable and energy-efficient construction.

Resources: *Green Building News* (newsletter); searchable green product database; green building library

Penn State Lean and Green Initiative

Department of Architectural Engineering
104 Engineering Unit A
University Park, PA 16802-1416
(814) 863-2080
email: aegeneral@engr.psu.edu;
www.engr.psu.edu/leanandgreen/

The Initiative develops high-performance processes for high-performance building projects. Its goal is to incorporate the waste elimination principles of lean production into the project processes of green projects to create high-performance processes.

Resources: *Field Guide for Sustainable Construction;* various publications

The Pharos Project

Healthy Building Network
2001 S Street NW, Suite 570
Washington, DC 20009-1176
(202) 741-5717 or (877) 974-2767;
fax: (202) 898-1612
www.pharosproject.net

The Pharos Project is a subscription-based service that connects the user to a network of building professionals and manufacturers committed to transparency as a core value on the path to sustainability. Pharos provides health and environmental data about the manufacture, use, and end of life of building materials specified and used every day.

Resources: Materials database

Photovoltaic Systems Research and Development Program

Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM 87185-1110
(505) 844-1548
email: pvsac@sandia.gov;
http://photovoltaics.sandia.gov/

The Program works with the U.S. photovoltaic industry, the U.S. Department of Energy, the National Renewable Energy Laboratory, other government agencies, and international organizations to increase the worldwide use of photovoltaic power systems by reducing cost, improving reliability, increasing performance, removing barriers, and growing markets.

Resources: Sun♦Lab photo database; system design tools; various electronic publications; fact sheets

Physicians for Social Responsibility (PSR)

1875 Connecticut Avenue, Suite 1012
Washington, DC 20009-5747
(202) 667-4260; fax (202) 667-4201
email: psrnatl@psr.org; www.psr.org

PSR is committed to eliminating weapons of mass destruction, preserving a sustainable environment, and reducing violence and its causes. It uses its members' expertise and professional leadership influence within the medical community and strong links to policymakers to address threats to human welfare and survival. PSR is the U.S. affiliate of International Physicians for the Prevention of Nuclear War, a network of physicians in over 80 countries. They work to protect people from environmental health hazards; to shift government spending priorities away from wasteful military expenditures; to educate the medical community, public, policymakers, and the media about the human costs of unnecessary military spending and the environmental crisis; to research the health effects of environmental degradation; and to

promote international cooperation and local community action.

Resources: *PSR Reports* (members-only newsletter); *Environment and Health Activist* (newsletter); *PSR Monitor* (monthly electronic newsletter)

Population Action International (PAI)

1300 Nineteenth Street NW, Suite 200
Washington, DC 20036-1624
(202) 557-3400; fax (202) 728-4177
email: pai@popact.org;
www.populationaction.org

PAI promotes public awareness, population growth reduction programs, and voluntary access to family planning services. Emphasis is on the relationship between population and environmental degradation.

Resources: Several publications

Population Connection (formerly Zero Population Growth)

2120 L Street NW, Suite 500
Washington, DC 20037-1534
(800) POP-1956 (202) 332-2200;
fax (202) 332-2302
email: info@populationconnection.org;
www.populationconnection.org

Population Connection supports efforts to create a sustainable society, both in the United States and worldwide, that integrates an awareness of the central role population plays in meeting this objective. Specifically, for the United States, these include efforts to conserve energy and natural resources and improve efficiency, eliminate the "disposable society" lifestyle, and use the best possible technology to protect the natural and human environment.

Resources: Fact sheets; factoids; *The Reporter* (tri-annual magazine)

President's Council on Sustainable Development (PCSD)

http://clinton5.nara.gov/PCSD/

This legacy site contains information developed by the PCSD during the 1990s on sustainable development. Site provides information on sustainable development and governmental policy in the United States.

Resources: Various publications

Product Stewardship Institute (PSI)

29 Stanhope Street
Boston, MA 02116-5111
(617) 236-4855; fax (617) 236-4766
email: scott@productstewardship.us;
www.productstewardship.us

PSI is a national nonprofit membership-based organization that works with state and local government agencies to partner with manufacturers, retailers, environmental groups, federal agencies, and other key stakeholders to reduce the health and environmental impacts of consumer products. PSI takes a unique product stewardship approach to solving waste management problems by encouraging product design changes and mediating stakeholder dialogues.

Resources: Quarterly newsletter; *Recycled Paint Standard*; various publications

Public Citizen (PC)

1600 Twentieth Street NW
Washington, DC 20009-1001
(202) 588-1000
www.publiccitizen.org

Public Citizen fights for clean, safe, and sustainable energy sources and for strong health, safety, and environmental protections.

Resources: Various publications on energy

Public Employees for Environmental Responsibility (PEER)

2000 P Street NW, Suite 240
Washington, DC 20036-6924
(202) 265-7337; (202) 265-4192
email: info@peer.org; www.peer.org

PEER is a national nonprofit alliance of local, state, and federal scientists, law enforcement officers, land managers, and other professionals dedicated to upholding environmental laws and values. Emphasis is on monitoring natural resource management agencies and informing the administration, Congress, state officials, media, and the public about substantive environmental issues.

Resources: *White Papers; PEEReview* (quarterly newsletter); Peermail (bi-weekly e-publication); agency surveys

Rails-to-Trails Conservancy (RTC)
The Duke Ellington Building
2121 Ward Ct., NW, 5th Floor
Washington, DC 20037-1251
(202) 331-9696; fax (202) 331-9680
email: RTCMail@Transact.org;
www.railstotrails.org/index.html

The Conservancy seeks to convert thousands of miles of abandoned railroad corridors to public trails for walking, bicycling, horseback riding, cross-country skiing, wildlife habitat, and nature appreciation. Emphasis is on linking major metropolitan areas via rail-trails.

Resources: *Rails-to-Trails Magazine* (quarterly); RTC online library; other publications

Rainforest Action Network (RAN)
221 Pine Street, 5th Floor
San Francisco, CA 94104-2788
(415) 398-4404; fax (415) 398-2732
email: answers@ran.org; www.ran.org

The network campaigns for forests, their inhabitants, and the natural systems that sustain life by transforming the global marketplace through grassroots organizing, education, and nonviolent direct action. Emphasis is on protecting old-growth forests from logging.

Resources: *Guide to Tree-Free, Recycled, and Certified Papers; Cut Waste, Not Trees: A Wood Use Reduction Guide; Guide to Endangered Trees; The Panther* (quarterly e-magazine)

Rainforest Alliance
665 Broadway, Suite 500
New York, NY 10012-2331
(888) MY-EARTH (212) 677-1900;
fax (212) 677-2187
email: info@ra.org;
www.rainforest-alliance.org

The alliance promotes the conservation of the world's tropical forests by developing sound alternatives to the activities that cause tropical deforestation. It also provides public education for conservation. Emphasis is on Smart Wood certification, medicinal plant projects, and nontimber forest products.

Resources: *The Canopy* (monthly online publication); *Eco-Exchange; Rainforest Matters* (email newsletter); *RA Perspectives; Profiles in Sustainability;* handbooks and manuals

Reef Relief, Inc.
631 Greene Street
Key West, FL 33040-6624
(305) 294-3100; fax (305) 293-9515
email: info@reefrelief.org;
http://reefrelief.org/

Reef Relief preserves and protects living coral reef ecosystems of the Florida Keys. Emphasis is on educating the public and policymakers to achieve conservation, protection, and restoration of the coral reefs.

Resources: *Reef Line* (quarterly newsletter)

Renewable Energy Policy Project (REPP)
1612 K Street, NW, Suite 202
Washington, DC 20006-2805
(202) 293-2898; fax (202) 293-5857
email: gsterzinger@repp.org; www.repp.org

REPP supports the advancement of renewable energy technology through policy research. REPP seeks to define growth strategies for renewables that respond to competitive energy markets and environmental needs. Since its inception in 1995, REPP has investigated the relationship among policy, markets, and public demand in accelerating the deployment of renewable energy, which include biomass, hydropower, geothermal, photovoltaic, solar thermal, wind, and renewable hydrogen. The organization offers a platform from which experts in the field can examine issues of medium-to long-term importance to policymakers, green energy entrepreneurs, and environmental advocates.

Resources: Various publications on hydro, bioenergy, geothermal, wind, solar, and hydrogen energy

Rocky Mountain Institute (RMI)
2317 Snowmass Creek Road
Snowmass, CO 81654-9118
(970) 927-3851; fax (927) 927-3420
www.rmi.org

RMI consults and researches increased energy efficiency in buildings while addressing building and community design, comfort, and health. RMI's research leads to the development of free online tools, books, videos, and interactive web tools.

Resources: *RMI Solutions Journal* (quarterly journal); *Natural Capitalism online resources*; case studies; Green Footstep online carbon calculator; other publications

Save the Dunes Conservation Fund

444 Barker Road
Michigan City, IN 46360-7426
(219) 879-3937; fax (219) 872-4875
email: std@savedunes.org;
www.savedunes.org

The fund works to protect the Indiana dunes for public use and enjoyment by promoting the control of air, water, and waste pollution. Emphasis is on erosion and policy issues affecting the Indiana Lake Michigan shoreline, wetlands preservation, and groundwater protection.

Resources: Newsletter

Scenic America

1250 I Street NW, Suite 750
Washington, DC 20005-3910
(202) 638-0550; fax (202) 638-3171
email: scenic@scenic.org; www.scenic.org

This organization works to preserve the scenic quality of America's communities and countryside. It provides information and technical assistance on scenic byways, tree preservation, economics of aesthetic regulation, and billboard and sign control.

Resources: *Scenic Overlook* (monthly online newsletter); technical bulletins; *Facts for Action;* case studies

Scientific Certification Systems, Inc. (SCS)

2200 Powell Street, Suite 725
Emeryville, CA 94608-1955
(510) 452-8000; fax (510) 452-8001
www.scscertified.com

SCS is a for-profit, third-party certification organization that evaluates and certifies environmental claims made by manufacturers. Manufacturers may include the SCS label on their products. SCS does not release proprietary information but does share the standards and processes used for evaluation. For example, the Forest Stewardship Council principles are used for the SCS Forestry Program. SCS also develops standards to test against.

Resources: Environmental Claims Program List of Certified Products and Claims; Forestry Management Program information; Greenhouse Gas (GHG) Inventory; National Climate Standard, LCA Standard, Green products certification

Sierra Club

85 Second Street, 2nd Floor
San Francisco, CA 94105-3456
(415) 977-5500; fax (415) 977-5799
email: information@sierraclub.org;
www.sierraclub.org

The Sierra Club protects the wild places of the Earth and promotes the responsible use of ecosystems and resources by educating the public. Emphasis is on old-growth forest protection, global warming, wilderness/national parks protection, toxic waste regulations, and international development lending.

Resources: *Sierra* (magazine); *Sierra Club Insider* (twice-monthly e-newsletter)

Smart Growth Network (SGN)

International City/County Management Association
777 North Capitol Street NE, Suite 500
Washington, DC 20002-4290
(202) 962-3623
email: smartgrowth@icma.org;
www.smartgrowth.org

The SGN works to encourage development that serves the economy, the community, and the environment. It raises public awareness of how growth can improve community quality of life; promotes smart growth best practices; develops and shares information, innovative policies, tools, and ideas; and cultivates strategies to address barriers to and advance opportunities for smart growth.

Resources: *Getting Smart!* (bimonthly electronic newsletter); case studies; reports

Soil and Water Conservation Society

945 SW Ankeny Road
Ankeny, IA 50023-9723
(515) 289-2331; fax (515) 289-1227
email: swcs@swcs.org; www.swcs.org

The society promotes the conservation of soil, water, and related natural resources.

Resources: *The Journal of Soil and Water Conservation*; *Conservogram* (monthly e-newsletter); *Advocacy Publications*

South Coast Air Quality Management District (AQMD)

21865 Copley Drive
Diamond Bar, CA 91765-4178
(800) CUT-SMOG (909) 396-2000
www.aqmd.gov

This organization provides public information, governing board agenda, minutes and committee agendas, rules and regulations, business assistance.

Resources: *AQMD Rules and Regulations; Rule 1168 "Adhesive and Sealant Applications"*; newsletters, fact sheets, brochures

Southwest Network for Environmental and Economic Justice (SNEEJ)

P.O. Box 7399
Albuquerque, NM 87194-7399
(505) 242-0416; fax (505) 242-5609
email: info@sneej.org; www.sneej.org

The network supports the direct link between economic and environmental issues. It brings together activists and grassroots organizations to address social, racial, and economic injustices.

Resources: E-newsletter; corridor map; reports

Steel Recycling Institute (SRI)

680 Andersen Drive
Pittsburgh, PA 15220-2700
(800) 876-7274 (412) 922-2772;
fax (412) 922-3213
email: sri@recycle-steel.org;
www.recycle-steel.org

SRI educates the solid waste industry, government, businesses, and, ultimately, consumers about the benefits of steel's recycling cycle. Emphasis is on recycling construction materials and LEED certification.

Resources: Fact sheets; educational resources; Steel Recycling database

The Student Conservation Association, Inc. (SCA)

P.O. Box 550
Charlestown, NH 03603-0550
(603) 543-1700; fax (603) 543-1828
www.thesca.org/

The SCA provides educational opportunities for volunteers to assist with the stewardship of public lands and natural resources. Emphasis is on encouraging youth (particularly minorities and women) to pursue careers in conservation and resource management.

Resources: *The Green Way* (quarterly newsletter)

Sustainable ABC

P.O. Box 30085
Santa Barbara, CA 93130-0085
(805) 898-9660; fax (805) 898-9199
www.sustainableabc.com

This website is devoted to exploring the relationship between ecology and sustainability. It works to educate the public and design professionals about sustainable construction, architecture, and environmental protection.

Resources: *Green and Healthy Building Materials Online Product Directory;* newsletter

Sustainable Building Industry Council (SBIC)

1112 Sixteenth Street NW, Suite 240
Washington, DC 20036-4818
(202) 628-7400; fax (202) 393-5043
email: sbic@sbicouncil.org; www.psic.org

SBIC is an independent, nonprofit organization whose mission is to advance the design, affordability, energy performance, and environmental soundness of U.S. buildings.

Resources: *Green Building Guidelines: Meeting the Demand for Low-Energy,*

Resource-Efficient Homes; High-Performance School Buildings Resource and Strategy Guide; Energy-10 software

Sustainable Forestry Initiative Inc. (SFIB)

900 17th Street, NW, Suite 700
Washington, DC 20006-2515
(202) 596-3450; fax (202) 596-3451
email: contact@aboutsfb.org;
www.aboutsfb.org

The SFI is a fully independent, charitable organization dedicated to promoting sustainable forest management. They work with conservation groups, local communities, resource professionals, landowners, and countless other organizations and individuals who share their passion for responsible forest management.

Resources: Certification audit reports; Sustainable Forestry Initiative (SFI) Standard; newsletter

Thomas Legislative Information on the Internet

The Library of Congress
101 Independence Avenue SE
Washington, DC 20540-1000
(202) 707-5000
email: Thomas@loc.gov;
http://thomas.loc.gov/

This searchable database, established in 1995, stores bill text, *Congressional Record* text, bill summaries and status, *Congressional Record* index, the Constitution, and public laws by number.

TreePeople

12601 Mulholland Drive
Beverly Hills, CA 90210-1332
(818) 753-4600; fax (818) 753-4635
email: info@treepeople.org;
www.treepeople.org/

TreePeople's mission reaches far beyond the simple act of planting a tree. K-12 education programs raise environmental awareness, also enrich academic lessons, and teach potent life skills. Forestry programs restore watersheds and fragile habitats, heal innercity communities, bring neighbors together, establish cool and green campuses, and address serious urban issues such as water and energy conservation, flood prevention, and stormwater pollution. The T.R.E.E.S. project works to change the nation's approach to urban watershed management, motivating other cities to adopt best management practices.

Resources: *Seedling News* (quarterly newsletter); other publications

Triangle J Council of Governments

4307 Emperor Boulevard, Suite 110
P.O. Box 12276
Research Triangle Park, NC 27709-2276
(919) 549-0551; fax (919) 549-9390
email: tjcog@tjcog.org; www.tjcog.dst.nc.us

The organization works to meet the region's needs in a wide range of areas, from land-use planning, economic development, and emergency medical services support to environmental protection, programs for the aging, and information services. It is also a leader in construction and demolition waste reduction efforts and has published *WasteSpec*, a manual to help architects and engineers specify waste reduction and recycling measures before construction projects begin.

Resources: *WasteSpec;* North Carolina Green Building Technology (NC GBT) database, *High-Performance Guidelines: Triangle Region Public Facilities; COG Connection* (newsletter)

Tropical Forest Foundation (TFF)

2121 Eisenhower Avenue, Suite 200
Alexandria, VA 22314-4688
(703) 518-8834; fax (703) 518-8974
email: tff@igc.org;
www.tropicalforestfoundation.org

The foundation is a nonprofit, educational institution dedicated to the conservation of tropical forests through sustainable forestry. TFF is widely recognized for establishing demonstration models and training schools to show the advantages and teach the principles of sustainable forest management and reduced-impact logging (RIL). TFF's *Legal Verified with Chain of Custody® (CoC)*

program provides a standard for legality and helps with independent auditing to confirm to customers and authorities that tropical wood products are legal for sale in countries around the world. This program is the first step toward achieving full compliance with the RIL Verified Standard®.

Resources: *TFF Newsletter; RIL Standard*

The Trust for Public Land (TPL)

116 New Montgomery Street, 4th Floor
San Francisco, CA 94105-3638
(800) 714-LAND (415) 495-4014;
fax (415) 495-4103
email: info@tpl.org; www.tpl.org

TPL assists public agencies and communities in acquiring and protecting land of recreational, ecological, and cultural value for the public. Specializing in urban open space, TPL provides education and assistance for nonprofit land acquisition processes.

Resources: *Land and People* (magazine); *TPL Near You* (email newsletter); *Landlink* (newsletter)

UL Environment, Inc.

333 Pfingsten Road
Northbrook, IL 60002-2096
(888) 485-4733; fax (360) 817-6263
email: ulenvironment@ulevironment.com;
www.ulenvironment.com

UL Environment helps support the growth and development of sustainable products, services and organizations in the global marketplace through standards development, educational services, and independent third party assessment and certification.

Resources: *Database of Validated and Certified Products*

Union of Concerned Scientists (UCS)

2 Brattle Square
Cambridge, MA 02238-9105
(617) 547-5552; fax (617) 864-9405
email: ucs@ucsusa.org; www.ucsusa.org

UCS investigates renewable energy options, the impacts of global warming, the risks of genetically engineered crops, and related topics.

Resources: *Catalyst* (quarterly magazine); *Earthwise* (quarterly newsletter); *Greentips* (monthly e-newsletter)

United Nations Development Programme (UNDP)

One United Nations Plaza
New York, NY 10017-3514
(212) 906-5000; fax: (212) 906-5364
www.undp.org

UNDP helps countries build and share solutions to the challenges of democratic governance, poverty reduction, crisis prevention and recovery, energy and environment, and HIV/AIDS. UNDP's Energy and Environment Practice works in six priority areas: frameworks and strategies for sustainable development, effective water governance, access to sustainable energy services, sustainable land management to combat desertification and land degradation, conservation and sustainable use of biodiversity, and national/sectoral policy and planning to control emissions of ODS and POPs.

Resources: Reports and publications

United Nations Division for Sustainable Development

Department of Economic and Social Affairs
2 United Nations Plaza, Room DC2-2220
New York, NY 10017-4403
(212) 963-2803; fax (212) 963-4260
www.un.org/esa/sustdev

The Division for Sustainable Development provides leadership and is an authoritative source of expertise within the United Nations system on sustainable development. It promotes sustainable development as the substantive secretariat to the UN Commission on Sustainable Development (CSD) and through technical cooperation and capacity building at international, regional, and national levels. The context for the Division's work is the implementation of Agenda 21, the Johannesburg Plan of Implementation, and the Barbados Programme of Action for Sustainable Development of Small Island Developing States. The Division includes the Commission on Sustainable Development.

Resources: Reports and discussion papers; newsletters

United Nations Environment Programme (UNEP)

Regional Office for North America
900 17th Street, NW, Suite 506
Washington, DC 20006-2508
(202) 785-0465; fax (202) 785-2096
www.rona.unep.org

UNEP is the environmental agency of the United Nations. It helps develop and coordinate environmental policies at the municipal, national, regional, and international levels by working with scientific agencies, the private and public sectors, nongovernmental organizations, legal institutions, and others. The North American office works with the governments and civil society organizations of Canada and the United States to promote effective responses to international environmental challenges and to foster cooperation on environmental issues between North America and the broader international community.

Resources: *Our Planet* (magazine); *Annual Report of the Executive Director*; regional and specialized newsletters

United Nations Population Fund (UNFPA)

220 East Forty-second Street
New York, NY 10017-5880
(212) 297-5000; fax (212) 370-0201
email: hg@unfpa.org; www.unfpa.org

UNFPA assists developing countries with population problems and plays a leading role in the UN system in promoting population programs. Changes in the structure, distribution, and size of populations are interlinked with all facets of sustainable development. Thus, UNFPA works to advance sustainable development.

Resources: *State of World Population* (annual report); *Dispatches* (newsletter); reports and studies

U.S. Department of Commerce (DOC)

National Technical Information Service (NTIS)
Technology Administration
5301 Shawnee Road
Alexandria, VA 22312-2312
(703) 605-6585, fax: (703) 487-4650
email: info@ntis.gov; www.ntis.gov

The DOC is the federal government's central source for the sale of scientific, technical, engineering, and related business information produced by or for the U.S. government.

Resources: Numerous

U.S. Department of Energy (DOE)

Building Technologies Program (BTP)
1000 Independence Ave., SW
Room 6070, MS EE-2J
Washington, DC 20585
(202) 586-9192
www1.eere.energy.gov/buildings/

The Building Technologies Program, in partnership with the private sector, state and local governments, national laboratories, and universities, works to improve the efficiency of buildings and the equipment, components, and systems within them. The program supports research and development (R&D) activities and provides tools, guidelines, training, and access to technical and financial resources. The United States has many opportunities for energy and cost savings in its buildings. BTP is leading the way with advanced technologies and zero energy building design.

Resources: Publications and software

U.S. Department of Energy (DOE) Energy Efficiency and Renewable Energy Information Portal

1000 Independence Ave., SW
Mail Stop EE-1
Washington, DC 20585-0001
(877) 337-3463
www1.eere.energy.gov/informationcenter/

The EERE Information Portal is a gateway to hundreds of websites and thousands of online documents on energy efficiency and renewable energy.

Resources: Numerous

U.S. Department of Energy (DOE) Energy Information Administration National Energy Information Center

EI-30, 1000 Independence Avenue SW
Washington, DC 20585-0001
(202) 586-8800
email: infoctr@eia.doe.gov; www.eia.doe.gov

The center provides information on DOE programs and distributes fact sheets and publications on energy resources, consumption, imports, exports, and related economic and statistical information.

Resources: Numerous; e-mail newsletters

U.S. Department of Energy (DOE) National Renewable Energy Laboratory (NREL)

Central Regional Support Office
1617 Cole Boulevard
Golden, CO 80401-3305
(303) 275-3000; fax (303) 275-4053
www.nrel.gov

NREL is a leading laboratory for research and development of renewable energy and energy efficiency technologies. Major programs include advanced vehicle technologies and fuels, basic energy science, biomass, building technologies, electric infrastructure systems, energy analysis, geothermal energy, hydrogen and fuel cells, and solar and wind energy.

Resources: Publications; *CleanTech* Communications (monthly email update); *Energy Innovations Newsletter*; *Energy Analysis at NREL* (monthly newsletter); PIX (photograph library); renewable resources maps and data

U.S. Environmental Protection Agency (EPA) Clean Energy Program

www.epa.gov/cleanenergy/index.html

EPA's Clean Energy Programs work with state policymakers, electric and gas utilities, energy customers, and other key stakeholders to identify, design and implement clean energy policy and technology solutions. These programs provide useful, objective information and technical assistance for available clean energy technologies.

Resources: Power Profiler; eGRID (emissions and generation resource integrated database); *Clean Energy Resources Database* (searchable directory); Greenhouse Gas Equivalencies Calculator

U.S. Environmental Protection Agency (EPA) Design for the Environment (DfE) Program

Office of Pollution Prevention & Toxics
US EPA
1200 Pennsylvania Avenue, NW
Mail code 7406-M
Washington, DC 20460-0002
(202) 272-0167
email: opt.homepage@epa.gov; www.epa.gov

EPA's Design for Environment (DfE) works in partnership with industry, environmental groups, and academia to reduce risk to people and the environment by finding ways to prevent pollution. DfE evaluates human health and environmental concerns associated with traditional and alternative chemicals and processes in a range of industries. DfE identifies safer chemicals, including life cycle considerations, through Alternatives Assessment. DfE promotes its mission through it Safer Product Labeling Program and its Partnership Projects.

Resources: News by email; *Go Green!* monthly newsletter

U.S. Environmental Protection Agency (EPA) National Program Chemicals Division

EPA West Building
Mail Code 7404T
1200 Pennsylvania Avenue, NW
Washington, DC 20460-0002
(202) 566-0517; fax: (202) 566-0473
www.epa.gov/asbestos/

This office provides the public sector, including individual citizens and community services, information on handling, abatement, and management of asbestos in schools, workplaces, and homes.

U.S. Environmental Protection Agency (EPA)
Hotlines and Clearinghouses
Ariel Rios Building
1200 Pennsylvania Avenue NW
Washington, DC 20460-0003
(202) 272-0167
www.epa.gov/epahome/hotline.htm

This organization maintains an alphabetized list of EPA hotlines and clearinghouses.

U.S. Environmental Protection Agency (EPA)
Indoor Environments Division (IED)
1200 Pennsylvania Avenue, NW
Mail Code 6609J
Washington, DC 20460-0002
(202) 343-9370; fax (202) 343-2394
www.epa.gov/iaq/

The IED is responsible for implementing IEPA's Indoor Environments Program, a voluntary (nonregulatory) program to address indoor air pollution. The IED works to reduce human health risks posed by contaminants in indoor environments. They conduct public education and outreach programs to reduce public health risks from indoor air quality problems. Indoor air pollutant priority areas include: radon, indoor asthma triggers, environmental tobacco smoke, and air toxics. Building type priority areas include: schools, public and commercial buildings, and homes.

Resources: Various publications, fact sheets, and tools/models/studies

U.S. Environmental Protection Agency (EPA)
Office of Resource Conservation and Recovery
Municipal Solid Waste (MSW)
1200 Pennsylvania Avenue, NW
Mail Code 5305P
Washington, DC 20460
www.epa.gov/epawaste/nonhaz/municipal/index.htm

EPA's MSW program seeks to implement environmentally sound management of MSW through source reduction first, recycling and composting second, and disposal in landfills or waste combustors last.

Resources: Glossary; hazardous waste data; municipal solid waste facts and figures; news stories; publications; *RCRA Online* (electronic database)

U.S. Environmental Protection Agency (EPA)
Office of GroundWater and Drinking Water (OGWDW)
Ariel Rios Building
1200 Pennsylvania Avenue NW
Washington, DC 20460-0003
(202) 564-3750; fax (202) 564-3752
www.epa.gov/safewater

This office works with states, tribes, and partners to protect public health by ensuring safe drinking water and protecting groundwater.

U.S. Environmental Protection Agency (EPA)
Office of Science and Technology (OST)
Ariel Rios Building
1200 Pennsylvania Avenue NW
Mail Code 4301T
Washington, DC 20460-0003
(202) 566-0430
email: Ost.Comments@epa.gov;
www.epa.gov/waterscience/

OST develops sound, scientifically defensible standards, criteria, advisories, guidelines, limitations, and standards guidelines for water quality and industrial water pollution.

Resources: *Fish Consumption Newsletter*; list servers; reference library

U.S. Environmental Protection Agency (EPA)
Office of Solid Waste and Emergency Response
Ariel Rios Building
1200 Pennsylvania Avenue NW
Washington, DC 20460-0003
(800) 424-9346
www.epa.gov/swerrims

This office develops guidelines and standards for land disposal of hazardous wastes and underground storage tanks.

Resources: Chemical Emergency Preparedness and Prevention publications; Citizen's Guides; Brownfields and Environmental Justice publications; Technology Innovation publications

U.S. Environmental Protection Agency (EPA)
Office of Wastewater Management (OWM)

Ariel Rios Building
1200 Pennsylvania Avenue NW
Mail Stop 4204M
Washington, DC 20460-0003
(202) 260-5850
email: comments.web@epa.gov;
www.epa.gov/owm

OWM oversees a range of programs contributing to the well-being of the nation's waters and watersheds. Through its programs and initiatives, OWM promotes compliance with the requirements of the Federal Water Pollution Control Act. It works in partnership with EPA regions, states, and tribes to regulate discharges into surface waters such as wetlands, lakes, rivers, estuaries, bays, and oceans. Specifically, OWM focuses on the control of water collected in discrete conveyances (also called point sources), including pipes, ditches, and sanitary or storm sewers.

Resources: Publications on biosolids, pollution prevention and control, pretreatment, stormwater and combined sewer overflows, treatment, water conservation and efficiency, and water quality and standards

U.S. Environmental Protection Agency (EPA)
Office of Wetlands, Oceans, and Watersheds (OWOW)

Ariel Rios Building
1200 Pennsylvania Avenue NW
Mail Stop 4501T
Washington, DC 20460-0003
(202) 566-1300; fax (202) 566-1736
email: center.water-resource@epa.gov;
www.epa.gov/owow/

OWOW and its partners work together on a watershed basis to protect the nation's water resources.

Resources: Databases, data systems, mapping, and water quality models; numerous publications

U.S. Environmental Protection Agency (EPA)
Safe Drinking Water Hotline

Ariel Rios Building
1200 Pennsylvania Avenue NW
Mail Stop 4601
Washington, DC 20460-0003
(800) 426-4791; fax (202) 564-3753
www.epa.gov/safewater/hotline/index.html

The hotline provides the general public, regulators, medical and water professionals, academia, and media with information about drinking water and groundwater programs authorized under the Safe Drinking Water Act. Topics covered include local drinking water quality, drinking water standards, public drinking water systems, source water protection, large-capacity residential septic systems, commercial, and industrial septic systems, injection wells, and drainage wells.

Resources: *Water Lines* (monthly hotline activity report); drinking water data and databases; reports

U.S. Environmental Protection Agency (EPA)
Office of Wastewater Management WaterSense Program

Ariel Rios Building
1200 Pennsylvania Avenue NW
Mail Stop 4204M
Washington, DC 20460-0003
(866) WTR-SENS (987-7367)
www.epa.gov/watersense/

The EPA's WaterSense program promotes water efficiency and enhances the market for water-efficient products, programs, and practices. Products that meet WaterSense water efficiency and performance criteria carry the WaterSense label. WaterSense partners with manufacturers, retailers and distributors, and utilities to bring these

products to the marketplace. The program currently labels: toilets, bathroom sink faucets and accessories, flushing urinals, and new homes. WaterSense is working on specifications for pre-rinse spray valves, showerheads, and weather- or sensor-based irrigation control technologies.

Resources: Various publications, fact sheets; *WaterSense Current* (quarterly update)

U.S. EPA Regional Offices

Each of the EPA's 10 regional offices listed below is responsible within its states for the execution of the agency's programs. The regional offices offer a library of local resources, superfund records, environmental laws and regulations, and regional data about toxic chemicals.

U.S. Environmental Protection Agency EPA Region 1 (New England)

John F. Kennedy Federal Building
5 Post Office Square, Suite 100
Boston, MA 02109-3912
(888) 372-7341; (617) 918-1111;
fax: (617) 918-0101
email: R1_Web_Inquiry@epamail.epa.gov;
www.epa.gov/region1

Region 1 includes Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont, and 10 tribal nations.

U.S. Environmental Protection Agency EPA Region 2

290 Broadway
New York, NY 10007-1866
(212) 637-3660
email: R2_Web_Inquiry@epamail.epa.gov;
www.epa.gov/region2

Region 2 includes New Jersey, New York, Puerto Rico, U.S. Virgin Islands, and seven tribal nations.

U.S. Environmental Protection Agency EPA Region 3 (Mid-Atlantic)

1650 Arch Street (3PM52)
Philadelphia, PA 19103-2029
(800) 438-2474; (215) 814-5000
email: R3_Web_Inquiry@epamail.epa.gov;
www.epa.gov/region3

Region 3 includes Delaware, District of Columbia, Maryland, Pennsylvania, Virginia, and West Virginia.

U.S. Environmental Protection Agency EPA Region 4 (Southeast)

Sam Nunn Atlanta Federal Center
61 Forsyth Street SW
Atlanta, GA 30303-8960
(800) 241-1754 (404) 562-9900; fax: (404) 562-8174
www.epa.gov/region4

Region 4 includes Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, and Tennessee, and six tribes.

U.S. Environmental Protection Agency EPA Region 5

77 West Jackson Boulevard, Suite 1600
Chicago, IL 60604-3608
(800) 621-8431 (312) 353-2000
email: r5hotline@epa.gov;
www.epa.gov/region5

Region 5 includes Illinois, Indiana, Michigan, Minnesota, Ohio, Wisconsin, and 35 tribes.

U.S. Environmental Protection Agency EPA Region 6 (South Central)

1445 Ross Avenue, Suite 1200
Dallas, TX 75202-2750
(800) 887-6063 (214) 665-6444
www.epa.gov/region6

Region 6 includes Arkansas, Louisiana, New Mexico, Oklahoma, Texas, and 66 tribes.

U.S. Environmental Protection Agency EPA Region 7

901 North Fifth Street
Kansas City, KS 66101-2907
(800) 223-0425 (913) 551-7003;
fax: (913) 551-7066
www.epa.gov/region7

Region 7 includes Iowa, Kansas, Missouri, Nebraska, and seven tribal nations.

U.S. Environmental Protection Agency EPA Region 8 (Mountains and Plains)
80C-EISC, 1595 Wynkoop Street,
Denver, CO 80202-1129
(800) 227-8917 (303) 312-6312
www.epa.gov/region8

Region 8 includes Colorado, Montana, North Dakota, South Dakota, Utah, Wyoming, and 27 tribal nations.

U.S. Environmental Protection Agency EPA Region 9 (Pacific Southwest)
75 Hawthorne Street. 11th Floor
San Francisco, CA 94105-3922
(866) EPA-WEST (415) 947-8000
www.epa.gov/region9

Region 9 includes Arizona, California, Hawaii, Nevada, The Pacific Islands, and over 140 tribal nations.

U.S. Environmental Protection Agency EPA Region 10 (Pacific Northwest)
1200 Sixth Avenue, Suite 900
Seattle, WA 98101-3140
(800) 424-4PEA (206) 553-1200
www.epa.gov/region10

Region 10 includes Alaska, Idaho, Oregon, Washington, and native tribes.

U.S. Green Building Council (USGBC)
2101 L Street, NW, Suite 500
Washington, DC 20037-1560
(202) 828-7422; fax (202) 828-5110
email: info@usgbc.org; www.usgbc.org

The council is the nation's foremost coalition of leaders from across the building industry working to promote buildings that are environmentally responsible, profitable, and healthy places to live and work.

Resources: Leadership in Energy and Environmental Design (LEED) Green Building Rating System; conferences; reports

U.S. Office of Science and Technology Policy (OSTP)
Executive Office of the President
725 17th Street, Room 5228
Washington, DC 20002-7231
www.whitehouse.gov/administration/eop/ostp

OSTP serves as a source of scientific and technological analysis and judgment for the president with respect to major policies, plans, and programs of the federal government.

Urban Ecology, Inc.
582 Market Street, Suite 1020
San Francisco, CA 94104-5311
(415) 617-0158; fax: (415) 617-0016
www.urbanecology.org/

Urban Ecology is an international organization dedicated to creating sustainable cities through use of ecology principles in urban planning and development. Emphasis is on land use planning, transportation, restoration, international education, and eco-city research.

Resources: *Blueprint for a Sustainable Bay Area; The Walkable Streets Toolkit;* neighborhood plans

Vanderbilt University Center for Environmental Management Studies (VCEMS)
2301 Vanderbilt Place
Nashville, TN 37235-1831
(615) 322-2697
email: james.h.clarke@vanderbilt.edu;
www.vanderbilt.edu/VCEMS/

VCEMS promotes and develops alliances among industry, government, and academia to study the relationship of environmental policy to business management and operations. The center is a Vanderbilt University systemwide initiative jointly led by the School of Engineering, the Owen Graduate School of Management, and the Law School. Center activities are interdisciplinary and focus on environmental business, management, and technology.

Webdirectory
The Environmental Directory
email: info@webdirectory.com;
www.webdirectory.com

The directory is created and maintained by a group of people dedicated to helping others keep in touch and informed on the World Wide Web. With thousands of sites, it is the

largest exclusively environmental organization directory on the Web and includes sites from over 100 countries.

The Wilderness Society

1615 M Street NW
Washington, DC 20036-3209
(800) THE-WILD, (202) 833-2300;
fax (202) 429-3959
email: tws@tws.org; http://wilderness.org/

The society works to protect wildlands and wildlife. Emphasis is on the Arctic Wildlife Refuge, national forest policy, national parks, endangered species protection, and economics of public land use.

Resources: *WILDALERT NEWS; WILDALERTS; Wilderness Report; Wilderness Year* (quarterly magazine)

The Wildlife Society

5410 Grosvenor Lane, Suite 200
Bethesda, MD 20814-2144
(301) 897-9770; fax (301) 530-2471
email: tws@wildlife.org;
http://joomla.wildlife.org/

The society is dedicated to conserving wildlife productivity and diversity through resource management. Emphasis is on education for wildlife managers.

Resources: *The Journal of Wildlife Management* (quarterly publication); *The Wildlifer* (bimonthly newsletter); *Journal of Wildlife Management* (monthly journal); *Wildlife Monographs* (single topic, peer-reviewed studies); technical reviews; *Wildlife Policy News* (e-newsletter); books and publications

WoodWise Program
Better Paper Project

Green America
1612 K Street NW, Suite 600
Washington, DC 20006-2810
(800) 58-GREEN
email: info@woodwise.org;
www.greenamericatoday.org/programs/woodwise/

This program works to preserve forests by reducing demand for wood products and promoting sustainable alternatives.

Resources: *WoodWise Guide*

World Health Organization (WHO)

Programme on Indoor Air Pollution
Avenue Appia 20
1211 Geneva 27
Switzerland
(+41 22) 791 21 11; fax: (+41 22) 791 31 11
email: indoorair@who.int;
www.who.int/indoorair/en/

The program works to combat the substantial and growing burden of disease and high levels of indoor air pollution caused by cooking and heating with solid fuels.

Resources: Publications, fact sheets, and databases on air pollution

World Resources Institute

10 G Street NE, Suite 800
Washington, DC 20002-4252
(202) 729-7600; fax (202) 729-7610
email: swilson@wri.org; www.wri.org

The institute helps governments, the private sector, nonprofit organizations, and others address human needs and economic growth while preserving natural resources. Emphasis is on forests, biodiversity, economics, technology, climate, energy, pollution, education, and governance.

Resources: Several publications; charts and maps

World Society for the Protection of Animals USA (WSPA USA)

Lincoln Plaza
89 South Street, Suite 201
Boston, MA 02111
(800) 883-9772; fax (617) 737-4404
email: wspa@wspausa.com;
www.wspa-usa.org/

The society is an international animal protection/wildlife conservation organization. Emphasis is on enacting animal protection legislation, disaster relief program to aid animal victims of disasters, animal spectacles, education, and less developed countries.

Resources: *WSPA e-Newsletter*

Worldwatch Institute

1776 Massachusetts Avenue NW
Washington, DC 20036-1904
(202) 452-1999; fax (202) 296-7365

email: worldwatch@worldwatch.org; www.worldwatch.org

Worldwatch is an environmental research institute. Emphasis is on interdependence of the world economy and its environmental support systems.

Resources: *State of the World* (annual report); *WorldWatch* (magazine); *The WorldWatch Papers; Vital Signs* (annual report)

World Wildlife Fund (WWF)

1250 Twenty-fourth Street NW, Suite 500
P.O. Box 97180
Washington, DC 20090-7180
(202) 293-4800; fax (202) 293-9211
www.worldwildlife.org

The WWF seeks to preserve endangered wildlife and wildlands by encouraging sustainable development. Emphasis is on conservation of tropical rain forests and preserving biological diversity.

Resources: Publications

University Education Programs

This category includes educational programs with a sustainable focus to assist those considering entering a career in sustainable design or construction. The list is not exhaustive but offers a brief overview of available programs for further investigation by the reader.

Graduate Programs in Sustainable Architectural Design and Construction

Master's Degree Programs

Carnegie Mellon University: M.S. in Sustainable Design
The Catholic University of America: M.S. in Sustianable Design
Graduate School of the Environment, United Kingdom: MSc Architecture—Advanced Environmental and Energy Studies
Murdoch University, Perth, Western Australia: M.S. in Energy Studies and Environmental Architecture
Philadelphia University: M.S. in Sustainable Design
University of Minnesota: M.S. in Sustainable Design
University of Pittsburgh: M.S. in Construction Management and Sustainability
University of Texas at Austin: M.S. in Sustainable Design

Joint Degree Programs

The Catholic University of America: Joint degrees in Architecture and Sustainable Design, MSSD/M.Arch.
Yale University: Joint degree program in Architecture and Environmental Management

Specializations/Concentrations/Emphases

Ball State University: Sustainability Concentration
Kansas State University: M.S. in Architecture with emphasis in Ecological and Sustainable Design
New Jersey Institute of Technology: M.S. in Architecture w. concentration in Sustainable Design
University of Michigan: Environmental Sustainability Concentration
University of Oklahoma: Focus on Sustainability and Regional Response
University of Texas at Austin: Specialization in Sustainable Design

Certificates

Boston Architectural College: Certificate in Sustainable Design
The Catholic University of America: Certificate in Sustainable Design
Graduate School of the Environment, United Kingdom Professional Diploma in Architecture—Advanced Environmental and Energy Studies
Harvard University: Certificate in Sustainable Design
New Jersey Institute of Technology: Certificate in Sustainable Design
New Jersey Institute of Technology: Sustainable Architecture Graduate Certificate

Texas A & M University: Certificate in Sustainable Urbanism
University of California, Berkeley Extension Professional Program in Sustainable Design and Solar Energy and Green Building
University of California, Riverside: Sustainable Development and Green Design
University of California, Davis: Green Building and Sustainable Design Certificate
University of Florida: Certificate in Sustainable Architecture
University of Florida: Certificate in Sustainable Construction

Architecture Degrees with Sustainable Emphasis

Ball State University Major in Environmental Design

Department of Architecture
Architecture Building (AB), Room 104
Ball State University
Muncie, IN 47306
(765) 285-5859; fax (765) 285- 3726
email: cap@bsu.edu;
www.bsu.edu/cap/curriculum/undergrad/En_Arch.html

The university offers a bachelor of science or bachelor of arts with an undergraduate major in environmental design for students interested in alternative careers in design, construction, and related fields.

Boston Architectural Center

Continuing Education
320 Newbury Street
Boston, MA 02115-2703
(617) 585-0101
email: ce@the-bac.edu;
www.the-bac.edu/x350.xml

The center offers a certificate in sustainable design. The program prepares practitioners to design spaces in harmony with the environment. The sustainable design certificate may be earned at either the undergraduate or graduate level. Students seeking a graduate certificate must have a prior bachelor's degree and take the required courses (excluding the elective) at the graduate level. The sustainable design certificate program is available entirely online in partnership with BuildingGreen, Inc.

Ecosa Institute, The

201 North Alarcon, Suite B
Prescott, AZ 86301-3100
(877) 541-1006 (928) 541-1002;
fax (928) 776-8086
email: info@ecosainstitute.org;
www.ecosainstitute.org

This educational institute provides undergraduate and graduate design students with a detailed understanding of the impact of design on the environment and exposes them to alternative strategies for reducing that impact. Ecosa also offers programs for architecture instructors.

Minneapolis College of Art and Design (MCAD)

2501 Stevens Avenue
Minneapolis, MN 55404
(800) 874-MCAD (612) 874-3618;
fax: (612) 874-3704
email: online@mcad.edu;
www.mcad.edu/showPage.php?pageID=1311

MCAD offers a sustainable design online certificate. The online program covers topics from theoretical underpinnings to practical design techniques. Individual classes are also available on topics such as: systems thinking and Life Cycle Analysis; principles of sustainable design applied to graphic design, packaging, and product design; green marketing; international standards; and green design innovation.

San Francisco Institute of Architecture (SFIA)

Box 2590
Alameda, CA 94501
(510) 523-5174; fax (510) 523-5175
email: info@sfia.net;
www.sfia.net/EcoDes.asp

The institute offers a master of ecological design degree program with options for students with architecture degrees, degrees in

other fields, or work experience. The Institute also offers distance learning courses in ecological design, planning, and construction.

Santa Clara University

Environmental Studies Institute (ESI)
500 El Camino Real
Santa Clara, CA 95050-4901
(408) 551-7086; fax (408) 554-2312
www.scu.edu/envs/

ESI is an interdisciplinary community of scholars—composed of faculty, staff, and students—dedicated to understanding the interactions between humans and the natural world. They serve local and global communities by addressing environmental issues through education, research, and leadership. ESI's bachelors level degrees in Environmental Science and Environmental Studies challenge undergraduates to integrate knowledge and research in the natural and social sciences with ethics, service and leadership to promote a sustainable world. ESI provides a variety of campus and community programs including seminars, internships, and opportunities for research, service, and study abroad.

University of California at Berkeley

Building Science Program
http://arch.ced.berkeley.edu/resources/bldgsci/building_science.htm

This program is dedicated to the energy efficiency and environmental quality of buildings. It offers bachelors, masters, and doctoral degrees as well as research opportunities.

University of Michigan

ERB Institute for Global Sustainable Enterprise
(734) 647-9799; fax: (734) 647-8551
email: erbinstitute@umich.edu;
www.erb.umich.edu/

The institute offers bachelor's, master's, doctoral, and executive level degrees. Students gain an understanding of the grand challenges of sustainability by viewing them through multiple lenses both internal and external to the organizations. Students graduate from the programs with deep knowledge and sophisticated tools to help organizations achieve competitive advantages through the creation and implementation of innovative strategies for sustainability.

University of Manchester

Beyer Building
Oxford Road
Manchester, UK, M13 9PL
sustainability.manchester.ac.uk/education

The university offers a wide range of undergraduate and postgraduate courses in the field of sustainability. Separate modules are also offered in many other courses.

University of Texas at Austin

School of Architecture
1 University Station, Mail Stop B7500
Austin, TX 78712-0222
(512) 471-0185; fax (512) 471-0716
http://soa.utexas.edu/

The Graduate Architecture program offers a master of architecture with a specialization in sustainable design and master of science in Sustainable Design. The program studies the relationship between the built and natural environments. The expanded program focuses on three areas of interest: natural systems, buildings systems, and cultural systems.

Wallace Research Group, The

P.O. Box 50128
Bellevue, WA 98015-0128
(425) 637-9049
email: info@wallaceresearch.net;
www.wallaceresearch.net/educationNorthAmerica.html

The Wallace Research Group provides an online listing of international architecture and building environment degree programs that emphasize sustainable, environmental, or green design courses.

Resources: Alphabetic listing by U.S. State or Canadian Province

APPENDIX B

Summary of Environmental Issues in CSI MasterFormat™ Organization

To assist readers in asking appropriate questions regarding the greenness of a material, this appendix lists issues relative to resource management, toxicity/IEQ, and performance according to CSI MasterFormat sections.

This summary was developed by theGreenTeam, Inc., and is the result of its ongoing work with building owners, building product manufacturers, green building trade/professional organizations, standards development organizations, and environmental organizations to develop sustainable building. This summary is intended to be a guide for researching environmental issues relative to building products. No warranty is made as to completeness or accuracy of information contained herein. References to manufacturers do not represent a guaranty, warranty, or endorsement thereof.

theGreenTeam, Inc.
136 East 18th Street
Tulsa, OK 74119
Phone: (918) 295-TEAM (8326)
www.thegreenteaminc.com

The information is organized according to CSI Masterformat™. Section and division numbers and titles that follow are based on the 2004 edition of CSI MasterFormat™ with 1995 edition section numbers indicated parenthetically. Much of the information has been incorporated into the *Federal Green Construction Guide for Specifiers* available on the Whole Building Design Guide website http://fedgreenspecs.wbdg.org.

DIVISION 01 GENERAL REQUIREMENTS

01 10 00 (01100)	SUMMARY: Identify owner's environmental goals and requirements, including energy efficiency, resource management, and specific project issues. Also, clearly indicate a team approach to addressing environmental issues.
01 20 00 (01200)	PRICE AND PAYMENT PROCEDURES: If submittal of updated environmental management plans are required with Application for Payment, coordinate with related sections. See SECTION 01 57 19.11 (SECTION 01352)—Indoor Air Quality (IAQ) MANAGEMENT; SECTION 01 57 19.12 (SECTION 01353)—NOISE & ACOUSTICS MANAGEMENT; SECTION 01 57 19.13 (SECTION 01354)—ENVIRONMENTAL MANAGEMENT; AND, SECTION 01 74 19 (SECTION 01351)—CONSTRUCTION WASTE MANAGEMENT.
01 23 10 (01231)	ENVIRONMENTAL ALTERNATES: Identify options for green products. Use of this section will allow the owner to compare financial and practical viability of green product options for a particular project.
01 25 13 (01630)	PRODUCT SUBSTITUTION PROCEDURES: Specify that substitutions may be considered when the contractor becomes aware of a product or procedure that is more environmentally sensitive.
01 30 00 (01300)	ADMINISTRATIVE REQUIREMENTS: Require contractor to designate an on-site party responsible for instructing workers and overseeing the environmental goals for the project. Coordinate with environmental management sections for project quality control, coordination, and construction meetings. Review environmental procedures and status of environmental plans at each construction meeting. See SECTION 01 57 19.11 (SECTION 01352)—Indoor Air Quality (IAQ) MANAGEMENT; SECTION 01 57 19.12 (SECTION 01353)—NOISE & ACOUSTICS MANAGEMENT; SECTION 01 57 19.13 (SECTION 01354)—ENVIRONMENTAL MANAGEMENT; AND, SECTION 01 74 19 (SECTION 01351)—CONSTRUCTION WASTE MANAGEMENT. Where violation of environmental procedures requirements will irreversibly damage the site, identify requirements for documentation of progress at specific intervals. Documentation may also be useful for educational purposes.
01 33 00 (01330)	SUBMITTAL PROCEDURES: Clarify need for submission of material safety data sheets (MSDSs). Often owners and architects will incorporate a blanket request for MSDSs in response to environmental issues. While this may be appropriate, remember that interpreting chemical profile and test results requires understanding the health effects of exposure to the emitted chemicals, which is beyond the professional expertise of most architects; furthermore, adequate information is not available for most chemicals. Coordinate with SECTION 01 67 00 (SECTION 01611)—ENVIRONMENTAL REQUIREMENTS FOR PRODUCTS.
01 41 00 (01410)	REGULATORY REQUIREMENTS: Compliance with applicable regulatory requirements is the responsibility of the contractor. The environmental risks and costs associated with compliance can be a significant aspect of the project. EPA's Office of Compliance publishes *Managing Your Environmental Responsibilities: A Planning Guide for Construction and Development* (the *MYER Guide*). This assistance tool reflects significant input from stakeholders and is a product of joint effort by the industry, states, other federal

agencies, nongovernmental organizations and EPA. The *MYER Guide* complements the *Federal Environmental Requirements for Construction* guide.

The EPA-sponsored Construction Industry Compliance Assistance (CICA) Center provides information on state and federal requirements. This and similar tools are available through the Associated General Contractors of America (AGC) Environmental Services website.

01 42 00 (01421)	REFERENCES: Include environmental reference standards that are applicable to the entire project. Coordinate with individual specification sections to avoid duplication of references.
01 43 50 (01435)	CONTINUAL IMPROVEMENT OF ENVIRONMENTAL QUALITY: This section includes requirements for continual improvement of environmental performance during construction; and, requirements for coordination with continual improvement of owner's environmental performance after construction. Where the owner utilizes an Environmental Management System (EMS), cite specific environmental aspects from owner's EMS and the associated actions (including objectives and targets) that may be related to construction.
01 50 00 (01500)	TEMPORARY FACILITIES AND CONTROLS: Include contractor requirements for installation, maintenance, and removal of temporary facilities and controls that are required for construction. Contractor is responsible for compliance with environmental regulations that apply during the construction phase of the project.
01 57 19.11 (01352)	INDOOR AIR QUALITY (IAQ) MANAGEMENT: This section includes requirements for IAQ management during construction. Coordinate with requirements of other sections; verify that products and installation methods specified in other sections are environmentally appropriate. This Section may include procedures for testing baseline IAQ. Baseline IAQ requirements specify maximum indoor pollutant concentrations for acceptance of the facility. This section may include requirements for Independent Materials Testing of specific materials anticipated to have measurable impact on IAQ.
01 57 19.12 (01353)	NOISE & ACOUSTICS MANAGEMENT: This section includes requirements for noise management. Refer to ASTM E1433, Standard Guide for Selection of Standards on Environmental Acoustics, for an overview of the ASTM standards relative to environmental acoustics.
01 57 19.13 (01354)	ENVIRONMENTAL MANAGEMENT: This section includes requirements for the protection of natural resources. This section emphasizes an integrated team approach to address environmental issues. This section does not address environmental remediation, abatement, regulatory requirements, or requirements for environmental impact statements/reports. Coordinate with requirements of other sections; verify that products and installation methods specified in other sections are environmentally appropriate.
01 67 00 (01611)	ENVIRONMENTAL REQUIREMENTS FOR PRODUCTS: Coordinate with Section 01 60 00 (01600). Section 01 60 00 (01600)—Product Requirements addresses general requirements for delivery, storage, and handling. Sometimes, it also specifies general requirements for materials and equipment identified as "new." New materials include those manufactured with recycled content. New materials do not include materials salvaged or purchased for reuse. For general information related to toxicity of various substances, refer to the Agency for Toxic Substances and Disease Registry

(ATSDR), an agency of the U.S. Department of Health and Human Services. ATSDR is directed by congressional mandate to perform specific functions concerning the effect on public health of hazardous substances in the environment. These functions include health consultations concerning specific hazardous substances, health surveillance and registries, information development and dissemination, and education and training concerning hazardous substances. Also, the Center for Disease Control and Prevention (CDC) scientifically considers all factors that affect the health of the nation. The interaction between people and their environments, natural as well as human-made, continues to emerge as a major issue concerning public health; therefore, the CDC promotes the Designing & Building Healthy Places program.

01 74 13 (01740) PROGRESS CLEANING: Require nontoxic cleaning materials and procedures.

01 74 19 (01351) CONSTRUCTION WASTE MANAGEMENT: This section includes requirements for waste management. This section represents data quality objectives and waste management consistent with ASTM D5792, Standard Practice for Generation of Environmental Data Related to Waste Management Activities: Development of Data Quality Objectives, for typical commercial construction. This section does not address environmental remediation, abatement, regulatory requirements, or requirements for environmental impact statements/reports.

Resource Management: Diversion of waste from landfills supports close-the-loop life cycles that help conserve natural resources. Additionally, it can reduce greenhouse gas emissions associated with landfilling and incineration. EPA provides a Waste Reduction Model (WARM) to help solid waste planners and organizations track and voluntarily report greenhouse gas emissions reductions from several different waste management practices, including landfilling, recycling, incineration, composting, and source reduction.

Performance: EPA GreenScapes provides a Recycling and Reusing Landscape Waste Cost Calculator that estimates the cost and environmental benefits of four scenarios for handling hardscape and landscape wastes (concrete and asphalt, brick, lumber, and yard waste):

- Reusing all waste possible on-site, then recycling all waste possible that cannot be reused, and then disposing of waste remaining
- Reusing all waste possible and disposing of waste remaining;
- Recycling all waste possible and disposing of waste remaining; and
- Disposing of all waste materials

The calculator demonstrates that recycling and reusing landscape waste can offer significant savings compared to disposal, depending on a facility's material needs and proximity to recycling facilities. The calculator also estimates the environmental impacts avoided by reusing and recycling landscape materials instead of landfilling them as waste.

01 78 23 (01830) OPERATION AND MAINTENANCE DATA: Require maintenance instructions for specified products with attention to indoor air quality impacts of the recommended maintenance procedures and materials. Also identify maintenance contracts and take-back programs (green leases). Green leasing

is a new and dramatic shift in the traditional perspective of leased equipment. Under a green lease, the product manufacturer is responsible for the disposition of the product at all times. Thus, when the customer no longer requires the use of the particular product or requires an updated model, the manufacturer would be obligated to reclaim it and refurbish it or disassemble it for recycling as appropriate. Coordinate with the appropriate technical section(s).

01 78 53 (01780) SUSTAINABLE DESIGN CLOSEOUT DOCUMENTATION: Identify requirements for closeout documentation related to sustainable design and to comply with green building rating systems. Also, for federal projects, require submittal of Resource Conservation and Recovery Act Project Summary.

01 79 11 (01821) ENVIRONMENTAL DEMONSTRATION & TRAINING: Require education for owner's personnel regarding both facility systems and the green materials in the building. Because the green items may be different from the systems and materials with which the owner's personnel are familiar, education about the environmental qualities as well as the operation and maintenance requirements, may be necessary.

01 81 13 (01111) SUSTAINABLE DESIGN REQUIREMENTS: This section includes general sustainable design requirements such as participation in a green building rating program. It may include a checklist of the specific credits/points targeted in the designated green building rating program. For most projects, including such a checklist is problematic. Specific project requirements, including submittal requirements related to a green building rating program, should be identified in the appropriate technical sections. To cite project requirements in two locations (i.e., in a Technical Section and in a Division 01 Section) risks redundancies and conflicts that could cause significant cost impacts, design impacts, performance impacts, and/or scheduling impacts for the project. To cite technical project requirements, such as VOC limitations for paint, only in a Division 01 section risks oversight of the project requirements by the affected trades. Further, it tends to isolate the sustainable design requirements rather than integrating them into the project and design process.

01 81 30 (13600) GREEN POWER REQUIREMENTS

Resource Management: Once energy efficiency is maximized for a project, providing the required energy via clean, renewable resources is more sustainable than using fossil fuels, which are finite in supply and incur environmental impacts throughout their life cycle. The Federal Energy Management Program (FEMP) provides information on technologies that have been proven in field testing or recommended by reliable sources. The U.S. federal government is one of the largest energy users; it purchases $10–20 billion in energy-related products annually. With ownership of more than 500,000 buildings, including 422,000 housing structures, the federal government has a tremendous interest in energy efficiency in buildings. The Energy Policy Act of 1992 and Executive Order 13123 set goals for energy reduction and provide some guidelines for implementing conservation measures and renewable energy measures. Annual energy use in Federal buildings has dropped from 140,000 Btu/sq ft (1,600 MJ/m2) in 1985 to 116,000 Btu/sq ft (1,300 MJ/m2) in 1997. To meet the Executive Order 13123 requirements, annual energy use must drop to 90,800 Btu/sq ft (1,000 MJ/m2) by 2010. EO13123 also directs agencies to significantly increase the use of renewable

energy and to install 20,000 solar energy systems by 2010. Agencies have set a goal of 2.5 percent of Federal energy use from renewables by 2010 from green power purchases, on-site renewable energy projects, or other projects developed on Federal land. Executive Order 13514; *Federal Leadership in Environmental, Energy, and Economic Performance*; was signed on October 5, 2009. It expands upon the energy and environmental performance requirements of previous Executive Orders. In particular, it requires that all new Federal buildings, entering the design phase in 2020 or later, are designed to achieve zero net energy by 2030.

Toxicity/IEQ: Electric renewables systems include battery storage if off-grid, and safeguards should be taken while installing and maintaining the electrolyte and batteries shall be properly recycled at the end of their useful life. While there are well-known concerns regarding the toxic components of batteries, overall the systems that utilize renewable energy sources are generally considered to be less hazardous to human health and environmental health because they do not involve the combustion of a fossil fuel.

Performance: This is a rapidly changing field. DOE—Energy Efficiency and Renewable Energy (EERE) and the National Renewable Energy Laboratory (NREL) offer resources for renewable energy, green power, and high performance buildings. Other options for renewable energy include contracting for "green power" generated and supplied by a utility. Buying green power contributes to the renewable energy goals and encourages utilities to invest in these promising resources. With the deregulation of the electric utilities, many new procurement options are becoming available, including the possibility of buying green energy from nonpolluting, renewable sources. While many utilities charge a premium for green power, a trend is for regulators to require utilities to include wind power in their resource planning without a premium because it is not more expensive that conventional plants.

01 91 00 (01810) COMMISSIONING: This section includes requirements for commissioning of facilities and facility systems to verify compliance with design, including optimum energy-efficient operations. This section includes requirements for commissioning activities and documentation in compliance with the green building rating system used. For the U.S. Green Building Council (USGBC), edit as per USGBC—LEED™ rating program, including: commissioning activities and documentation for the LEED™ section on "Energy and Atmosphere" prerequisite of "Fundamental Building Systems Commissioning" and commissioning activities and documentation for the LEED™ section on "Additional Commissioning." The LEED™ rating program includes prerequisite requirements for commissioning: HVAC & R systems, lighting and daylighting controls, domestic hot water systems, and renewable energy systems. For Green Globes—US rating system, edit to include Commissioning Plan—Documentation as required by that system. Other options for systems commissioning may be added as appropriate to Owner's needs. For example, systems commissioning may address: fire and life safety systems, process chillers, rainwater harvesting, and detailed building control systems.

01 92 00 (01800) FACILITY OPERATION: Operation of facilities directly impacts the performance of the facilities. Even the best of designs, if poorly operated, will fail to achieve the intended efficiencies. Different systems will require different maintenance and operation procedures. Such instructions

should be collected in the operations and maintenance manuals; refer to Section 01 78 23 (01830) Operation and Maintenance Data. All facilities should be monitored to assess how closely actual operation conforms to the intended design. This section includes requirements for monitoring and reporting the performance of energy systems and water systems.

DIVISION 02 EXISTING CONDITIONS

02 41 13 (02220) SELECTIVE SITE DEMOLITION

Resource Management: Thoughtful and considered disassembly as opposed to standard demolition will produce more usable "reusables" and will help prevent damage to items scheduled to remain. Deconstruction also supports salvage. Traditionally, salvage is implemented for reuse of items by the owner. However, increasingly extended producer responsibility is providing additional options for product stewardship—salvage for reuse and/or recycling by the manufacturer. The EPA Office of Waste provides guidance for extended producer responsibility. For manufacturers, the essence of extended producer responsibility is taking on responsibility and addressing the environmental impacts of their products where they have not done so before. This can include rethinking the very concept of the product (e.g., selling a service rather than a product); exploring new methods of product delivery; creating a feed-back loop with customers to drive environmentally sound redesign of products; and creating a closed-loop life cycle, conserving resources by handling end-of-life products as assets.

Toxicity/IEQ: Coordinate with applicable regulations regarding detection and abatement of hazardous materials.

Performance: Deconstruction is typically more labor intensive than demolition.

DIVISION 03 CONCRETE

03 30 00 (03300) CAST-IN-PLACE CONCRETE

Resource Management: Improper mining of raw materials (aggregate and components of Portland cement: limestone, oxides of calcium silicon, clay, shale, and sand) can produce soil erosion, pollutant runoff, and habitat loss. Materials for concrete and cement manufacture (aggregates, Portland cement, supplementary cementitious materials, and water) are found throughout the United States, allowing for minimal shipping distances, yet localized depletion of these resources may occur. Supplementary cementitious materials consist of natural pozzolans and recycled products from other industries. Natural pozzolans include: diatomaceous earths, volcanic ash, and pumicites. Recycled supplementary cementitious content materials for pozzolanic concrete include: fly ash, slag cement, and silica fume. Recycled concrete can also be used in concrete or as a subbase material. Many cement manufacturing facilities are reducing their CO_2 emissions through energy efficiency improvements and through increased use of waste lime (instead of converting limestone to lime) and scrap tires. Resource-efficient options for permanent formwork include earth forms and insulated panels or blocks made from expanded polystyrene (beads or extruded), known as insulated concrete forms. Temporary forms (metal pan forms, wood forms,

and corrugated paper forms) are generally reusable and easily recyclable. Most typically contain recycled content.

Toxicity/IEQ: The production of Portland cement generates significant volumes of CO_2, a significant greenhouse gas. By volume, a concrete mix typically consists of 10 to 15 percent Portland cement or other cementitious material. Some facilities have reduced their CO_2 emissions through energy efficiency improvements and through increased use of waste lime (instead of converting limestone to lime). Approximately 50 percent of the kilns in North America use hazardous waste as fuel. Wastes such as spent solvents, printing inks, paint residues, and cleaning fluids often are designated as hazardous because they are flammable and have high fuel values. These materials can be burned to destruction as fuel in a cement kiln at temperatures of about 2700°F (1480°C) while reducing the need to use fossil fuels. There is controversy over the burning of waste materials (tires, MSW, and hazardous materials) in cement kilns. The EPA and the Cement Kiln Recycling Coalition are addressing citizen concerns. Concrete is relatively inert once cured. Admixtures, curing compounds, and sealers may emit VOCs, especially during the curing process; however, virtually all emissions are eliminated before enclosing the building. Hazardous materials may also be "encapsulated" by being mixed with or imbedded in nonporous, durable concrete, commonly known as solidification and stabilization. However, it is necessary to consider future disassembly and possible options for recycling concrete that has "encapsulated" hazardous materials.

Performance: Performance in place is comparable for green methods and standard methods. Concrete construction provides thermal mass, fire resistance, and durable construction. The thermal mass effect has been proven to reduce heating and cooling loads in most climates. Concrete structures can be designed to last in excess of 100 years, which will result in lower repair and reconstruction resources. The coefficient of reflectivity of concrete allows reduced need for lighting and subsequent electricity when used for paving of roads and parking areas. Steel reinforcing may be separated with magnets from concrete aggregate during recycling operations. Separation of plastic from concrete aggregate may require water to float plastic shards.

03 40 00 (03400) PRECAST CONCRETE

Resource Management: Plant fabrication handles raw materials and by-products at a single location that typically allows greater efficiency and better pollution prevention than job site fabrication. Aggregates for use in concrete include normal sand and gravel, crushed stone, expanded clay, expanded shale, expanded slate, pelletized or extruded fly ash, expanded slag, perlite, vermiculite, expanded polystyrene beads, or processed clay, diatomite, pumice, scoria, or tuff. Architectural items (planters, lintels, bollards) fabricated from lightweight and recycled content aggregates are available. The quantity and type of recycled materials vary from manufacturer to manufacturer and include: cellulose, fiberglass, polystyrene, and rubber. Autoclaved aerated concrete (AAC) is a type of lightweight precast concrete prevalent in Europe, Asia, and the Middle East and recently available through manufacturing facilities in the United States. It is made with Portland cement, silica sand or fly ash, lime, water, and aluminum powder or

paste. The aluminum reacts with the products of hydration to release millions of tiny hydrogen gas bubbles that expand the mix to approximately five times the normal volume. When set, the AAC is cut into blocks or slabs and steam-cured in an autoclave.

Toxicity/IEQ: Refer to Section 03 30 00 (03300)—Cast-in-Place Concrete. Precast concrete generally requires less Portland cement per volume of concrete for similar performance due to better quality control.

Performance: Performance is more predictable in precast operations since more exact dimensions, placement of reinforcing, and surface finishing can be obtained. Precast concrete can be fabricated with continuous insulation. AAC is significantly lighter (about 1/5 the weight of traditional concrete) than normal concrete and can be formed into blocks or panels. Lighter-weight concretes generally have greater fire and thermal resistance but less strength than traditional normal-weight concrete. A full range of lightweight concretes are available and their strength and weight is determined by the aggregates used.

DIVISION 04 MASONRY

04 20 00 (04200) UNIT MASONRY

Resource Management: Mining of clay, shale, soil, sand, limestone, and metal ores can produce soil erosion, pollutant runoff, and habitat loss. Clay masonry firing produces fluorine and chlorine emissions. Manufacturing waste is typically recycled in new units. Salvaged units are available in many communities. Industrial waste by-products can be used for aggregate in concrete block (although documenting this can be difficult) including: air-cooled slag, cinders or bottom ash, ground waste glass and concrete, granulated slag, and expanded slag. Refer to Section 03 30 00 (03300)—Cast-in-Place Concrete for information regarding concrete materials.

Toxicity/IEQ: Masonry is considered to be relatively inert. Refer to Section 03 30 00 (03300)—Cast-in-Place Concrete for information regarding Portland cement. VOCs may be emitted due to additives, sealers and coatings. Because oil is commonly added (and burned away) during the production of clay masonry, the manufacturer can use oil-contaminated soil that is free from hazardous contaminates. Although radon has been associated with certain soils, bricks do not produce abnormal exposure to radon gas except in rare situations.

Performance: Performance is comparable for green methods and standard methods. Traditional masonry construction provides thermal mass and durable construction. Masonry construction, when roughly textured, ribbed or fluted, can help reduce noise by dispersing sound waves. Consider interlocking concrete masonry units for landscape retaining walls; interlocking concrete masonry units do not require mortar and are easy to disassemble and reuse. Masonry is reusable and easily recyclable. Lightweight concrete masonry units are available that have superior thermal and fire resistive properties. Segmental retaining walls and interlocking concrete pavement components for earth retention and pavement applications that do not require the use of mortar are manufactured with similar environmental benefits as concrete masonry units.

04 24 00 (04290) ADOBE UNIT MASONRY

Resource Management: Adobe blocks are made from local clays/soils and dried in the sun, avoiding associated pollution of standard masonry manufacture. Primary ingredients include adobe soil and water. Adobe soils are principally from alluvial deposits and are acquired primarily as a byproduct of sand and gravel mining. Straw is sometimes added to prevent cracking. Moisture will disintegrate adobe; therefore, adobe is protected with cement plaster and overhangs. Also, adobe may be stabilized with asphalt emulsion. Asphalt emulsion is made by combining asphalt, a byproduct of crude oil distillation, with water and proprietary surfactants.

Toxicity/IEQ: Only limited VOC outgassing is associated with asphalt emulsion.

Performance: Adobe construction provides thermal mass. Sizes and shapes of adobe blocks vary, and include: structural bricks, face brick, and tiles. Adobe construction is suitable for a wide range of climates (not just American Southwest), including extremely cold and extremely wet. Performance may vary in accordance with the type of soil materials available locally. An unstabilized adobe wall without protection from rain will erode at rate of approximately 1 inch per 20 years in the American Southwest. Demolished adobe can disintegrate and return to the soil. Adobe is an indigenous construction technique; refer to Section 06 90 00 (06700)—Alternative Agricultural Products. Adobe construction dates back to the walls of Jericho (now located in Israel), around 8300 B.C.

Cob wall construction uses material similar to adobe (earth mixed with sand and straw) but requires no forming. The word *cob* comes from the early English building technique of using earth (mixed with sand and straw) to form organic shapes or "cobs" of the material, which is then placed to form walls. The cobs require no cement or mortar. The thick walls are sculpted, many times in curves with arches for doors and windows.

04 29 50 (04295) RAMMED EARTH

Resource Management: Rammed earth is a compacted mixture of earth, other soil materials, and Portland cement.

Toxicity/IEQ: Rammed earth construction is natural and nontoxic. It is frequently left unfinished on the interior. Refer to Section 03300 (03 30 00)—Cast-in-Place Concrete for information regarding Portland cement.

Performance: Lifts of the soil material are "rammed" within formwork, which is constructed on-site and removed after walls have undergone adequate curing. Tampers compact approximately 8 inches depth of mix into 4 inches of depth in each layer. The walls are characterized by "strata" of mixture indicating the construction technique. Walls (both interior and exterior) may be left exposed or plastered. Like adobe, rammed earth structures perform best in sunny climates, although they can withstand water. Rammed earth is an indigenous construction technique; refer to Section 06 90 00 (06700)—Alternative Agricultural Products. The Great Wall of China, constructed around 200 B.C., is made of rammed earth. Currently, approximately 15 percent of France's population reside in rammed earth structures. Rammed earth construction provides thermal mass, and is water- and fire-resistant.

Traditional rammed earth construction is not appropriate where subject to seismic loads. To comply with building codes in California, rammed earth construction has been used as infill for a post and beam structure, and has been pneumatically sprayed (similar to gunite) over reinforcement anchored to a concrete foundation.

04 40 00 (04440) STONE ASSEMBLIES

Resource Management: Quarrying stone produces soil erosion, pollution runoff, and loss of habitat. In some instances, quarry sites have been restored to approximate previous condition. From 15 percent to 90 percent of the stone can be wasted during the quarrying process due to chipping, trimming, and inferior materials. Most such waste is disposed of as fill at the quarry site or used for base aggregate in local road construction. Stone is available in this country and abroad. Use of local stone reduces transportation impacts.

Toxicity/IEQ: Toxicity/IEQ is comparable for green methods and standard methods. Radon may be a consideration in extremely rare circumstances.

Performance: Stone construction is very durable and can provide thermal mass. Stone is reusable and easily recyclable. However, excess and demolished stone is usually crushed and landfilled.

04 70 00 (04700) MANUFACTURED MASONRY

Resource Management: Various alternative masonry products are available in block, plank, and panel form. Depending on the particular manufacturer, components may include: cement, wood fibers, straw, recycled plastic, and expanded polystyrene foam beads.

Toxicity/IEQ: Like concrete masonry, simulated masonry is considered to be relatively inert. However, plastic and EPS components may outgas.

Performance: Methods of erection are similar to standard concrete masonry units although some products feature laying without mortar joints (dry stacking). Methods of insulating are also similar to concrete masonry units. Alternative masonry products tend to be lighter than standard CMU and more thermally efficient. Efficient recycling of mixed composition materials (e.g., synthetic plastic and cellulose) is problematic at this time as the technology to separate different materials is still evolving.

DIVISION 05 METALS

05 05 00 (05050) COMMON WORK RESULTS FOR METALS

Resource Management: Mining raw materials (iron, limestone, coal) can produce soil erosion, pollutant runoff, and habitat loss. Ore refinement produces heat, combustion emissions and requires significant amounts of water. Supply of some of the raw materials (nickel, chromium, and manganese) is very limited. The iron and steel industry sector has multimedia impacts, including air emissions (CO, SOx, NOx, PM2), wastewater contaminants, hazardous and solid wastes. As an industry, minimills are the largest U.S. consumers of recycled steel scrap, but also face issues related to contaminants in scrap products. The energy used by minimills generates greenhouse gas emissions from power generation. An emerging trend to generate heat on-site by burning carbon may improve energy efficiency but may also increase emissions. Aluminum is fabricated from bauxite, a

mineral found primarily in tropical areas. A significant factor in the clearcutting of tropical rainforests is the desire to gain access to bauxite mines. Aluminum is extensively recycled from both post-industrial sources, such as stamping offal and head, butt and edge trim from rolling or extrusion operations, and postconsumer sources, such as used beverage cans, scrapped automobiles, and end-of-life building products. Mass-produced aluminum is a relatively young building material. This fact, coupled with the long life of aluminum building components, means that aluminum is only beginning to be recycled from building applications. To produce aluminum from recycled material requires only 5 percent of the energy and greenhouse gas emissions required to produce aluminum from bauxite ore, and each ton of recycled aluminum saves 4 tons of bauxite. In addition, using recycled aluminum instead of raw materials reduces the generation of air pollution, such SOx and NOx, by 95 percent and water pollution by 97 percent. About one third of the aluminum used in the United States comes from recycled material with postconsumer scrap contributing about 40 percent of that total.

Toxicity/IEQ: Metal is considered inert. Factory applied finishes emit considerably less VOCs in situ than field applied coatings because the primary outgassing occurs at the plant under controlled conditions.

Performance: Performance is comparable for green methods and standard methods.

Where feasible, use mechanical connections to allow for deconstruction and reuse.

05 10 00 (05100) STRUCTURAL METAL FRAMING

Resource Management: Refer to Section 05 05 00 (05050) for general information on mining and metals industries. The steel industry, the world's largest recycler, utilizes scrap in both of the primary manufacturing processes (Basic Oxygen Furnace and Electric Arc Furnace). The Electric Arc Furnace process, sometimes called minimills, utilizes virtually 100 percent steel scrap, while the Basic Oxygen Furnace process utilizes approximately 30 percent steel scrap in making new steel. Steel in existing buildings may be considered a resource for the future. To date, there is no single organization that provides estimates for potential future supplies of steel scrap. However, the AISI, SRI, and IISI provide estimates for steel production and recycling rates. Iron is the largest raw material stream in steelmaking. The first record of the use of iron goes back to 2500–2000 B.C., and the first deliberate production of iron began around 1300 B.C. Small furnaces that burned charcoal were used in iron production. High-temperature processes were first introduced in Germany around AD 1300, using a very similar design to today's modern blast furnaces. Charcoal was the primary fuel used in the furnaces until 1718 when the first use of coke is reported in the United Kingdom. The modern blast furnace was developed after the Second World War and remains the main process used to make iron. Per the *U.S. EPA Profile of the Iron and Steel Industry*, EPA/310-R-95-005, numerous outputs are produced as a result of the manufacturing of coke, iron, and steel, the forming of metals into basic shapes, and the cleaning and scaling of metal surfaces.

Toxicity/IEQ: Metal is considered inert. Factory applied finishes emit considerably less VOCs in situ than field applied coatings because the primary outgassing occurs at the plant under controlled conditions.

Performance: Steel is made by reducing the carbon content in iron to levels below 2 percent. The reduction of carbon reduces the brittleness of the material, making it easier to shape.

Performance is comparable for green methods and standard methods.

Where feasible, use mechanical connections to allow for deconstruction and reuse.

05 70 00 (05700) DECORATIVE METAL

Resource Management: Mining raw materials produce soil erosion, pollutant runoff, and habitat loss. Ore refinement produces heat, combustion emissions, and requires significant amounts of water. Metal ores are a nonrenewable resource.

Copper has been used for roofing since ancient Greece (the Parthenon in Athens had copper shingles). Approximately 50 percent of the copper used in the United States comes from scrap, which is as usable as the primary copper refined from ore. Declining ore grades have led to increasingly large mines. Ore is crushed and mixed with water and surfactants to make the minerals float to the surface. After smelting, which separates the copper form the iron, sulfur, and other minerals, the copper is refined by fire or electrolytic processes. Sulfur dioxide is produced in copper smelting.

Aluminum is subject to corrosion and must have a protective coating (anodized or duranodic finish). Although aluminum beverage containers are readily recyclable in most communities, most are recycled into new beverage containers. Most aluminum building products contain virgin material. Aluminum is fabricated from bauxite, a mineral found primarily in tropical areas. A significant factor in the clearcutting of tropical rain forests is the desire to gain access to bauxite mines. Aluminum manufacture is water-intensive; wastewater contaminants include: aluminum, fluoride, nickel, cyanide, and antimony.

Wrought iron (iron that is fashioned or formed into intricate patterns) uses iron with a carbon content of 0.03 to 0.05 percent (ASTM A186); carbon is the ingredient that gives iron a fibrous nature and allows it to be malleable when heated. The lower the carbon content, however, the more resistant it is to corrosion.

Stainless steel is a family of iron-base alloys containing about 10.5 percent chromium or more and other elements such as nickel, manganese, molybdenum, sulfur, selenium, and titanium. Sixty commercial stainless steel types were originally recognized by the American Iron and Steel Institute (AISI) in three primary categories: austenitic stainless steels are chromium-nickel-manganese compositions (AISI Series 200 and 300); ferritic stainless steels are straight chromium steels (AISI Series 400) that are not hardenable by heat treatment, and martensitic stainless steels are straight-chromium (AISI Series 400) and are hardenable by heat treatment.

Toxicity/IEQ: Metal is inert and has virtually no impact on IAQ.

Performance: Performance is comparable for green methods and standard methods.

DIVISION 06 WOOD, PLASTICS, AND COMPOSITES

06 05 73 (06070) WOOD TREATMENT

Resource Management: Some species of wood are naturally resistant to decay caused by the elements, while others are resistant to termite attack. These include the following species whose heartwood is commonly recognized by the building codes as resistant to decay: black locust, cedar, and black walnut. Redwood and eastern red cedar are resistant to termites.

Toxicity/IEQ: Lumber, timber, wood structural panels, piles, and poles supporting permanent structures are often required by building codes to be preservative treated in accordance with the requirements of an applicable American Wood-Preservers Association (AWPA) standard for the species, product, preservative and end use. There are three broad classes of wood preservatives: (1) creosote, which is generally used in railroad ties, utility poles, and pilings; (2) oil-borne preservatives, such as pentachlorophenol and copper naphthenate, generally used for utility poles, assembly area roof supports, and glulam construction; and, (3) waterborne preservatives which are the most common preservatives used in residential, commercial and industrial construction. Waterborne preservatives include: ammoniacal copper arsenate (ACA), alkaline copper quaternary (ACQ-B and ACQ-D), ammoniacal copper zinc arsenate (ACZA), chromated copper arsenate (CCA), copper boron azole (CBA-A and CA-B), and copper napthenate, sodium borate (SBX). Chlorothalonil is also used as a fungicide to control fungal diseases on trees and crops. In use, wood preservatives are usually of fairly low volatility, but may outgas over time. While their emissions rates are not large and they do not generally result in high indoor air concentrations, some may pose health hazards. CCA has been the most common waterborne preservative treatment. However, on February 12, 2002, the EPA announced a voluntary decision by industry to move consumer use of treated lumber products away from preservatives that contain arsenic by December 31, 2003, in favor of preservatives that do not contain arsenic for most residential uses. This transition affects preservative-treated wood used in play-structures, decks, picnic tables, landscaping timbers, residential fencing, patios and walkways/boardwalks. As of January 1, 2004, the EPA does not allow CCA to be used to treat wood intended for any of these residential uses. This decision on CCA, however, does not restrict the use of CCA preservative-treated wood for pilings, permanent wood foundations, and similar applications.

Performance: Wood preservatives are used to make wood resistant to fungus growth and termite attack. Most building codes require that structural wood elements in direct contact with earth, embedded in concrete/masonry that is in direct contact with earth, or exposed to moisture, be of naturally durable wood or preservative-treated wood. Where alternative products or systems are used, a variance from the building department may be required. Do not specify wood furnishings or finishes that require tight humidity controls of the mechanical systems. Comfort standards typically allow humidity to fluctuate to save energy costs.

06 10 00 (06100) ROUGH CARPENTRY

Resource Management: Wood is a renewable resource. Forests provide many environmental benefits, including: habitats, potential sources for medicines,

and climatic control. Many certified sources of sustainably harvested wood are available. Nonsustainable harvesting of wood can produce soil erosion, pollutant runoff, increased levels of atmospheric carbon dioxide, global warming, and habitat loss. Forest Certification Standards in North America include:

- The American Tree Farm System developed by the American Forest Foundation
- Canada's National Sustainable Forest Management Standard
- ISO 14001 developed by the International Organization for Standardization. Although not a forest-specific standard, ISO offers a special technical report ISO 14061 that is specific to forestry and assists with implementation of ISO 14001 in forestry
- The Principles for Natural Forest Management developed by The Forest Stewardship Council
- The Sustainable Forestry Initiative created through the American Forest & Paper Association and currently managed by the Sustainable Forestry Board (an independent entity established to manage SFI)

Most trees in the United States are referred to as either "hardwoods" or "softwoods." Hardwood trees are deciduous trees that, with a few exceptions, lose their leaves in the fall or winter. Softwood forest types are conifers and evergreens such as pines, spruces, firs, and junipers. Wood that is used in construction of buildings is primarily softwood. Much of America's hardwoods, such as oaks, are found along the East Coast. Softwood trees are concentrated in the West and South. Douglas fir is the dominant softwood in the West, while southern pines, such as loblolly and shortleaf, are the most abundant softwoods in the South. Quaking aspen, a hardwood, is the most widely distributed tree species in North America.

The term "Engineered Wood Product" (EWP) refers to a wood-based product that has a set of design properties assigned to it. EWPs are often manufactured as a combination of smaller pieces of wood that together create larger high-strength structural elements or components. Engineered wood components include: plywood, oriented strand board (OSB), composite wood panels, glue-laminated beams, structural composite lumber, including laminated veneer lumber and parallel strand lumber, as well as I-joists and metal plates connected wood trusses. An additional subcomponent of structural composite lumber would include laminated strand lumber. Finger-jointed lumber, which is interchangeable with solid sawn lumber, is also considered an EWP. Finger-jointed lumber or end-jointed lumber is permitted to be used interchangeably with solid sawn members of the same species and grade. However, when finger-jointed lumber is marked "STUD USE ONLY" or "VERT USE ONLY," such lumber shall be limited to use where any bending or tension stresses are of short duration. Engineered wood products are typically prefabricated, not site fabricated. Engineered wood products are frequently more efficient in construction of assemblies than solid sawn lumber due to the lower coefficient of variance of EWPs. EWP assemblies tend to be more resource efficient than assemblies constructed of solid sawn members.

Toxicity/IEQ: Adhesive binders used in engineered wood products are any of several synthetic resins that pose varying degrees of human health risks. Refer to Section 06 05 73 (06070)—Wood Treatment for information regarding treated wood.

Performance: Wood is a natural and efficient building material. The structural design characteristics of wood change over time as a result of changes in weather and other growing factors. These changes in structural design values of various wood species are recorded through a in-grade testing program of lumber and published periodically in ANSI/AF&PA's National Design Specification© (NDS©) for Wood Construction. For efficient resource use of solid sawn lumber, it is recommended that the least acceptable grade of lumber be specified to suit the purpose. As an alternate to new solid sawn lumber, reclaimed lumber can be used since it performs comparably to new lumber if properly graded by a grading agency in accordance with American Lumber Standards Committee grading rules. Further, the use of engineered wood products can result in resource efficiencies than might be expected of conventional lumber/timber construction. However, engineered wood products might be more difficult to recycle than standard, solid sawn lumber due to the binders used in the manufacture of the engineered wood product.

06 16 00 (06160) SHEATHING

Resource Management: Sheathing includes boards, wood structural panels, particleboard, chipboard, Medium Density Fiberboard (MDF) and hardboard. Alternative products such as cellulose fiberboard (recycled newsprint), honeycomb cardboard (recycled paper or alternative agricultural fibers), and straw fiberboard (agricultural waste) are available and can serve many of the same purposes as MDF and particleboard; refer to Section 06 90 00 (06700)—Alternative Agricultural Products. Specify the sheathing product that is cost-effective to meet performance requirements. Each type of wood-based sheathing provides unique structural and serviceability properties. Wood structural panels, for example, are manufactured from veneers, or wood strands, or a combination of veneer and wood strands, bonded together with waterproof synthetic resins or other suitable bonding systems. Examples of wood structural panels are: composite panels, a structural panel that is made of layers of veneer and wood-based material; oriented strand board (OSB), a wood structural panel that is a mat-formed product composed of thin rectangular wood strands arranged in oriented layers; and plywood, a wood structural panel composed of plies of wood veneer arranged in cross-aligned layers. Wood structural panels are used in applications, such as wall bracing and diaphragms because of their strength properties. MDF, which uses smaller waste wood particles than OSB is seldom used for structural applications because of its brittleness. Likewise, the use of particleboard, which uses the smallest wood particles, is restricted in the codes because of its brittleness.

Toxicity/IEQ: Processed wood and wood waste products such as particleboard, chipboard, and hardboard often utilize a formaldehyde-based resin as a binder or adhesive. Formaldehyde is considered a "probable" carcinogen based on animal data. ANSI standard A208.189 for particleboard limits formaldehyde emissions to 0.30 ppm for general-purpose products and 0.20 ppm for flooring. Interior grade particleboard is fabricated with

urea-formaldehyde; exterior grade particleboard is fabricated with phenol resin, which is considered less toxic than urea formaldehyde. Particleboards that are formaldehyde free are also available. Alternative binders include: parafin wax (such as some cellulosic fiberboard), rosin, starch, and methyl diisocyanate (such as straw fiberboard or some MDF).

Performance: Performance is comparable for green methods and standard methods. Since each product has unique structural and serviceability characteristics, performance is dependent on the design and application of the sheathing.

06 20 00 (06200) FINISH CARPENTRY

Resource Management: Refer to Section 06 10 00 (06100)—Rough Carpentry for information on wood as a renewable resource and on sustainable forestry. Sheathing materials manufactured from alternative agricultural products are available; refer to Section 06 90 00 (06700)—Alternative Agricultural Products. Plastic laminates are composed of thin layers of paper and thermosetting resins. Two types of resins, melamine and phenol, are typically used. Melamine resin contains melamine (produced from urea) and formaldehyde (produced from methanol); phenol contains phenol (produced from benzene and propylene, which in turn are obtained from crude oil and natural gas) and formaldehyde. Two types of paper, kraft (brown, unbleached) and alpha-cellulose (white, bleached), are typically used. Both types of paper are typically manufactured from virgin materials. Pigments and inks color the decorative top layer of paper (the alpha-cellulose paper).

Toxicity/IEQ: VOCs may be emitted during the curing process for adhesives and finishes. Low and zero VOC adhesives are available. Low VOC finishes for wood are available. Refer to Section 09 90 00 (09900)—Painting. Plastic laminates are relatively inert after manufacture. Other finish products include: linoleum, tile, solid surfacing, and wood veneer.

Performance: Plastic laminates are easy to clean and disinfect, but can scratch easily. Plastic laminates are difficult to recycle because they are a composite material with thermosetting resins. Refer to other sections for information on other finish products.

06 60 00 (06600) PLASTIC FABRICATIONS

Resource Management: Plastic lumber is generally fabricated from 100 percent recycled pre- and postconsumer plastics. It may also contain recycled cellulose.

Toxicity/IEQ: As a substitute for treated lumber, it reduces potential leaching of chemicals used in wood treatment. Refer to Section 06 05 73 (06070)—Wood Treatment.

Performance: Plastic lumber is a durable, weather-resistant, and low-maintenance material. Plastic lumber is integrally colored and homogenous and so does not require painting. It is recyclable. One hundred percent recycled content plastic lumber may not perform well in lengths greater than 6 feet or where deflection and creep are significant considerations (e.g., fencing, decking, and bollards). For such uses, consider plastic lumber with fiber such as cellulose or glass. The fiber improves stability and resistance to screw pullout.

06 75 00 (06750) STRAW BALE CONSTRUCTION

Resource Management: Straw is a renewable resource and an agricultural waste product that is typically burned, thus contributing to air pollution. Straw is often confused with hay, which is a food product; straw is the dry stems of cereal grains after the seed heads have been removed.

Toxicity/IEQ: Straw is natural and nontoxic, although some people may be allergic to it. While straw bales do not represent a food sources, they may provide a home for microbes, insects, and small animals, so it is important to encapsulate the bales inside and outside with Portland cement plaster.

Performance: Straw bale walls can be either load-bearing or non-load-bearing. Typically, straw bale walls are stacked bales pinned together using reinforcing bar (rebar) dowels, which are drilled or driven into the successive courses of bales. Transverse loading testing, in accordance with ASTM E-330, Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference, resulted in a maximum deflection of 1.87″ at 20 psf for unstuccoed straw bale walls, and a maximum deflection of 0.13″ at 20 psf and a maximum deflection of 0.22″ at 50 psf for stuccoed straw bale walls. Fire testing in accordance with ASTM E-119, Method for Fire Tests of Building Construction and Materials, resulted in a survived flame penetration for unstuccoed straw bale wall of 34 minutes, and for stuccoed straw bale walls of 120 minutes (the test discontinued at 120 minutes). The stuccoed straw bale walls survived the fire hose test with no indication of distress or failure. The R-value for straw bale walls, as tested by Sandia Laboratories, is 2.67 per inch of thickness; thermal values for walls range from R-44 to R-52. There are many jurisdictions that allow straw bale building under the alternative materials and methods provisions of the existing codes, but there are also some that have specific provisions for straw bale construction, including parts of Arizona (the City of Tucson, Pima County, Pinal County, the Town of Guadalupe); California (State Guidelines and several counties and municipalities); Boulder, Colorado; the state of New Mexico; and Austin, Texas.

06 90 00 (06700) ALTERNATIVE AGRICULTURAL PRODUCTS

Resource Management: The number of species of plants and animals upon which society depends is exceptionally small relative to the number of species that are available and adequate to the purpose. By promoting the use of alternative agricultural products, the building industry can not only promote less toxic, renewable resource, carbon sinking products but also revitalize the market interest in a variety of flora and help to preserve the earth's biodiversity. Alternative agricultural products refers to a growing market segment for the building industry (and other industries) that is capitalizing on little-known and underutilized species. Consider alternate, nonendangered/nonthreatened species. The Convention on International Trade and Endangered Species (CITES) lists wood species that are endangered or threatened. Alternative agricultural building products include alternative lumber species and nontimber products fabricated from wheat straw, kenaf fibers, soy resins, and bamboo. Starch-based plastics have penetrated the consumer market and are gaining ground in packaging. There are starch-based plastics and cellulose aggregate additives in development that might have potential for the construction industry. Alternative fuels and the

systems that utilize them should also be considered. The EPA promotes and expands the use of environmentally beneficial alternative fuels and vehicles by providing the states with tools, such as benefits models, State Implementation Plan Credits, and the Clean Fuels Fleet program. It should be recognized that agricultural processes are not without potential for environmental impacts, including soil erosion, non-point-source pollution, and destruction of habitat. For additional information, refer to the U.S. Department of Agriculture Natural Resources Conservation Service; Conservation Reserve Program, which: reduces soil erosion, protects the nation's ability to produce food and fiber, reduces sedimentation in streams and lakes, improves water quality, establishes wildlife habitat, and enhances forest and wetland resources. It encourages farmers to convert highly erodible cropland or other environmentally sensitive acreage to vegetative cover, such as tame or native grasses, wildlife plantings, trees, filterstrips, or riparian buffers. Farmers receive an annual rental payment for the term of the multi-year contract.

Toxicity/IEQ: Most of the alternative agricultural products are designed to replace petroleum and synthetic chemical-based products and have been specifically developed to be environmentally friendly.

Performance: Typically, only a limited number of wood species (relative to the tremendous diversity available) have approval by governing agencies based upon their documented structural characteristics (bending strength, compression strength, etc.), and by millwork fabricators based upon their physical characteristics (grain, luster, heartwood color, sapwood color, texture, odor, ease of drying, weathering, etc.) and woodworking characteristics (blunting effects, boring, carving, cutting resistance, gluing, mortising, molding, nailing, painting, planning, polishing, sanding, screwing, varnishing, veneering, etc.). Introducing alternative species for structural purposes may require a variance from the building department. Alternative agricultural products are often based in indigenous materials. Indigenous materials include: straw, wool, coconut fibers, cactus juice, leaves, ice, and sod. Most governing agencies classify "indigenous" construction as "alternative" construction. Use of alternative or indigenous building materials and methods may require a variance from the building department. Most alternative agricultural products perform adequately to the purpose for which they were designed. In some instances, however, the manufacturer does not have all the testing data typically used to describe performance requirements (e.g., compression, screw pull-out, etc). Furthermore, the standard test methods may not be appropriate to the alternative of material. ASTM, ISO, and other standards organizations are beginning to address this need.

DIVISION 07 THERMAL AND MOISTURE PROTECTION

07 10 00 (07100) DAMPPROOFING & WATERPROOFING

Resource Management: Natural materials such as bentonite clay are available (and have long been used) for waterproofing below grade. Many sheet membrane waterproofing materials contain a small percentage of recycled

asphalt or rubber. Zero VOC, clear penetrating water repellent for masonry, concrete, and stucco are available.

Toxicity/IEQ: VOCs may be emitted during the curing process.

Performance: Performance is comparable for green methods and standard methods when using below grade. For proper performance of bentonite waterproofing materials, confinement of the material is critical. Bentonite should only be used for below-grade applications, not above-grade applications. Bentonite requires initial exposure to moisture to properly hydrate and function but cannot be exposed to standing or moving water. Bentonite cannot dry out once hydrated.

07 20 00 (07200) THERMAL PROTECTION

Resource Management: Thermal batt insulation includes: glass fiber, cotton insulation, mineral wool (made from slag wool, an industrial byproduct from iron ore blast furnace, and rock wool, natural material such as basalt and diabase). Sprayed insulation includes: mineral wool and cellulose. Loose fill insulation includes: perlite, vermiculite, polystyrene beads, mineral wool, fiberglass, and cellulose. Foamed in place insulation includes: silicate foam (made from inorganic cementitious stabilizer, magnesium oxide, a catalyst, and compressed air) and low density closed cell polyurethane. Rigid board insulation includes: fiberglass, cellular glass foam, expanded polystyrene, extruded polystyrene, polyisocyanurate, and polyurethane. Insulation made from renewable resources, such as cellulose, is available. Straw, wool, coconut fibers, leaves, and sod are traditional and indigenous insulation materials; refer to Section 06 90 00 (06700)—Alternative Agricultural Products. Insulation made from recycled materials such as cellulose and textiles and glass are available.

Toxicity/IEQ: Adsorptive materials such as batt insulation may act as sinks for VOCs. Thermal- and fireproof-insulation materials do not necessarily need soft, adsorptive surface; consider coating with a smooth and impermeable membrane to reduce the adsorption of VOCs. Design such that an impermeable layer is not located to create a moisture problem in the exterior envelope. Trapped moisture in insulation may promote growth of mold and mildew. The International Agency for Research on Cancer (IARC) has removed glass, rock, and slag wool fibers from its list of substances "possibly carcinogenic to humans." A complete report documenting the science behind this change in classification, *IARC Monograph on the Evaluation of Carcinogenic Risks to Humans, Volume 81, Man-Made Vitreous Fibres*, was made available in October 2002 through IARC. OSHA requires warning labels and MSDSs for fiberglass material identifying it as a "possible" carcinogen. The long, thin fibers of fibrous minerals are suspected of increasing the risk of cancer. Fibrous glass insulation materials may contain formaldehyde-based resin binder materials. OSHA also requires MSDSs for rock and slag wool insulations. The Consumer Product Safety Commission (CPSC) requires labeling on cellulose insulation to inform individuals that a fire hazard exists where cellulose insulation is improperly installed too close to the sides or over the top of recessed electrical light fixtures, or installed too close to the exhaust flues from heat producing devices or apparatus such as furnaces, water heaters, and space heaters. The National Toxicology Program (NTP) classifies fiberglass as a "possible" carcinogen. Cellulose

is regulated as a hazardous substance (29 CFR 1910.1000 Table Z). Cellulose insulation is required by the Federal Hazard Communication Standard to provide MSDSs regarding adverse health effects. Cellulose insulation can contain chemical additives, such as ammonium sulfate, boric acid, and sodium borate, for fire retardancy. Borates are generally considered to have low acute toxicity for mammals.

Performance: Insulation conserves energy; adding insulation above the minimum requirements set by codes for the health and comfort of the occupants can help protect the environment and reduce emissions. The thermal resistance of insulation is designated by R-value. R-value is resistance to heat flow. The higher the R-value, the greater the insulating power. Thickness of insulation is only one factor that determines its R-value. In fact, according to the Federal Trade Commission's Home Insulation Rule, insulation should always be specified by R-value, not thickness. 16 CFR Part 460. The R-value per inch of fiber-based insulation can vary depending on density. Optimal thickness of the insulation should be determined through Life Cycle Assessment with a goal of minimizing life cycle costs related to energy use. Equally important in selecting insulation is that the product's R-value does not deteriorate over time. Loose fill cellulose insulation materials can settle over time thereby reducing their insulation value; however, loose fill spray insulation can have an added binder to reduce settling. The Insulation Contractors Association of America (ICAA) recommends that an additional 25 percent of thickness for cellulose insulation be added above the labeled settled thickness. The weight of insulation products may also alter the quality of performance. For example, when installing insulation above ceilings, caution should be taken to ensure that the insulation weight does not alter the integrity of the ceiling structure. Based on U.S. Gypsum weight limit recommendations, the installed density of cellulose insulation can cause ceiling drywall to sag at R-values above R-30 for cellulose insulation when installed above 1/2 inch thick gypsum board ceilings supported with framing spaced 24 inch on centers. Building materials that introduce moisture into the building envelope like cellulose insulation should demonstrate an established drying time before enclosing the wet material behind the walls. Moisture can also adversely affect the thermal performance of cellulose insulation products. And, to reduce thermal loss from air movement in the gaps between insulation board joints, provide two layers of insulation, with staggered board joints. Foil facing can provide some resistance to air infiltration and adds a radiant barrier, if a sealed air space is provided on both sides of the material. Avoid thermal bridging, especially with highly conductive metal framing systems. Glass, rock, and slag wool are naturally noncombustible and remain so for the life of the product.

07 30 00 (07300) STEEP SLOPE ROOFING

Resource Management: Mining raw materials for the manufacture of stabilizers and surfacing granules produces soil erosion, pollutant runoff, and habitat loss. Asphalt, modifiers, and fiberglass mat binders are derived from petrochemicals. Extraction of petroleum and natural gas can generate air and water pollution. Organic felt with recycled fiber content is available in some asphalt shingles. Roof tiles may be fabricated from clay, fiber cement, concrete, plastics and polymer-based composites or metal. Refer to

Section 03 30 00 (03300)—Cast-in-Place Concrete for information regarding Portland cement. Fiber-cement roofing can include recycled content fiber. Felt underlayment can include recycled content. Metal roofing tiles and panels can contain up to 100 percent recycled metal.

Toxicity/IEQ: Asphalt base shingles contain petroleum products and will outgas, especially in warm, sunny climates. Clay, concrete, fiber cement, and metal are generally considered inert. Since the material is on the exterior of the structure, there is generally little direct contamination of indoor air quality.

Performance: Provide light colored roof surfaces to improve albedo. Asphalt shingles are recyclable, especially for paving, but the infrastructure necessary to effectively recycle them is not yet developed. Recycled rubber shingles can have a class A fire rating, pass wind tests up to 110 mph, and be sawed and nailed like wood. Photovoltaic shingles are available; refer to Section 48 14 00 (13600)—Solar Energy Electrical Power Generation. Clay, concrete, fiber cement, plastics, and polymer-based composites and metal are durable, fire and insect resistant, and, easily disassembled. Clay, concrete, and fiber cement may be crushed and used for subbase material or fill. Fiber cement products typically do not perform well where freeze-thaw cycles occur.

07 33 63 (02930) VEGETATED ROOFING

Resource Management: Green roofing systems offer an excellent opportunity to incorporate renewable resources into the built environment. Some systems are available with drainage layers manufactured from recycled plastic. Green Roofs for Healthy Cities, a nonprofit, provides information related to the economic, social, and environmental benefits of green roof infrastructure across North America.

Toxicity/IEQ: Green roofing systems have the capacity to improve environmental quality. Plants process carbon dioxide (carbon sinking). They can process certain types of toxins through their leaves and roots. Green roofing systems can provide biofiltration of rainwater.

Performance: Modern systems have evolved from traditional building techniques and include membranes and drainage layers appropriate to modern building needs. Warranted garden roof systems have been used in Europe for decades. Green roofing systems, when properly detailed and installed, can provide excellent thermal and acoustic insulation. The plants contribute to carbon sinking and can provide wildlife corridors, urban agriculture, and recreational areas. By using water in situ, they also help minimize stormwater runoff and improve local hydrologic cycle functions. Care must be taken to design for anticipated live and dead loads.

07 50 00 (07500) MEMBRANE ROOFING: *Resource Management*: Membrane manufacturers are developing products fabricated from postconsumer materials. Refer to Section 07 30 00 (07300)—Steep Slope Roofing for additional information.

Toxicity/IEQ: The cold adhesives used in adhesive application of roofing membranes are generally volatile chemicals. Roofing adhesive that is water-based and/or low-VOC is available. Refer to Section 06 60 00 (06600)—Plastic Fabrications for information regarding plastics.

Performance: Provide light colored roof surfaces to improve albedo. Membrane roofing is difficult to recycle because of the variety of materials

involved and because those materials are generally adhered to each other. While reuse and recycling of membrane roofing is not typical, it is possible. Mechanically fastened membranes are easier to disassemble in the future; facilitating recycling of membrane and of substrate. Installation of a layer of sheathing between roofing insulation and roofing membrane, may allow for membrane removal without damage to insulation.

FEMP maintains recommendations for roofing materials.

07 55 63 (07530) VEGETATED PROTECTED MEMBRANE ROOFING

Resource Management: Refer to Sections 07 33 63 (02930) and 07 50 00 (07500).

Toxicity/IEQ: Refer to Sections 07 33 63 (02930) and 07 50 00 (07500).

Performance: Refer to Sections 07 33 63 (02930) and 07 50 00 (07500).

07 92 00 (07900) JOINT SEALANTS

Resource Management: A variety of sealants, single component and multi-component, are available for different applications. There are few, if any, alternative agriculture or recycled content choices.

Toxicity/IEQ: VOCs may be emitted during the curing process. Generally, sealants continue to outgas throughout their life. Closed cell backer rods outgas when ruptured. Open cell polyurethane backer rods are sponge-like and may absorb moisture.

Performance: Performance is comparable for green methods and standard methods. Sealants reduce air infiltration and moisture penetration. Verify that the proper sealant is specified for the given application. Improper selection can result in reapplication, air infiltration, water damage.

DIVISION 08 OPENINGS

08 05 00 (08050) COMMON WORK RESULTS FOR OPENINGS

Resource Management: Refer to Division 06 for information related to wood and plastic. Refer to Division 05 for information related to metal.

Toxicity/IEQ: Plastics and factory coatings may outgas.

Performance: Specify window systems that are compatible with the calculated thermal loads of the building. This will reduce condensation not only on the glazing and sash, but also on the adjacent wall and other interior surfaces. For wood doors and windows, see comments in Division 06 (6). Provide thermal break for exterior framing systems, and weather-stripping for doors in exterior frame to reduce thermal conductivity and improve energy efficiency.

08 11 00 (08100) METAL DOORS AND FRAMES

Resource Management: Core materials for metal doors vary widely, including fiberglass and plastic foams (poly-styrene and polyurethane) for insulating doors, steel ribs, honeycomb paperboard (which often has recovered content), or a fire-resistive core (such as mineral fiber) for fire-rated doors. HFC-free, HCFC-free expanded polystyrene is the preferable insulating core; refer to Section 07 20 00 (07200)—Thermal Protection for information on blowing agents.

Where possible, specify factory finishing. Where field finishing is required, specify a high solids, low VOC-durable coating such as a

high-performance water-based acrylic paint. Avoid alkyd enamel paint, a solvent-based paint that emits large quantities of VOCs.

Toxicity/IEQ: Metal is inert and has virtually no impact on IAQ.

Performance: Specify an insulation core for exterior metal doors.

08 14 00 (08210) WOOD DOORS

Resource Management: Refer to Division 06 (6) for information on wood.

Toxicity/IEQ: Refer to Division 06 (6) for information on wood.

Performance: Performance is comparable for green methods and standard methods.

08 44 00 (08900) CURTAIN WALL AND GLAZED ASSEMBLIES

Resource Management: Refer to Section 08 80 00 (08800) Glazing for information regarding glass and refer to Section 05 05 00 (05050)—Common Work Results for Metals for information regarding metals.

Toxicity/IEQ: Glass and metal are considered inert.

Performance: Photovoltaic curtain wall panel systems are available; refer to Section 48 14 00 (13600)—Solar Energy Electrical Power Generation Equipment).

08 50 00 (08500) WINDOWS

Resource Management: Windows can be fabricated from a variety of wood, metal, and plastic. Refer to Divisions 05, 06, and 09 (5, 6, and 9) for information on these materials.

Toxicity/IEQ: Windows can be fabricated from a variety of wood, metal, and plastic. Refer to Divisions 05, 06, and 09 (5, 6, and 9) for information on these materials.

Performance: The energy efficiency of the window can vary with glazing selection, window type (casement, double-hung, etc.) and construction (thermal break, aluminum-clad, etc.). Window properties are critical to energy performance and visual satisfaction. Specify low U value to reduce winter heat loss and summer heat gain. Windows on the west and east sides experience maximum solar gain in summer and should have a low Solar Heat Gain Coefficient (SHGC). Low SHGC is achieved with selective glass, tinted glass, or reflective coating. Specify selective glass for clear appearance or when high visible transmittance is required for daylighting goals. South-side glass may be protected from summer sun by an overhang and have a high SHGC if winter heat is useful. Specify a low SHGC for south-side glass if the building is dominated by internal heat gain and solar heat is unwelcome even in winter. North-side receives very little sun and requires no special treatment. FEMP maintains a guide on residential window recommendations.

08 60 00 (08600) ROOF WINDOWS AND SKYLIGHTS: *Resource Management*: Resource management impacts are comparable for green methods and standard methods.

Toxicity/IEQ: Toxicity/IEQ is comparable for green methods and standard methods.

Performance: Daylight tubes that “pipe” or “duct” natural light into a space are available. Active tracking devices are available that follow the sun’s path and maximize the amount of natural light directed through the skylight

opening. Refer to Section 08 50 00 (08500)—Windows for information regarding The National Fenestration Rating Council (NFRC) rating program.

08 70 00 (08700) HARDWARE

Refer to Section 05 05 00 (05050)—Common Work Results for Metals for information on metals and metal finishing.

08 80 00 (08800) GLAZING

Resource Management: Mining raw materials (sand, limestone, and soda ash) produces soil erosion, pollutant runoff, and habitat loss. Manufacturing is energy-intensive and can generate heat, air, and water pollution.

Recycled glass products are available for decorative architectural glass (stained glass and glass block).

Toxicity/IEQ: Glass is inert and has virtually no impact on IAQ. VOCs may be emitted from glazing compounds during the curing process.

Performance: Glazing technologies are improving rapidly. Control of light and heat transmittance, and the corresponding energy efficiency, is becoming much more sophisticated. At one end of the spectrum is the traditional insulated glazing. Typical, off-the-shelf energy efficiency specifications may call for double-glazed, low-E units with coating on the second surface (inner side of outer panel) in climates below 3,000 heating degree days, and on the third surface (outer side of inner panel) for climates at or over 3,000 heating degree days. At the other end of the spectrum, however, are photovoltaic spandrel panels and films that turn increasingly translucent/opaque when exposed to heat. Refer to Section 08 44 00 (08900)—Curtain Wall and Glazed Assemblies).

DIVISION 09 FINISHES

09 22 00 (09100) SUPPORTS FOR PLASTER AND GYPSUM BOARD

Resource Management: Refer to Section 05 10 00 (05100)—Structural Steel for information regarding steel.

Toxicity/IEQ: Thermal bridging at steel framing in exterior walls can create cold spots in the wall that promote the growth of mold.

Refer to Section 05 10 00 (05100)—Structural Steel for information regarding steel.

Performance: Thermal bridging at exterior walls can negatively impact energy efficiency. Dimpled framing is being tested to determine if a dimpled leg, with less surface area in direct contact with sheathing materials, will improve performance. Proper design with sufficient insulation can address this problem as well.

Refer to Section 05 10 00 (05100)—Structural Steel.

09 29 00 (09250) GYPSUM BOARD

Resource Management: Mining raw materials (gypsum, limestone, clay, talc, mica, and perlite) produces soil erosion, pollutant runoff, and habitat loss. Gypsum is a nonrenewable although relatively abundant resource. Preconsumer recycled gypsum may be obtained from synthetic sources such as Flue Gas Desulfurization and acid neutralization in chemical processes. Also, clean construction waste can be processed to renew the gypsum in the core. Calcining (heating at 325–340°F to become the hemihydrate of

calcium sulfate, stucco) produces particulate emissions, including: calcium sulfate dihydrate, calcium sulfate hemihydrate, anhydrous calcium sulfate, and gangue. Paper (cellulose) is a renewable resource. Paper manufacture is considered water intensive and energy intensive. It generates air and water pollutants; however, it should be noted that the paper industry has made significant progress in converting its papergrade bleached kraft mills' bleaching processes to elemental chlorine free (ECF) bleaching. Effluents from mills using ECF are "non-detect" for dioxin, using the EPA approved method with a minimum level of 10 parts per quadrillion (ppq).

Toxicity/IEQ: Additives used to produce waterproof gypsum board ("green board") and fire resistant gypsum board may include VOCs. The paper backing may contain chemicals from previous uses (most paper backing contains recycled materials) and additives or chemicals used in the production of the paper itself. VOCs may be emitted from taping compounds and finishes during the curing process.

Performance: Performance is comparable for green methods and standard methods.

09 30 00 (09300) TILE

Resource Management: Mining raw materials (clay, silica, talc, feldspar, and limestone) for tile produces soil erosion, pollutant runoff, and habitat loss. Clay and sand are non-renewable although relatively abundant resources. Adhesives for setting tile and for latex mortar and grout are typically derived from petrochemicals. Standard Portland cement mortar is composed of Portland cement, sand, and water; refer to Section 03 30 00 (03300)—Cast-in-Place Concrete for information regarding Portland cement. Pigments include a variety of crystalline materials obtained from the calcining of oxides of metals such as cobalt, nickel, aluminum, and chromium.

Manufacturing of ceramic tile is considered energy intensive; however, there have been some energy efficiency improvements in firing techniques in recent years. Manufacture generates particulate emissions. Most manufacturers reclaim their fired scrap materials. Tile containing recycled glass is available; generally, the recycled glass is preconsumer, industry waste such as windshield glass and waste from light bulb manufacture. Tile containing feldspar tailings, a byproduct of feldspar refining process, is available.

Toxicity/IEQ: Tile (ceramic and quarry) is inert and cementitious mortar and grout is considered inert when cured. VOCs may be emitted from self-leveling cements and adhesives during the curing process.

Performance: Tile is extremely durable and requires little maintenance. Performance is comparable for green methods and standard methods.

09 51 00 (09510) ACOUSTICAL CEILINGS

Resource Management: The major constituents of acoustical ceiling tiles are mineral wool (fabricated from slag and rock wool), cellulose, starch (primarily from corn), clay (for fire-rated products), fiberglass, and paint. Mining raw materials produces soil erosion, pollutant runoff, and habitat loss. Manufacture of acoustic ceiling tiles does not generate much waste because scrap material is recycled back into the process. Acoustic ceiling tile manufactured from recycled cellulose is available; generally, the recycled cellulose is preconsumer, industry waste. Ceiling tile manufactured from slag wool, which is a preconsumer recycled material, is also available.

Steel framing containing recycled steel is available. Specify reclamation of existing acoustical ceiling tiles for remodel projects in order to reduce waste generated by project and to promote closing the loop for recycling.

Toxicity/IEQ: Paints used in ceiling tiles and panels are typically low VOC, water-based paints. PVC is used in the vinyl facing on some ceiling tiles. Refer to Section 09 65 00 (09650)—Resilient Flooring for additional, related information. Adsorptive materials may act as sinks for VOCs emitted from other sources. When the concealed spaces above suspended ceilings are used as return air plenums, both the upper and lower surfaces of the ceilings are exposed to the circulating airstream. The temperatures at the ceiling surfaces are generally among the warmest in the interior space due to the thermal stratification that normally occurs. The increased temperature results in increased emissions of VOC from the ceiling materials. Cornstarch used as a binder can, in the presence of moisture, fuel growth of bacteria and mold.

Performance: Performance of green materials for noise reduction coefficient (NRC) standards and light reflectance is comparable to standard materials. Cellulose, fiberglass, and mineral wool ceiling tiles are suitable for dry areas and moderate acoustical requirements. Where acoustical demands are higher, specify mineral fiber tiles or cellulose tiles, which are coated with low-VOC, water-based paint. Cellulose, mineral fiber, and glass fiber can absorb moisture in a high-humidity areas and promote microbial growth. In high-humidity areas, specify tiles with nonabsorptive cores such as glass-fiber-reinforced polyester.

09 64 00 (09640) WOOD FLOORING

Resource Management: Wood flooring manufactured from reclaimed lumber and from alternative species is available. Bamboo, for example, is a fast-growing grass that can be finished into beautiful hardwood flooring. Bamboo can be specified in Section 09 62 23—Bamboo Flooring. Refer to Section 06 90 00 (06700)—Alternative Agricultural Products for information on alternative species. Refer to Section 06 10 00 (06100)—Rough Carpentry for information on wood as a renewable resource and on sustainable forestry. Most stains and varnishes are derived from petrochemicals.

Toxicity/IEQ: Avoid wood floor finishes that are solvent-based polyurethanes. Water-based polyurethanes contain mostly aliphatic hydrocarbons instead of the mostly carcinogenic aromatic hydrocarbons found in solvent-based finishes. Other alternatives include waxes and citrus-based finishes.

Performance: Performance is comparable for green methods and standard methods. Bamboo has twice the stability of red oak and up to 90 percent of the hardness. Installation and maintenance is similar to a hardwood floor. Water-based polyurethanes may not perform as well as solvent-based in high-traffic areas.

09 65 00 (09650) RESILIENT FLOORING

Resource Management: Plastic tiles are available in a variety of polymers, including polyolefin and vinyl. Ingredients in vinyl flooring include polyvinyl chloride (PVC), which is made from petroleum, chlorine from salt, and plasticizers. Vinyl flooring made from 100 percent recycled-content PVC is available in tile and plank sizes. Typically, vinyl composition floor tile consists of 85 percent limestone filler. Cork is a renewable resource harvested on

a nine-year cycle. Some cork flooring is fabricated from bottle-cork industry waste. Some cork floors use synthetic binders in the manufacturing process and synthetic finishes providing more durable walking surfaces. Ingredients in rubber flooring may include either natural rubber or synthetic materials, although the majority of rubber flooring is made form synthetic materials. The polymerization process used to make synthetic rubber can be varied to achieve different characteristics in a rubber floor. Natural rubber is a renewable raw material that is extracted from the sap of the tropical rubber plant (without harming the plant).

Toxicity/IEQ: VOC emissions from the maintenance (e.g., wax and strip cycle) required by many flooring products may exceed the VOC emissions associated with installation. Leveling compounds may contain latex or polyvinyl acetate resins, and can emit VOCs, including 4-PC. Adhesives may also be a source of VOCs. Factory-backed adhesive tiles, typically used in residential applications, have fewer emissions than standard "wet" adhesive installation. Some styles of plastic flooring are available in loose-laid design (puzzle pieces that are tapped together with a rubber mallet) that can be installed without adhesive. VOC emissions can be emitted from resilient flooring. The Resilient Floor Covering Institute (RFCI) has established the FloorScore IAQ Certification Program for testing for VOC emissions from hard surface flooring. Under this program, an independent third-party organization certifies that hard surface flooring products meet the VOC emissions requirements of California Section 1350. This California standard sets limits for VOC emissions for specific chemicals based on health risk assessments. For a variety of perspectives regarding the health impacts of vinyl over its life cycle, refer to the US Green Building Council's PVC Task Group website.

Performance: Rubber, cork, and plastic flooring are available in both sheet and tile forms. Typically, cork provides better sound absorption characteristics than most plastic and rubber flooring. Typically, commercial plastic flooring and rubber flooring are more durable than cork flooring. Typically, no waxes are required to maintain rubber floors.

09 65 16.13 (09654) LINOLEUM

Resource Management: Linoleum is manufactured from cork, linseed oil, wood flour, and pine resin. Ground up stone and wood are added for color. Backing is typically jute or polyglass. As agricultural products, cultivation of jute, flax (linseed oil), and pine can contribute to carbon sinking; they can also result in runoff of pesticides and chemical fertilizers. The wood flour and cork flour are typically obtained from preconsumer, industrial wastes. Polyglass is a combination of fiberglass and polyester fibers. The finish coat is typically a waterborne acrylic. Manufacture generates very little waste because nearly all manufacturing waste is recycled back into product.

Toxicity/IEQ: Linoleum is made predominantly from renewable resources, and while it has a distinctive odor, it is not believed to emit dangerous VOCs. Offgassing from linoleum may cause problems for persons with chemical sensitivity, especially during the first few days after installation. After a few days–weeks, the oxidation of the linseed oil decreases significantly. Linoleum is naturally antibacterial because of the continuous oxidation of the linseed oil. Refer to Section 09 65 00 (09650)—Resilient Flooring for additional, related information.

Performance: Linoleum is very durable when maintained properly. Linoleum is available in sheet or tiles. Linoleum should not be installed in areas where moisture problems are anticipated as wet conditions may damage the floor. Some linoleum manufacturers recommend (as an alternative to traditional wet maintenance procedures) a dry maintenance system that requires periodic spray buffing. When using a wet procedure to maintain linoleum, caution should be used no to use a high pH cleaner which can damage the floor.

09 66 00 (09400) TERRAZZO FLOORING

Resource Management: Terrazzo flooring was originally developed as a byproduct of Italian mosaic artwork. As mosaic artists chipped marble tessera for their mosaic pieces, the marble and lime mortar tailings that fell to the floor were swept out on the terrace where there were trampled into the surface. Soon, such flooring was common on Italian terraces; hence, "terrazza." Today, the chips are generally not byproducts, but are specifically mined. Mining raw materials (marble, granite, quartzite, quartz, silica pebbles, sand, and components of Portland cement) produces soil erosion, pollutant runoff, and habitat loss. Underground mining of crushed stone is becoming more common due to increased environmental and economic benefits. In underground (room-and-pillar) mining, there is less overburden to be removed, and operations can continue all year long. Components of resins, primers and sealers are typically derived from petrochemicals. Refer to Section 03 30 00 (03300)—Cast-in-Place Concrete for information regarding Portland cement.

Terrazzo aggregate can contain recycled glass stone and glass aggregate.

Toxicity/IEQ: When cured, terrazzo is fairly inert. VOCs may be emitted from plastic matrix during the curing process and from sealers during curing and periodic maintenance. Coordinate with temporary ventilation in Section 01 35 43 (01351)—Environmental Procedures, especially where epoxy terrazzo systems are used. Waterborne acrylic sealers are available for most applications. Avoid epoxy sealers except where chemical or stain resistance is required. Avoid polyvinyl divider strips; refer to Section 09 65 00 (09651)—Resilient Flooring for information on PVC.

Performance: Performance is comparable for green methods and standard methods. Terrazzo with glass aggregate has an apparent depth and luminescence that can be very beautiful. An alternative to sealing Portland cement terrazzo is to clean with a neutral cleaner/water solution. After several cleanings, the residue of cleaner on the floor will make it buffable. After approximately two months, the floor finish will have a patina that requires less maintenance.

09 68 00 (09680) CARPETING

Resource Management: Carpet is a composite product made from face fibers that are bonded to primary and secondary backing material, usually with an adhesive. Manufacturers make carpet from different face fibers, which makes carpet recycling programs more challenging, as most carpet recyclers only accept carpet made from a particular type of face fiber. The most common face fibers (and their respective percentage of the carpet market) are: nylon (57 percent), polypropylene "Olefin" (36 percent), polyester "PET" (7 percent), and wool (0.4 percent). Wool, cotton, jute,

hemp, seagrass, and sisal rugs and carpets are available; however, most natural fiber carpets do not meet accepted performance requirements of commercial carpet. Many synthetic carpets contain recycled content. Some carpet manufacturers offer a close-the-loop reclamation program. Starch-based plastic fibers (polylactic acid or "PLA" fibers) are in development. Carpet pads manufactured from recycled textiles and waste carpets are available.

Toxicity/IEQ: Synthetic carpet fiber, backing, pad, adhesive, seam sealants, and floor preparation chemicals are all potential sources of VOC in indoor air. Carpet treatment for natural and synthetic carpet fibers (mothproofing, antimicrobial, etc.) are potential sources of VOCs in indoor air. VOCs may be emitted from adhesives and from interaction of adhesive and carpet backing during the curing process. However, since the inception of the Carpet and Rug Institute's (CRI) Green Label Program in 1992, the industry has made substantial reductions in the levels of TVOCs, as well as reductions in 4-phenylcyclohexene (4-PC), the compound most associated with "new carpet odor." CRI has established Green Label criteria for carpet, cushion, adhesive, and vacuum cleaners. Installation with tack strips (stretch in method) over pads can avoid potential adhesive interaction with carpet backing. Provisions can be made for carpet with self-adhesive. Carpeting also provide a sink for adsorbing VOCs emitted from other sources and home for a variety of bacteria, microbes, dust mites, etc. Area rugs are a possible alternative because they can be removed and cleaned outdoors by beating and letting the sun bake them. Refer to Section 09 65 00 (09650)—Resilient Flooring for additional, related information.

Performance: Carpeting provides improved thermal and acoustic performance. In addition to the close-the-loop recycling programs developing in the carpet industry, a few manufacturers also have green lease programs. CRI has introduced a Carpet Component Identification Code labeling system to make component identification easier for future recycling collection and sorting. This labeling system is currently being used by many CRI member companies. Carpet America Recovery Effort^{sm} (CARE) is a voluntary initiative of the carpet industry and government to develop market-based solutions for the recycling and reuse of postconsumer carpet. CARE was established in January 2002 as a result of a Memorandum of Understanding for Carpet Stewardship (MOU), a national agreement signed by members of the carpet industry, representatives of government agencies at the federal, state, and local levels, and nongovernmental organizations. The MOU establishes an ambitious 10-year schedule to reduce the amount of waste carpet going to landfills.

09 69 00 (10270) ACCESS FLOORING

Resource Management: Access flooring is fabricated with aluminum, steel, and medium-density fiberboard parts. At least one manufacturer, Camino Modular Systems, offers refurbished access flooring and refurbishing it for reuse.

Toxicity/IEQ: Medium-density fiberboard generally contains formaldehyde. The concealed space between the raised floor and the structural floor can be a source of contaminants, either gaseous or particulate. However, it can also be used for locating sophisticated personal air control systems.

Performance: Performance is comparable for green methods and standard methods.

09 72 00 (09720) WALLCOVERINGS

Resource Management: Wallcoverings manufactured from recycled cotton, sustainably harvested wood, and natural materials such as sisal, jute, straw, and wool are available. Cellulose in wallpaper is a renewable resource. Refer to Section 09 29 00 (09250)—Gypsum Board for information regarding paper. Polyvinyl chloride (PVC) may be used in vinyl wallcovering. Refer to Section 09 65 00 (09650)—Resilient Flooring for information on PVC.

Toxicity/IEQ: Fabrics, plastics, and paper wall coverings each have unique potential chemical content and emission characteristics. Refer to Section 09 65 00 (09650)—Resilient Flooring for information on PVC. VOCs may be emitted from adhesives and backings during the curing process. Nonpermeable wall coverings may trap moisture and promote the growth of mold and mildew. Refer to Section 09 65 00 (09650)—Resilient Flooring for additional, related information.

Performance: Performance is comparable for green methods and standard methods.

09 90 00 (09900) PAINTING & COATING

Resource Management: Most standard paints contain some materials that are derived from petroleum products. Petroleum is a nonrenewable resource and extraction and refining are known to produce air and water pollutants. Paints manufactured from natural plant and mineral based finishes are available. They contain extracts from plant sources and minimally processed earth minerals, such as chalk or iron oxides. Solvents for natural paints include citrus oils and small amounts of low-odor petroleum solvents (dearomaticized isoparrafinics.) Milk-based paint contains lime, milk protein, clay, and earth pigments. Recycled content paints are available.

Toxicity/IEQ: Most conventional paint and coating products offgas VOCs that are added to enhance product performance and shelf life. High quality, low-toxicity, and low-VOC substitutions are now available for these products. Emissions from paints and coatings are primarily from evaporating solvents and other volatile organic compounds (VOCs) released by oxidation. Water-based paints acrylic latex paints are lower in VOCs (<250 mg/L) than solvent-based paints. Low-VOC is generally accepted to mean paint with a VOC content less than 100 mg/L. While a variety of low-VOC and zero-VOC paints are now available to choose from, they vary in cost, toxicity, and performance. Therefore, paint selection should consider VOC content as well as overall composition and required performance characteristics, including hideability and durability. A paint can be "low-VOC" yet still contain odorous, toxic, or otherwise undesirable ingredients such as ammonia, formaldehyde, crystalline silica, odor masking agents, and many other compounds, including fungicides and bactericides. In addition, hazardous ingredients can degrade the natural environment during production and after disposal. Look for water-based paints that are formaldehyde-free, Zero- or low-VOC, and low-toxic. "Zero-VOC" or low-VOC paints minimize the indoor air pollution load and health risks to both workers and occupants. Water-based paints are generally safer to handle and can be cleaned

up with water, reducing health risks to workers and minimizing/avoiding hazardous waste. Note, there is no regulatory definition for "zero," "low," "formaldehyde-free," or "low-toxic" VOC paint and coatings. VOC and other constituent contents for these low and zero or constituent free products will vary depending upon the product category.

Performance: Milk-based paint, the most common paint prior to this century, is not recommended for exterior use or damp conditions. The performance of low-VOC paint has improved considerably over the last several years. Ceramic coatings for field application over typical exterior cladding materials (masonry, stucco, wood) are also available. Ceramic coatings are low-emissivity paints that reflect radiant energy. Such coatings can generate energy savings of up to 30 percent during the cooling season, and are extremely durable.

DIVISION 10 SPECIALTIES

10 14 00 (10400) SIGNAGE

Resource Management: Refer to Section 06 60 00 (06600)—Plastic Fabrications and Section 05 05 00 (05050)—Common Work Results for Metals.

Toxicity/IEQ: Refer to Section 06 60 00 (06600)—Plastic Fabrications and Section 05 05 00 (05050)—Common Work Results for Metals.

Performance: Performance is comparable for green methods and standard methods. Specify low power LED illuminated signage for exit signs and lit directional signage; refer to Section 26 50 00 (16500)—Lighting. Consider photovoltaic power for illuminated signage removed from a building electrical panel by distance or obstructions; refer to Section 48 14 00 (13600)—Solar Energy Electrical Power Generation.

10 21 13.19 (10170) PLASTIC TOILET COMPARTMENTS

Resource Management: Refer to Section 06 60 00 (06600)—Plastic Fabrications.

Toxicity/IEQ: Refer to Section 06 60 00 (06600)—Plastic Fabrications.

Performance: Plastic partitions perform as well or better than most toilet partitions. They are water-resistant, graffiti-resistant, and nonabsorbent, with plastic face sheets permanently fused to plastic core.

10 28 00 (10800) TOILET, BATH, AND LAUNDRY ACCESSORIES

Resource Management: Automatic, sensor-operated hand dryers are available.

Toxicity/IEQ: Automatic hand dryers replace paper towels and eliminate their disposal and associated bacteria.

Performance: Performance is comparable for green methods and standard methods.

10 30 00 (10300) FIREPLACES AND STOVES

Resource Management: Steel utilized on stoves is recycled material. Steel stoves used for heating that are manufactured from up to 100 percent post-consumer steel are available. Although local conditions vary, combustion

appliances rely on a relatively inefficient use of natural resources that generates air emissions and contributes to global warming.

Toxicity/IEQ: Combustion appliances including fireplaces and wood stoves can be sources of organic and inorganic gases and of particulate matter. Smoke particles are possible carcinogens.

Performance: Cast-iron wood stoves, gas stoves, and fireplaces may be used for space heating. Efficiencies have improved in recent years, and range from 50 percent to 90 percent.

10.81.16.13 (02872) BAT HOUSE

Resource Management: Bat houses themselves have minimal environmental impacts; however, the bats that they house are often important members of the local ecosystem. Bats have lived in America since the age of dinosaurs. Today they rank among our most endangered wildlife. The loss of bats threatens the balance of nature and our economy. The majority of bats in the United States eat insects; a few bat species in the Southwest and in Florida drink nectar and pollinate plants. The built environment can displace these valuable members of the ecosystem; bat houses offer a compromise for maintaining wildlife corridors through urban areas.

Toxicity/IEQ: Bats are very important controllers of night-flying insects. One little brown bat can catch up to 1,200 mosquitoes in just one hour. Bats may be considered biological pest control. Alternative pest control methods—such as biological pest controls—include design options and maintenance procedures to control sources of food, water, and harborage that are available to pests and to limit pest access into and throughout buildings; refer to Section 10 81 50 (10295)—Integrated Pest Management (IPM).

Performance: Minimal maintenance required.

10 81 50 (10295) INTEGRATED PEST MANAGEMENT (IPM)

Resource Management: Pesticide use exerts a powerful selection pressure for changing the genetic make-up of a pest population. Naturally resistant individuals in a pest population are able to survive pesticide treatments. The survivors pass on the resistance trait to their offspring. The result is a much higher percentage of the pest population resistant to a pesticide. In the last decade, the number of weed species known to be resistant to herbicides rose from 48 to 270, and the number of plant pathogens resistant to fungicides grew from 100 to 150. Resistance to insecticides is so common—more than 500 species—that nobody is really keeping score. Pesticides often kill off natural enemies along with the pest. With their natural enemies eliminated, there is little to prevent recovered pest populations from exploding to higher, more damaging numbers than existed before pesticides were applied. Additional chemical pesticide treatments only repeat this cycle.

Toxicity/IEQ: Only a minute portion of any pesticide application contacts the target organism. The remainder may degrade harmlessly, but too often water, wind, and soil carry pesticides to nontarget areas and organisms, affecting the health of human and wildlife populations. Public concerns over residues are deepened by the lack of research and knowledge about possible synergistic interactions between pesticide residues and the hundreds of other synthetic chemical residues now found in the environment. Both pests and

pesticides pose health concerns for building occupants. Pests carry human pathogens and may produce potent human allergens. Building occupants may be exposed to pesticides through the air, or direct contact with treated surfaces. IPM is being recognized by many experts as the best means to control pests effectively, while using the least amount of pesticide necessary. An increasing number of states, municipalities, and schools systems are mandating that IPM programs be implemented in their buildings.

Performance: Studies have indicated that in most situations where IPM has been implemented, both pesticide use and pest problems have decreased dramatically. The national goal of implementing integrated pest management (IPM) methods on 75 percent of the nation's cropland was jointly announced by the U.S. Department of Agriculture, the U.S. Environmental Protection Agency, and the Food and Drug Administration in September 1993. This goal represents a commitment by the federal government to work with its state and private sector partners to develop and implement ecologically based pest management approaches that rely less on synthetic chemical pest controls and are more sustainable. IPM has been used successfully for many years in agriculture, and is increasingly being applied in nonagricultural settings. In structural pest control (pest control in and around buildings), IPM focuses mainly on eliminating or reducing sources of food, water, and harborage that are available to pests, and limiting pest access into and throughout buildings. Control measures such as sanitation, and building maintenance and modifications are strong elements of a structural IPM program. The success of such a program requires the collaborative efforts of everyone involved in the management and maintenance of a building, including service contractors, tenants, custodians, and other employees. Education and cooperation are necessary parts of any IPM program.

DIVISION 11 EQUIPMENT

11 11 00 (11140) VEHICLE SERVICE EQUIPMENT

Resource Management: Electric charging stations and compressed natural gas (CNG) fueling stations are necessary for changing our transportation infrastructure. By utilizing alternative fuels, we can all help to reduce greenhouse gas emissions, especially one of the most significant—carbon dioxide. Carbon dioxide is a major greenhouse gas. In the upper levels of the atmosphere, carbon dioxide acts similarly to the windshield on a car, trapping heat. Atmospheric carbon dioxide concentrations are significantly greater than preindustrial levels. Much of the carbon dioxide buildup is due to automobiles, which have increased in number steadily since World War II. Vehicle-washing equipment routinely recycles water. Additionally, purple pipe water may often be used for vehicle washing equipment. Depending on the applicable regulatory requirements, auto service centers may reclaim tires and recycle oil.

Toxicity/IEQ: Equipment that promotes alternative fuel and recycling is always environmentally preferable and less polluting.

Performance: Specific performance evaluations are difficult since they tend to be apples-and-oranges comparisons.

11 12 00 (11150) PARKING CONTROL EQUIPMENT

Resource Management: Traffic control speed bumps manufactured from recycled rubber are available. Parking stops manufactured from recycled plastic are available. Refer to Section 06 50 00 (06500)—Structural Plastics.

Toxicity/IEQ: Toxicity/IEQ is comparable for green products and standard products.

Performance: Performance is comparable for green methods and standard methods. Recycled rubber speed bumps often have longer life cycles than asphalt speed bumps. Recycled plastic parking stops often have longer life cycles than concrete parking stops; and, where colored stops are required, plastic outperforms concrete, as it is homogenous (including color) and does not require painting.

11 13 00 (11160) LOADING DOCK EQUIPMENT

Resource Management: Bumpers manufactured from recycled tires are available. For additional information on scrap tire programs and civil engineering applications refer to the EPA Product Stewardship Program.

Toxicity/IEQ: Toxicity/IEQ is comparable for green products and standard products.

Performance: Performance is comparable for green methods and standard methods.

11 23 00 (11110) COMMERCIAL LAUNDRY AND DRY CLEANING EQUIPMENT

Resource Management: Ozonation is an alternative method for laundry (and dishwashing) that conserves water and minimizes chemical usage. With ozone laundering, washing time can be reduced by nearly half because the rinse cycle can be eliminated.

Toxicity/IEQ: Ozone oxidizes bacteria, viruses, and other contaminants without undesirable odors or byproducts. Ozone is pH neutral, and reduces chemical usage up to 95 percent. Ozone oxidizes contaminants up to 3,000 times faster than chlorine.

Performance: With the addition of ozone as an oxidant, laundry and dishwashing machines can run at lower wash temperatures for shorter cycles. In most situations (including hotels) laundry is cleaned as effectively with ozonation as with chemical laundry methods. Ozonation reduces chemical costs, chemical storage requirements, and labor expenses. It requires weekly, rather than daily, chemical check. Also, it prolongs the life of equipment by reducing calcium and scale buildup.

11 28 00 (11680) OFFICE EQUIPMENT

Resource Management: Office equipment historically has been available on a lease basis. Various green lease programs are available or in development.

Toxicity/IEQ: Toxicity/IEQ is comparable for green products and standard products.

Performance: The EPA has developed minimum energy efficiency standards for Energy Star labeled products. EPA Energy Star categories include: computers, copiers, facsimile machines, monitors, printers, and scanners.

11 30 00 (11450) RESIDENTIAL EQUIPMENT

Resource Management: Several green manufacturers produce super-efficient appliances and most mainstream manufacturers now produce energy

efficient models. Some manufacturers have developed residential washers on the horizontal axis that require much less water. When used in combination with ionizing washer disks, they can significantly reduced water usage and pollution.

Toxicity/IEQ: IAQ impact is comparable for green appliances and standard appliances. However, by virtue of their improved energy efficiency, green appliances contribute far less contaminants to the environment during their lifetime than do standard appliances.

Performance: Obviously, energy efficient appliances require less energy to operate. Most perform the task for which they were designed comparably to the standard designs which they replace. Federal Trade Commission (FTC) regulations require appliances to be labeled indicating their energy performance (their bright yellow EnergyGuide label). Typically, horizontal axis washers are more efficient than top loading, and, top-bottom refrigerator/freezers are more efficient than side-by-side refrigerators. Recycling systems are available and include under-the-counter containers to separate recyclables. They also include interior composting systems which are generally a variation of the standard garbage disposal. In some designs, the composting chute empties to an externally accessible composting bin. FEMP maintains product efficiency recommendations for a wide range of residential equipment, including appliances and mechanical equipment.

DIVISION 12 FURNISHINGS

12 05 13 (12050) FABRICS

Resource Management: Typical fabrics used in building products include: wool, worsted wool, wool and polyester blend, polyester, vinyl, modacrylic, silk and flax, nylon, and chlorofiber. Wool, a natural fiber obtained from domesticated sheep, is valued for its absorbency, resiliency, insulation, and ability to take dye well. Wool has some environmental concerns relative to animal husbandry, including soil erosion due to overforaging and pesticide runoff due to the immersion treatment (for parasites on sheep). Polyester is produced from petroleum and natural gas. Manufacture of polyester fiber generates air emissions, including polymer dust, volatized residual monomer, and fiber lubricants. A variety of dyes are used, depending on the fabric and color desired. Many fabric dyes contain petrochemicals. Dyeing fabric is water-intensive and can generate toxic pollutants. Draperies, upholstery, and wall coverings manufactured from organically grown natural fibers with nontoxic dyes are available. Organically grown cotton grown in certain colors is available. Some fabrics are also available that have recycled plastic (generally PET—soda pop bottles) content. Unfortunately, this combines petroleum-based plastics and organics in a way that is difficult to separate for future recycling.

Toxicity/IEQ: Dyes and fabric treatments, such as wrinkle-free or fire-resistant ones, can be toxic. Chemicals used for finishes and other purposes on fabrics can be sources of VOCs. Cornstarch and tapioca are used as sizing. Copper compounds, chromium compounds, and chlorinated phenol are used to inhibit mold and mildew. Silico-fluorides and chromium-fluorides, camphor, naphthalene, and paradichlorobenzene are used for

mothproofing. Organic halo-genphosphorous compounds, aryl bromophosphate, triethanolamine, and trimethylol melamine are used as flame retardants.

Performance: Fabric produced from natural fiber*s*, especially when dyed with natural, nontoxic dyes, is biodegradable.

12 10 00 (12100) ART

Resource Management: Many artists have embraced environmental ethics. Options range from lead-free, recycled content stained glass to reclaimed, found-object sculpture, to green statements beautifully expressed in traditional mediums.

Toxicity/IEQ: While many media can be very toxic during production, most are considered inert when cured/complete.

Performance: Performance is comparable for green methods and standard methods. Do not specify artwork or furnishings that require tight humidity controls of the mechanical systems. Comfort standards typically allow humidity to fluctuate to save energy costs.

12 40 00 (12400) FURNISHINGS AND ACCESSORIES

Resource Management: A variety of green furniture products are available, including products manufactured from sustainably harvested wood, recycled metal, recycled plastic, alternative agricultural materials, and organically grown fibers.

Toxicity/IEQ: Fabric coverings may act as sinks for VOCs. Refer to Section 12 05 13 (12050)—Fabrics.

Performance: Performance is comparable for green methods and standard methods.

12 48 13 (12482) ENTRANCE FLOOR MATS & FRAMES

Resource Management: Refer to Division 09 (9) for information on resilient flooring and carpeting. Refer to Division 05 (5) for information on metals. Refer to Division 06 (6) for information on plastics. General purpose rubbers are the most widely used rubbers, largely because of their uptake in pneumatic tires, and account for about 80 percent of total rubber consumption. They comprise the following: natural rubber (chemically cis-1,4-polyisoprene and produced mainly from the botanical source, Hevea brasiliensis); butadiene rubber; styrene-butadiene rubber (SBR), by far the most widely consumed synthetic rubber); and isoprene rubber (the synthetic rubber equivalent of natural rubber).

Toxicity/IEQ: Refer to Division 09 (9) for information on resilient flooring and carpeting. Refer to Division 05 (5) for information on metals.

Performance: Performance is comparable for green methods and standard methods.

12 59 00 (12700) SYSTEMS FURNITURE

Resource Management: Several modular office furniture manufacturers have environmental lines including reclaimed, refurbished furniture, furniture with recycled materials, and furniture with organic fibers/fabric. A variety of green furniture products are available including products manufactured from sustainably harvested wood, recycled metal, recycled plastic, alternative agricultural materials, and organically grown fibers. Typical fabrics

used in building products include: wool, worsted wool, wool and polyester blend, polyester, vinyl, modacrylic, cotton, silk and flax, and nylon. Wool, a natural fiber obtained from domesticated sheep, is valued for its absorbency, resiliency, insulation, and ability to take dye well. Wool has some environmental concerns relative to animal husbandry, including soil erosion due to overforaging and pesticide runoff from the immersion treatment (for parasites on sheep). Polyester is produced from petroleum and natural gas. Manufacture of polyester fiber generates air emissions, including polymer dust, volatized residual monomer, and fiber lubricants. A variety of dyes are used, depending on the fabric and color desired. Many fabric dyes contain petrochemicals. Dyeing fabric is water-intensive and can generate toxic pollutants. Draperies, upholstery, and wall coverings manufactured from organically grown natural fibers with nontoxic dyes are available. Organically grown cotton grown in certain colors is available. Some fabrics are also available that have recycled plastic (generally PET—soda pop bottles) content.

Toxicity/IEQ: System furniture may be constructed from various materials. including composite wood products, insulations, and adhesives that are all potential sources of VOC emissions. Freestanding, partial height partitions (or panels) can interfere with the proper distribution of ventilation air. Install panels according to plans prepared after the design of the HVAC system. Raising partition bottoms above the floor may improve air flow at work stations contained within partial height panel systems. Fabric coverings may act as sinks for VOCs. Dyes and fabric treatments, such as wrinkle-free or fire-resistant ones, can be toxic. Chemical used for finishes and other purposes on fabrics can be sources of VOCs. Cornstarch and tapioca are used as sizing. Copper compounds, chromium compounds, and chlorinated phenol are used to inhibit mold and mildew. Silico-fluorides, and chromium-fluorides, camphor, naphthalene, paradichlorobenzene are used for mothproofing. Organic halogenphosphorous compounds, aryl bromophosphate, triethanolamine, and trimethylol melamine are used as flame retardants. The Business and Institutional Furniture Manufacturers Association (BIFMA), with input from government, commercial testing and manufacturing organizations, has developed standards associated with VOCs, BIFMA M7.1 and BIFMA X7.1.

Performance: Performance is comparable for green methods and standard methods. Fabric produced from natural fiber*s*, especially when dyed with natural, nontoxic dyes, is biodegradable. Do not specify artwork or furnishings that require tight humidity controls of the mechanical systems. Comfort standards typically allow humidity to fluctuate to save energy costs.

12 92 33 (12800) INTERIOR PLANTERS)

Resource Management: Many recycled content planters are available. Refer to Section 06 60 00 (06600)—Plastic Fabrications and Section 06 50 00 (06500)—Structural Plastics.

Toxicity/IEQ: There are potentially positive and negative impacts of plants on indoor air quality. Claims have been made that plants can remove contaminants from indoor air. The potential damage of plant materials and the associated growing media relate to elevated moisture levels and potential

amplification of microbial contaminants. Where plants are used, planters should be well drained and the drainwater removed to the exterior.

Performance: Performance is comparable for green methods and standard methods.

DIVISION 13 SPECIAL CONSTRUCTION

13 17 00 (13170) TUBS AND POOLS

Resource Management: Refer to Section 11 23 00 (11110)—Commercial Laundry and Dry Cleaning Equipment for information on ozonation.

Toxicity/IEQ: Ozonation is an alternative to chlorination. Chemical-free tub systems that utilize ozonation are available. Refer to Section 11 23 00 (11110)—Commercial Laundry and Dry Cleaning Equipment for information on ozonation.

Performance: Ozonation reduces total dissolved solids (TDS) so pools need to be drained less. Refer to Section 11 23 00 (11110)—Commercial Laundry and Dry Cleaning Equipment for information on ozonation.

13 19 00 (13185) KENNELS AND ANIMAL SHELTERS

Resource Management: Concentrated animal feeding operations (CAFO) issues have focused public attention on the potential environmental damage from animal operations. Such damage includes destruction of native habitat, erosion, and contamination of waterways. Proper design and operations can mitigate the environmental impact. For example, by placing composting bins under cages of vegetarian animals such as birds and rabbits, the droppings can be easily composted.

Toxicity/IEQ: Improper management of kennels, animal shelters, and CAFO can produce some extremely unhealthy conditions. Select products that are easily maintained with nontoxic methods to help promote proper management. Depending on the scale of the CAFO operations, an NPDES permit may be required.

Performance: From a human perspective, performance is comparable for green methods and standard methods. From an animal perspective, green methods are likely to perform much better. Animals respond instinctively to healthy and environmentally appropriate conditions.

13 42 00 (13020) BUILDING MODULES

Resource Management: Prefabricated assemblies are more resource-efficient than field-constructed assemblies. Standardized shapes and processes mean less waste. Shop fabrication allows for environmental controls unavailable at the site, such as paint booths that can reclaim overspray.

Toxicity/IEQ: Prefabricated module units have been severely criticized for their poor IAQ. The same considerations and investigations conducted on field-constructed components should be exercised when reviewing prefabricated components.

Preengineered structures that are assembled on-site can provide the best of both worlds: minimal waste and good IAQ.

Performance: Performance is comparable for green methods and standard methods.

13 48 00 (13080) SOUND, VIBRATION, AND SEISMIC CONTROL

Resource Management: Resource management is comparable for green methods and standard methods.

Toxicity/IEQ: Vibration transmitted through the building structure can cause occupant complaints similar to sick building syndrome complaints. Isolate mechanical equipment and other building equipment. Vibration sources can also include adjacent roadways or parking garages.

Performance: Performance is comparable for green methods and standard methods. In some cases, equipment life can be prolonged by appropriately dampening vibration.

DIVISION 14 CONVEYING SYSTEMS

14 20 00 (14200) ELEVATORS

Resource Management: Refer to Division 05 (5) for information regarding metal products. Refer to the applicable Division 09 (9) section for information regarding interior finish products.

Toxicity/IEQ: Hydraulic fluids and lubricants used in elevators can cause indoor air quality problems when exposed to indoor airstream. Hydraulic fluids and lubricants can contaminate groundwater.

Performance: Elevators consume a significant fraction of the total energy used in tall buildings. In low-rise and mid-rise buildings, their energy use is less substantial, but opportunities for improving conventional practices are huge. In addition to reducing energy use, newly selected elevators should minimize other environmental concerns, such as the potential for leaking hydraulic fluid, maintenance requirements, and future replacement cost. In very general terms, elevators for low- and mid-rise buildings are typically either hydraulic or traction (gear-driven) systems, while high-rise buildings use variable voltage-variable frequency (VVVF) controlled gearless AC-motors replacing earlier DC technology. A more recent evolution is the availability of VVVF systems for low- and mid-rise applications, which makes the energy efficiency and comfort of that technology available to buildings that are not so tall.

DIVISION 21 FIRE SUPPRESSION

21 07 00 (15080) FIRE SUPPRESSION SYSTEMS INSULATION

Resource Management: Refer to Section 07 20 00 (07200)—Thermal Protection.

Toxicity/IEQ: Refer to Section 07 20 00 (07200)—Thermal Protection.

Insulation may produce airborne fiberglass and microbial contamination. When soft, adsorptive duct linings become contaminated by particles, they can absorb up to 10 times more moisture; and moisture can contribute to microbial contaminants such us molds. Insulation for application to the outside of ductwork is preferable.

Performance: Specify minimum thickness in accordance with ASHRAE 90.1. Provide additional thickness to ensure that surface temperatures are below 100 degrees and to prevent condensation on cold surfaces.

DIVISION 22 PLUMBING

22 07 00 (15080) PLUMBING INSULATION

Resource Management: Refer to Section 07 20 00 (07200) Thermal Protection.

Toxicity/IEQ: Refer to Section 07 20 00 (07200)—Thermal Protection.

Insulation may produce airborne fiberglass and microbial contamination. When soft, adsorptive duct linings become contaminated by particles, they can absorb up to 10 times more moisture; and moisture can contribute to microbial contaminants such us molds. Insulation for application to the outside of ductwork is preferable.

Performance: Specify minimum thickness in accordance with ASHRAE 90.1. Provide additional thickness to ensure that surface temperatures are below 100 degrees and to prevent condensation on cold surfaces.

22 10 00 (15100) PLUMBING PIPING AND PUMPS

Resource Management: Traditional metal piping has been largely replaced by PVC piping for building piping. Refer to Section 09 65 00 (09650)—Resilient Flooring) for information regarding manufacture of PVC.

Toxicity/IEQ: Specify traditional metal piping. Avoid PVC piping. Refer to Section 09 65 00 (09650)—Resilient Flooring) for information regarding PVC. Several ionization options are available for preventing mineral buildup. These range from "drop-in" type toilet bowl cleaners to equipment spliced into piping runs. Grease traps that utilize bacteria to decompose the grease are available. When the food source is exhausted, the bacteria turn on each other; therefore, the bacteria supply must be replenished each day. Natural strains of bacteria are generally used; these have an exceptionally high capacity for digesting specific organic compounds found in grease traps. J-drains (traps) with removable panels for easy cleaning are available. These allow cleaning without use of polluting chemicals at sinks and lavatories.

Performance: Avoiding chemical pollution during operation typically means that the building owner must understand the operating system better and be willing to expend a pound of prevention instead of 10 pounds of cure. Verify that owner's operating manuals include information regarding J-drains, grease traps, and so on.

22 33 00 (15480) ELECTRIC DOMESTIC WATER HEATERS

Resource Management: Refer to Section 22 05 00 (15050)—Common Work Results for Plumbing).

Toxicity/IEQ: The primary IEQ consideration for domestic water supply is water quality, which, for most buildings, is largely determined by the municipal water treatment facility. Refer to Section 15050—Basic Mechanical Materials and Methods (22 05 00—Common Work Results for Plumbing).

Performance: Energy efficiency is improved over older heaters because of new heating technologies and better tank insulation. Obviously, energy-efficient appliances require less energy to operate. Most perform the task for which they were designed comparably to the standard designs they replace. Federal regulations require appliances to be labeled indicating their energy

performance (a bright yellow EER—energy efficiency rating—label). This is a developing field, and models are constantly being improved.

Instantaneous point-of-use (tankless, on-demand) electric water heaters are available for commercial and residential use. These are particularly effective when demand is located far away from domestic hot water mains.

22 40 00 (15400) PLUMBING FIXTURES

Resource Management: The systems specified for water use in a building can dramatically impact both the quantity of water resources used and the quality. Water use in the United States more than doubled from 1950 to 1995, increasing from 680 billion liters (180 billion gallons) per day to more than 1.5 trillion liters (400 billion gallons) per day. Federal agencies collectively spend more than $500 million annually on water and sewer costs. Zero water use fixtures, such as waterless urinals and composting toilets, are available. Composting reduces water usage and creates soil amendment. Vacuum toilet systems, traditionally associated with water conservation in marine, air and railroad transports are also available for application in commercial/residential buildings. Vacuum toilets not only reduce water consumption, but they reduce piping and can eliminate need for toilet vent pipes, allowing for flexibility in design layout.

Toxicity/IEQ: Water quality for most buildings is largely determined by the municipal water treatment facility. Most water treatment facilities rely upon chemicals, including chlorine, to combat pathogens. Chlorine is highly reactive and readily forms chlorinated compounds, many of which are considered to be dangerous. Chlorinated hydrocarbons, such as DDT, have been and are used as pesticides. Similarly, chemicals are often used for routine maintenance and cleaning of facility plumbing. By installing mechanical access to piping, mechanical means can be utilized for routine maintenance. Composting is the biological reduction of organic wastes to humus. It is a natural process that is critical for support of all terrestrial life. Although composting manure is a traditional and extremely valuable process, manure (especially from carnivorous animals) can promote unwanted bacteria and diseases if handled improperly. The statutory definition of "lead free" includes up to 8 percent lead. There are different requirements depending on where in the plumbing system something is installed.

Performance: When low flow fixtures were first developed, many were deemed unsatisfactory because they could not deliver the pressure Americans enjoyed. More recent models generally do not have this problem, except for extremely high-pressure demands in some high use areas. The standards established for water consumption by the Energy Policy Act restrict showerheads to 2.5 gallons (9.5 liters) per minute at 80 psi, urinals to 1 gallon (3.8 liters) per flush, faucets to 2.2 gallons (8.3 liters) per minute at 60 psi (410 kPa), and toilets to 1.6 gallons (6 liters) per flush at 80 psi (550 kPa). Toilets account for almost half of a typical building's water consumption. Americans flush about 4.8 billion gallons (18.2 billion liters) of water down toilets each day, according to the U.S. Environmental Protection Agency. Automated controls for faucets, toilets, and urinals help address occupants' concerns about disease transmission via contact with bathroom surfaces and fixtures—they can also reduce water consumption. Designers and building

owners should be aware that low-flow and zero-flow fixtures and accessories (such as waterless urinals, composting toilets, and sensor operators) may require special training. Because the green items may be different from the systems and materials with which the owner's personnel are familiar, education about the environmental qualities as well as the operation and maintenance requirements may be necessary.

DIVISION 23 HEATING, VENTILATING, AND AIR CONDITIONING

23 05 93 (15950) TESTING, ADJUSTING, AND BALANCING FOR HVAC

Resource Management: Refer to Section 40 90 00 (13400)—Measurement and Control Instrumentation.

Toxicity/IEQ Testing does not usually address IEQ issues. To better address IEQ issues relative to the HVAC system, coordinate with Section 01 35 43 (01351) and Section 01 91 00 (01810)—Commissioning.

Performance: Provide preoccupancy ventilation as specified in Section 01 35 43 (01351) Environmental Procedures; provide prior to final testing, adjusting, and balancing of HVAC system. Coordinate with commissioning; refer to Section 01 91 00 (01810)—Commissioning.

23 07 00 (15080) HVAC INSULATION

Resource Management: Refer to Section 07 20 00 (07200)—Thermal Protection.

Toxicity/IEQ: Refer to Section 07 20 00 (07200)—Thermal Protection.

Insulation may produce airborne fiberglass and microbial contamination. When soft, adsorptive duct linings become contaminated by particles, they can absorb up to 10 times more moisture; and moisture can contribute to microbial contaminants such us molds. Insulation for application to the outside of ductwork is preferable.

Performance: Specify minimum thickness in accordance with ASHRAE 90.1. Provide additional thickness to ensure that surface temperatures are below 100 degrees and to prevent condensation on cold surfaces.

23 09 00 (15900) INSTRUMENTATION AND CONTROL FOR HVAC)

Resource management: Refer to Section 40 90 00 (13400)—Measurement and Control Instrumentation.

Toxicity/IEQ: Refer to Section 40 90 00 (13400)—Measurement and Control Instrumentation.

Performance: Sensors may be used to detect airflow, contaminant concentrations, thermal properties, or moisture content of air. Humidity control can help prevent microbial growth. Steam is preferable to liquid water as source.

23 30 00 (15800) HVAC AIR DISTRIBUTION

Resource Management: Refer to Section 23 70 00 (15700)—Central HVAC Equipment.

Toxicity/IEQ: Locate outside air intakes away from potential sources of contamination (e.g., sources of motor vehicle emissions, building HVAC system exhausts). Exhaust directly outdoors the air in rooms where contaminants are generated (e.g., labs, copying areas). ASHRAE Standard 62 calls for

delivery of ventilation air to occupant breathing zone. Amount is contingent upon carbon dioxide levels; other contaminants must be considered separately. Harvard University, Duke University, and the University of Nevada have conducted studies of typical airstream materials, which demonstrate that all typical materials used in ducts can experience microbial growth when the proper conditions exist. Microbial growth can occur on any duct material if the proper moisture levels, temperature, and nutrients are present. Metal surfaces and cut liner with durable surfaces may be cleaned more easily without fear of damaging the surface material. NAIMA has a guide on cleaning fibrous glass or lined sheet metal ducts. Fibrous glass insulation materials may contain formaldehyde-based resin binder materials. VOCs may be emitted from duct sealant during the curing process. However, all fiberglass duct work is assembled using UL 181 approved duct tape, which is applied to the exterior of the duct board and is not exposed to the airsteam. These tapes have little or no VOCs.

Performance: Properly sizing and sealing ductwork can improve energy efficiency. Duct insulation can promote energy savings by helping to prevent conditioned air from escaping. Evaluate natural ventilation for appropriate spaces, and design air distribution systems to operate in the same direction as natural ventilation to reduce energy cost of pumping outdoor air.

23 31 00 (15890) HVAC DUCTS AND CASINGS

Resource Management: Refer to Section 23 05 00 (15050)—Common Work Results for HVAC) and Division 5 (05).

Toxicity/IEQ: Fiberboard ductwork has been implicated in microbial contamination. Metal surfaces can be cleaned more easily without fear of damaging the surface material. VOCs may be emitted from duct sealant during the curing process. They are very exposed to the airstream, so their emissions are very important. Fibrous glass insulation materials may contain formaldehyde-based resin binder materials. Install insulation so that unfaced fiberglass and mineral fiber insulation are not in contact with the airstream.

Performance: Properly sizing and sealing ductwork can improve energy efficiency.

23 70 00 (15700) CENTRAL HEATING, VENTILATING, & AIR CONDITIONING (HVAC) EQUIPMENT

Resource Management: The systems specified for energy use in a building can dramatically impact both the quantity of such resources used and the quality. Maximize passive opportunities to reduce HVAC load.

Toxicity/IEQ: HVAC systems can contribute to poor IAQ by failing to provide enough ventilation to dilute indoor contaminates to acceptable levels, by spreading contaminates introduced from outside sources, and by generating contaminates within the HVAC system itself. The primary contaminants from HVAC systems are microbial contaminants and particulate contaminants. Design system to prevent water collection.

Performance: According to the Consortium for Energy Efficiency (CEE), light, commercial heating, ventilating, and air conditioning (HVAC) equipment has significant energy-savings potential. Space cooling accounts for 15.4 percent of electricity used in commercial buildings, second to lighting.

According to the CEE, studies show that at least 25 percent of all rooftop units are oversized resulting in increased energy costs and increased equipment wear. Properly sized equipment dramatically cuts energy costs, increases the life of the equipment, cuts utility bills, and reduces pollution. Obviously, energy-efficient systems require less energy to operate. Most perform the task for which they were designed comparably to the standard designs which they replace. Because the green items may be different from the systems and materials with which the owner's personnel are familiar, education about the environmental qualities as well as the operation and maintenance requirements may be necessary. Refer to Section 01 79 11 (01821)—Environmental Demonstration and Training.

Refer to ASHRAE 15-2004 (or latest version) "Safety Standard for Refrigerant Systems" to learn about specifying safe design, construction, installation, and operation of refrigeration systems.

DIVISION 26 ELECTRICAL

26 05 00 (16100) COMMON WORK RESULTS FOR ELECTRICAL

Resource Management: Refer to Section 22 05 00 (15050)—Basic Mechanical Materials and Methods 22 05 00—Common Work Results for Plumbing and 23 05 00—Common Work Results for HVAC).

Toxicity/IEQ: Some experimentation with twisting of wires has been done to control the generation of electromagnetic fields. Theoretically, twisting is effective not so much because it brings wires closer together but because the actual geometry of the twisted wires makes their fields cancel. A certain number of twists per foot will be optimum for a certain frequency (presumably 60 Hz for North American power wiring). Twisting is used to reduce electromagnetic interference from inverter wires. Inverters are devices that typically take low-voltage DC electricity and convert it to high-voltage AC electricity. The low-voltage side of inverters can carry very large currents, and are, therefore, large generators of EMF. Twisting of wires is also commonly used inside audio electronics and computers to prevent internal interference.

Performance: Performance is comparable for green methods and standard methods.

26 50 00 (16500) LIGHTING

Resource Management: The systems specified for energy use in a building can dramatically impact both the quantity of such resources used and the quality. Coordinating use of daylighting with requirements of artificial lighting and the associated heat loads of each can improve energy efficiency and the related environmental impacts.

Toxicity/IEQ: Currently, products are not legally permitted to be manufactured with PCBs. Lead is commonly used in solder for ballasts on HID lamps; however, many manufacturers now crimp ballasts rather than solder. Mercury is commonly used in fluorescent lamps; however, some manufacturers have developed low-mercury fluorescent lamp products. Light quality is also a consideration for IEQ. Natural daylighting is preferred.

Performance: Lighting accounts for 25 percent of the electricity used in the federal sector. If advanced lighting technologies and designs were

implemented throughout the federal sector, electricity use for lighting would be cut by more than 50 percent, electrical demand dramatically reduced, and working environments significantly improved.

26 52 00 (16530) EMERGENCY LIGHTING

Resource Management: Refer to Section 26 50 00 (16500)—LIGHTING.

Toxicity/IEQ: Toxicity/IEQ is comparable for green methods and standard methods.

Performance: Light-emitting diode (LED) lighting is available, and is much more efficient than compact fluorescent lighting. LEDs last from 80 to 500 years. Specify LED type with maintenance-free battery backup for 120 minutes; UL listed.

DIVISION 28 ELECTRONIC SAFETY AND SECURITY

28 31 49 (13850) CARBON-MONOXIDE DETECTION SENSORS

Carbon monoxide detectors are available. These are similar in appearance and function to smoke detectors. Refer to Section 40 90 00 (13400)—Measurement and Control Instrumentation.

DIVISION 31 EARTHWORK

31 05 13 (02055) SOILS FOR EARTHWORK

Resource Management: Implement mulching and composting programs where appropriate to the project's scale and duration. Coordinate with Section 01 35 43 (01351) Environmental Procedures, and Section 31 10 00 (02230) Site Clearing. Soil amendment can be made from recycled scrap gypsum; coordinate with Section 09 29 00 (09250) Gypsum Board.

Toxicity/IEQ: Coordinate with Section 01 35 43 (01351) Environmental Procedures, to stockpile topsoil and to protect existing soils. Where soil tests indicate existing contamination, consider in situ treatment via phytoremediation instead of bioremediation and landfilling. Phytoremediation is an innovative technology that utilizes plants and trees to clean up contaminated soil and water. It is an aesthetically pleasing, solar-energy-driven, passive technique that can be used to clean up metals, pesticides, solvents, crude oil, polyaromatic hydrocarbons, and landfill leachates. Plants can break down (degrade) organic pollutants (those that contain carbon and hydrogen). Plants can also extract (phytoaccu-mulate) certain metal contaminants (nickel, zinc, and copper are the best candidates for removal by phytoextraction because they are the favorites of the approximately 400 known plants); the plants are harvested as necessary and either incinerated or composted to recycle the metals. Trees have longer tap roots and can act as organic pumps/filters. Poplar trees, for example, pull out of the ground 30 gallons of water per day. The pulling action of the roots decreases the tendency of surface pollutants to move downward toward groundwater/aquifers.

Performance: Traditional consideration focuses on bearing capacity and the amendments required for the selected landscaping elements. Environmental issues for performance should examine the potential to renew the soil, avoid erosion, and minimize stormwater runoff. Compost, for example can improve the quality of both sandy soil and clay soil by improving

the ability of the soil to percolate and to hold water. By breaking up clay soil and by congealing sandy soil, compost aids the healthy root growth of plants as well as contributing to their nutritional needs. Similarly, the appropriate selection of plants can help rebuild the local ecosystem, including the soil.

31 05 16 (02060) AGGREGATES FOR EARTHWORK

Resource Management: Aggregate fabricated from 100 percent recycled rubble or concrete is available. Due to the mass of the material and the corresponding energy/cost to transport, specify locally available sources. Fill material fabricated from 100 percent recycled tires is available.

Toxicity/IEQ: Toxicity is often a concern when utilizing recycled materials for aggregate, especially old tires. Tests are being performed by the University of Maine on the effect of tire chips on drinking water for chips placed both above and below the water table. To date, the accumulation of metals appears to be below secondary drinking water standards; some volatile and semi-volatile organic compounds have been detected for tire chips located below the water table.

Performance: Recycled porcelain, concrete, or stone may be expected to perform comparably to standard gravel/stone aggregate. Tire chips, 1″ to 2″ chips of waste steel and glass belted tires, have a low unit weight of 40 to 60 pcf versus the typical 125 pcf unit weight of gravel. Therefore, tire chips perform well where compressible, lightweight, stable fill is required, such as for retaining walls or for embankment construction where there is slope stability or excessive settlement caused by weak foundation soils and/or the weight of the embankment. Tire chips also insulate about eight times better than gravel in reducing frost penetration. The permeability of tire chips is greater than most gravel aggregate.

31 10 00 (02230) SITE CLEARING

Resource Management: Biodiversity can be damaged by extensive site clearing, especially on greenfield sites. Limit site clearing and sequence operations to protect existing biodiversity.

Toxicity/IEQ: Where existing soils are contaminated, consider phytoremediation techniques in addition to chemical and mechanical treatments.

Performance: This section typically specifies removal of vegetation from the site, including stripping of sod and soil, in preparation for construction and landscaping. Where vegetation must be removed, coordinate with Section 01 74 19 (01351)—Construction Waste Management to avoid loss of topsoil and contamination of waterways. Minimize site clearing activities and identify indigenous vegetation to be protected in situ or relocated. Plants that are native and indigenous to the site will not only help to preserve biodiversity but typically will perform better than most imported plants.

31 25 00 (02370) EROSION AND SEDIMENTATION CONTROLS

Resource Management: Specify recycled content and natural fiber erosion control blankets. Avoid solid surfacing for erosion control.

Toxicity/IEQ: Consider the impact of foreign substances such as synthetic chemicals in geotextiles on the ecosystems and groundwater. Refer to Section 31 32 00 (02340) Soil Stabilization.

Performance: By specifying plant materials in lieu of slope paving, erosion problems can be addressed without contributing to problems associated with stormwater runoff and flash flooding. Plants utilized for erosion control along drainage channels can form wildlife corridors that help preserve the biodiversity of the area. Coordinate with Section 32 90 00 (02900) Planting. Coordinate with Section 31 05 13 (02055) Soils for Earthwork, for improving performance of existing soils as a significant component of the local ecosystem.

31 25 73 (02635) STORMWATER MANAGEMENT BY COMPOST

Resource Management: According to the U.S. Department of Agriculture, the United States loses more than 2 billion tons of topsoil each year to erosion. Erosion removes fertile soil rich in nutrients and organic matter, which reduces the ability of plants to establish, grow and remain healthy in the soil. A reduction in plant growth and subsequent plant residue causes less soil cover, allowing the erosion process to perpetuate and become worse. Erosion not only causes loss of soil productivity but also creates water quality problems once the sediment leaves the site and enters surface waters. The U.S. EPA has declared that sediment contamination of our surface waterways is the biggest threat to our nation's water resources. Construction and development projects, where soil is excavated or moved around, are particularly subject to erosion problems. In addition, heavy machinery and constant traffic can compact the soil creating a "hard pan" that repels water, increases runoff, and prevents plant growth. Compost replaces valuable organic matter and soil nutrients essential to vegetative establishment and long-term plant health.

Toxicity/IEQ: Within the past few years, laboratory-, greenhouse-, and pilot-scale research has indicated that composting provides a cost-effective solution for managing hazardous industrial waste streams (solid, air, or liquid). Compost has also been found to successfully remediate soil contaminated with toxic organic compounds (such as solvents and pesticides) and inorganic compounds (such as toxic metals).

Performance: Compost breaks up compacted soils and increases soil structure allowing water to infiltrate the soil surface. If immediate planting is not feasible, compost can act as a protective layer or sediment filter until vegetation can be established. Compost-based erosion and sediment control systems have several advantages over more traditional storm water best management practices (BMPs) such as geotextile blankets, including:

- Increasing water holding capacity of soil which reduces runoff
- Buffering rainfall energy, which prevents soil compaction
- Facilitating plant growth by capturing and retaining moisture and providing a suitable microclimate and nutrients for seed germination
- Stimulating microbial activity to improve the soil structure
- Buffering soil pH which can increase vegetation establishment and growth

EPA GreenScapes provides an Erosion Control Calculator available online that helps estimate the cost of using environmentally beneficial compost filter berms or compost filter socks for erosion control, rather than conventional silt fences. The Cost Calculator demonstrates that environmentally

preferable erosion control methods are very cost competitive for all project sizes and durations, and that they offer significant savings for projects that run for more than a few months.

31 31 00 (02360) SOIL TREATMENT

Resource Management: For soil treatment options, resource management issues closely parallel toxicity issues. The more environmentally friendly alternative to canvassing the construction site with poison is to investigate, evaluate and adjust the local ecosystem such that the undesirable creatures are not attracted to materials and areas in which they are unwanted. For example, tree limbs or vegetation that touch the exterior walls or roof provide excellent transportation for unwanted, wood-boring insects. Rather than spraying the yard, consider relocating and/or trimming plants.

Toxicity/IEQ: This section typically specifies pesticides and herbicides to control unwanted vegetation, rodents, and insects. Soil treatments directly impact soil and groundwater; they directly impact the hydrologic cycle and the food chain. EO 13423 includes requirements for federal agencies to reduce "the quantity of toxic and hazardous chemicals and materials acquired, used, or disposed of by the agency." Therefore, utilize the least toxic treatment possible. Alternative control methods include low-tech options such as soil solarization; refer to Section 32 90 00 (02900)—Planting. Alternative control methods include design options and maintenance procedures to control sources of food, water, and harborage that are available to pests and to limit pest access into and throughout buildings; refer to Section 10 81 50 (10295)—Integrated Pest Management (IPM).

Performance: Termite infestation exists throughout the United States and overseas areas with the exception of Alaska. Some construction systems, such as masonry, steel, and concrete, are not considered to be susceptible to termite damage. Alternative termite-prevention systems, such as a termite sand barrier, generally require preventative maintenance on the part of the building owner, such as keeping vegetation and dead leaves away from the building. Verify that the owner understands the maintenance involved and is willing to perform such maintenance. Alternative systems may be used in combinations. For example, a mesh barrier system may be used in combination with other preventive measures such as a sand barrier system and pressure treated lumber for construction. Alternative systems may require a variance.

31 32 00 (02340) SOIL STABILIZATION

Resource Management: Specify natural clay binders. Also, consider using fly ash to partially replace cement.

Toxicity/IEQ: Soil stabilization involves the addition and integration of foreign material in and on soil in order to "strengthen" the soil material for the intended construction. Consider the possible impact of such foreign materials on the groundwater. Avoid asphalt soil stabilization methods and synthetic geotextile stabilization methods.

Performance: Performance is comparable for green methods and standard methods.

DIVISION 32 EXTERIOR IMPROVEMENTS

32 00 00 (02800) EXTERIOR IMPROVEMENTS

Resource Management: Specify site amenities (planters, benches, waste receptacles, bicycle racks, play field equipment, fencing, etc.) manufactured from sustainably harvested wood, 100 percent postconsumer recycled plastic lumber, and recycled metals.

Toxicity/IEQ: Where possible, specify untreated, naturally rot-resistant, heartwood such as redwood, western cedar, cypress, elm, black locust, chestnut, in order to avoid chemicals in treated wood. Many South American species, such as Cuchi and Pau Lope, are also naturally rot-resistant. Untreated Cuchi wood has been used for more than 100 years as railroad ties in the tropical climate of South America. Refer to Section 06 50 00 (06500)—Structural Plastics for information on plastic lumber.

Performance: Performance is comparable for green methods and standard methods; however, maintenance requirements for plastic lumber will generally be significantly less than painted amenities. Refer to Section 06 50 00 (06500)—Structural Plastics for information on plastic lumber.

32 10 00 (02700) BASES, BALLASTS, AND PAVING

Resource Management: Because of the mass of the material and the corresponding energy/cost to transport, specify locally available sources. Aggregate fabricated from recycled masonry and concrete is available. Fill material fabricated from recycled tires is available. Wheel stops made from recycled plastic are available; refer to Section 06 60 00 (06600)—Plastic Fabrications.

Toxicity/IEQ: Refer to Section 06 60 00 (06600)—Plastic Fabrications for information on plastic lumber. Toxicity is often a concern when utilizing recycled materials (such as old tires) for aggregate, especially when in contact with surface water or groundwater. For additional information on leachate from scrap tire in civil engineering applications refer to the EPA Product Stewardship Program: Tires and the resource links.

Performance: Pervious paving is preferable to solid surfacing with respect to stormwater runoff. Refer to Section 32 12 43 (02795)—Porous Paving. Recycled porcelain, concrete, or stone may be expected to perform comparably to standard gravel/stone aggregate. Tire chips, 1″–2″ chips of waste steel and glass belted tires, have a low unit weight of 40 to 60 pcf versus the typical 125 pcf unit weight of gravel. Therefore, tire chip perform well where compressible, lightweight, stable fill is required such as for retaining walls or for embankment construction where there is slope stability or excessive settlement caused by weak foundation soils and/or the weight of the embankment. Tire chips insulate better than gravel in reducing frost penetration. The permeability of tire chips is greater than most gravel aggregate.

32 12 43 (02795) POROUS FLEXIBLE PAVING

Resource Management: Pervious pavement (also referred to as porous paving and permeable paving) is a porous surface with an underlying stone reservoir to temporarily store surface runoff before it infiltrates into the subsoil. This porous surface replaces traditional pavement, allowing parking lot storm water to infiltrate directly and receive water quality treatment. There

are various porous pavement options, including: porous asphalt, pervious concrete, and grid paver systems. Porous asphalt and pervious concrete appear to be the same as traditional pavement from the surface, but are manufactured without "fine" materials, and incorporate void spaces to allow infiltration. Grid paver systems are concrete interlocking paving blocks or plastic paving forms with open areas designed to allow grass to grow within the void areas. Alternatively, loose fill permeable surfacing includes: gravel, cobbles, wood, mulch, brick, and natural stone. For additional information, refer to the EPA National Pollutant Discharge Elimination System (NPDES)—Post-Construction Storm Water Management in New Development & Redevelopment and the Stormwater Management for Federal Facilities under Section 438 of the Energy Independence and Security Act.

Toxicity/IEQ: It has been theorized that pervious pavement, especially pervious paving systems provide biofiltration similar to graywater systems. Two studies have been conducted on the long-term pollutant removal of porous pavement, both in the Washington, DC, area. They suggest high pollutant removal, although it is difficult to extrapolate these results to all applications of the practice.

Performance: Systems may be subject to failure when water freezes within them in cold climates. Verify with product manufacturers for maximum load on pervious paving systems; contact the Florida Concrete Paving Association for information regarding pervious concrete paving. Pervious pavement can be used to provide groundwater recharge and to reduce pollutants in storm water runoff. Some data suggest that as much as 70 to 80 percent of annual rainfall will go toward groundwater recharge. These data will vary depending on design characteristics and underlying soils. For additional information, refer to the Storm Water Technology Fact Sheet—Porous Pavement, EPA 832-F-99-023. Porous pavement should be sited at least 2 to 5 feet above the seasonally high groundwater table, and at least 100 feet away from drinking water wells.

32 71 00 (02670) CONSTRUCTED WETLANDS

Resource Management: Constructed wetlands address the management of the earth's fresh water resources. They attempt to address water quality issues with a broad view of the hydrologic cycle that involves less embodied energy and less chemicals than standard water treatment processes. Because they utilize natural systems to process wastewater, they also contribute to carbon sinking and may contribute to local habitats and wildlife corridors. The amount of land required for constructed wetlands will vary depending on the desired level of treatment and the complexity of the system. Simple, exterior wetland systems may require 10–20 times more square footage than greenhouse systems.

Toxicity/IEQ: Constructed wetlands treat water both mechanically and biologically—not chemically. Water can be treated to advanced tertiary standards and can process metals, fats, greases, oils, gasoline, and some industrial toxins. The U.S. EPA maintains a Constructed Treatment Wetland System Description and Performance Database, which contains system descriptions and performance data for a large number of pilot, and full-scale wetland systems treating a variety of sources, including municipal wastewater, stormwater runoff, industrial wastewater, and agricultural

runoff. While the emphasis is on constructed wetlands, natural wetlands are also included in the database. The Safe Drinking Water Act (SDWA) was originally passed by Congress in 1974 to protect public health by regulating the nation's public drinking water supply. The law was amended in 1986 and 1996 and requires many actions to protect drinking water and its sources: rivers, lakes, reservoirs, springs, and groundwater wells. For additional information, refer to the EPA Office of Ground Water and Drinking Water. Also, regional, state, and local governing agencies adopt their own standards to regulate water treatment. Minimum general standards for wastewater treatment: Secondary wastewater—BOD_5 < 30 mg/l and TSS < 30 mg/l; Advanced secondary wastewater—BOD_5 < 15 mg/l and TSS < 30 mg/l; Advanced tertiary wastewater—BOD5 < 10 mg/l and TSS < 15 mg/l; pathogen removal required for beneficial public use—fecal coliform < 200/100 ml.

Performance: Constructed wetlands reduce pressure on local municipal water treatment facilities. A constructed wetland is a system engineered and constructed for treatment of graywater, blackwater, and/or stormwater to levels that meet federal, state, and local discharge requirements. They can be interior (greenhouse wetlands) or exterior. Constructed wetlands may serve individual facilities or whole municipalities. They can process metals, fats, greases, oils, gasoline, and some industrial toxins. They also produce usable byproducts such as nursery and water garden plants, compost, and methane gas. Constructed wetlands may also produce potable water; however, local regulatory requirements for monitoring and acceptance of water treated by constructed wetlands may be challenging. Maintenance requirements will vary with size—approximately 1/2 hr/day for 5,000 g.p.d. system to monitor computers and to trim and harvest plants and organisms. Blackwater treatment systems generally require a licensed wastewater operator.

32 84 00 (02810) PLANTING IRRIGATION

Resource Management: The average American household uses about 30 percent of its water outdoors, while in some parts of the country, this can be as high as 70 percent. Experts estimate that as much as 50 percent of landscape water use goes to waste because of evaporation, wind, or runoff caused by over watering.

Toxicity/IEQ: Water quality for most buildings is largely determined by the municipal water treatment facility. Most water treatment facilities rely upon chemicals, including chlorine, to combat pathogens. Chlorine is highly reactive and readily forms chlorinated compounds, many of which are considered to be dangerous. Chlorinated hydrocarbons, such as DDT, have been and are used as pesticides. Landscape irrigation systems may be supplied by reclaimed, graywater, or rainwater harvesting systems. If nonpotable water is used, spray heads should be avoided in order to minimize potential for airborne pathogens. It may also be appropriate to consider a system design that minimizes physical contact with the public (and potential contact with or ingestion of nonpotable water).

Performance: Landscape irrigation wastes water—up to 1.5 billion gallons every day across the country. According to the U.S. DOE Federal Energy Management Program (FEMP), water efficiency for landscape irrigation must be considered from the initial irrigation system design phase through

installation to ensure optimal performance. Consistent management and maintenance are also essential. Failure to do so can result in losing more than 50 percent of irrigation water because of evaporation, wind, poor management, and/or improper system design, installation, or maintenance. Drip irrigation systems use 20 to 50 percent less water than conventional in-ground sprinkler systems by delivering a low volume of water slowly. This minimizes evaporation, runoff, and overspray. EPA GreenScapes provides a Sub-Surface Drip Irrigation Cost Calculator, available online, that compares the cost of landscaping irrigation with a water-saving subsurface drip irrigation system to the cost of irrigation with a conventional sprinkler system. The calculator demonstrates that environmentally preferable subsurface drip irrigation methods are very cost competitive compared with conventional sprinkler methods. Consider installing the following components for optimal water efficiency:

- Drip/micro irrigation for all areas suitable for such technology
- Check valves in all sprinklers to retain water in lateral pipes between cycles
- Demand-based irrigation controls (i.e., weather or sensor-based controls)
- Rain, freeze, and wind sensors to interrupt irrigation during unfavorable weather conditions
- Flow rate monitoring equipment that can interrupt irrigation if excess flow is detected. (i.e., caused by broken pipes, fittings, nozzles, emitters sprinklers, etc.)

32 90 00 (02900)

PLANTING: *Resource Management*: Specify plants based on a xeriscaping approach, preferably one that utilizes indigenous plants appropriate to the local ecosystems. Where possible, specify appropriate companion planting, seasonal mixes, and habitat vegetation. Companion planting is an art practiced by most gardeners that takes advantage of complementary relationships between some plants such as carrots and tomatoes or parsley and roses. Seasonal mixes utilize plants that thrive at various times of the year. Seasonal mixes are closely related to providing habitat vegetation. Many birds, animals, and insects—especially migratory creatures—depend upon certain plants flowering or seeding at specific times of the year and in certain regions.

Toxicity/IEQ: Specify an integrated pest management approach to plant establishment. Integrated pest management, according to the U.S. Department of Agriculture—Agricultural Research Service, is the judicious use and integration of various pest control tactics of the associated environment of the pest in ways that complement and facilitate the biological and other natural controls of pests to meet economic, public health, and environmental goals. Specify use of native beneficial insects. Specify use of appropriate companion plants, such as those with natural pyrethrums.

Performance: Xeriscaping utilizes indigenous plants, and low maintenance plants which are tolerant of site's existing soils and climate without supplemental irrigation or fertilization once established. Native plants typically will perform better than imported species and require less maintenance. Where plants are imported to a region, it is advisable to monitor sufficiently to determine the relative invasiveness of the imported species. "Exotic" plants,

plants not indigenous to a region, can blend into the local ecosystem; but, they can also overrun it, suffocating indigenous plants and crippling habitats. The American Society of Landscape Architects (ASLA) outlines sustainable approaches to landscaping in the ASLA Code of Environmental Ethics and ASLA Public Policies. EPA GreenScapes provides a Resource Conserving Cost Calculator available online that compares the cost of converting conventional landscapes to xeriscape landscapes. The calculator demonstrates that converting to a water saving landscape is often cost competitive due to savings on water bills and landscaping maintenance, and provides many environmental benefits. In November 2009, the Sustainable Sites Initiative released a rating system for the design, construction and maintenance of sustainable landscapes, with or without buildings. Sustainable Sites Initiative is an interdisciplinary partnership led by the American Society of Landscape Architects, the Lady Bird Johnson Wildflower Center at the University of Texas at Austin and the United States Botanic Garden. The rating system can apply to projects ranging from corporate campuses, transportation corridors, public parks and single-family residences. To test the rating system, the Sustainable Sites Initiative opened a call for pilot projects in conjunction with the release of the rating system. The call will remain open until February 15, 2010, and the initiative will work with and oversee the projects during the two-year process. The Sustainable Sites Initiative anticipates refining the 2009 rating system after the completion of the pilot project program.

DIVISION 33 UTILITIES

33 00 00 (02500) UTILITIES

Resource Management: Utility services include water, gas, sewerage, electrical power, and communication services brought to the building. Obviously, the preference is for the appropriate use of renewable resources such as wind or solar energy collected in situ, rainwater collection systems, and constructed wetlands for wastewater treatment. However, buildings that efficiently utilize common infrastructure may also be considered to be green. Many large complexes and even some urban areas are designed to take advantage of economies of scale via central utilities plants. For example, buildings may tap into a central supply of hot water and chilled water to provide heating and cooling. The routing of services across a site may impact local resources. Consider options for connecting to the infrastructure that preserve existing trees and minimize impact on the local ecosystem, even if it means adding a couple of feet to the service line. In lieu of storm sewerage, consider minimizing the footprint of the structure and utilizing permeable paving.

Toxicity/IEQ: Water quality is a growing concern in the United States. Most water treatment facilities are attempting to cope with industrial pollutants for which they were not originally designed. Also, many areas have grown so quickly that they have surpassed the capacity of the treatment facilities that serve them. Some municipalities have had to issue moratoriums on new construction based on water treatment capacity. All sources of drinking water contain some contaminants. Because water is the universal solvent, many materials are easily dissolved upon contact. The EPA has issued drinking water standards, or *maximum contaminant levels* (MCLs) for more than

80 contaminants, including: benzene (paint, plastic), 1,2-dichloroethane (paints), trichloroethylene (textiles, adhesives), vinyl chloride (PVC pipe), antimony (fire retardants, solder), barium (pigments, epoxy sealants), cadmium (galvanized pipe, paints), chromium (pigments), cyanide (steel, plastics), pentachlorophenol (wood preservatives), phthalate (PVC and other plastics), xylenes (paints), and lead (plumbing, solder, faucets). The EPA generally sets MCLs at levels that will limit an individual's risk of cancer from that contaminant to between 1 in 10,000 and 1 in 1,000,000 over a lifetime. In 1996, 4,151 systems of the nation's approximately 55,000 community water systems, or 7 percent, reported one or more MCL violations, and 681 systems (less than 2 percent) reported violations of treatment technique standards. Electromagnetic radiation is a growing concern relative to electric utility supply and electrically operated products. There is some evidence linking EM fields surrounding power lines to certain cancers.

Performance: Design choices for material selection, systems selection, and general layout of building will greatly impact efficiencies and are addressed under other Sections. The performance of renewable energy systems is improving daily; refer to Sections 48 14 00 (13600)—Solar Energy Electrical Power Generation Equipment and 48 15 00 (13600)—Wind Energy Electrical Power Generation Equipment. Because of the state of flux in energy distribution systems, communication technologies, and urban approaches to water and waste management, perhaps the greatest performance issue for utility services is flexibility. Ideally, the building owner should be able to easily access, monitor, and, potentially, convert utility services as more efficient and environmentally friendly options are made available. The axiom of design for disassembly and reuse is particularly relevant to the work of this section.

33 16 20 (11201) RAINWATER HARVESTING

Resource Management: Rainwater harvesting systems are available for irrigation and potable water. The system can be as simple as a barrel under a downspout or as complex as a system with filters, settling tanks, pumps, UV radiation and water purification treatment. Rainwater harvesting keeps rainwater on site. It lessens the burden to municipal water facilities and decreases erosion and flooding caused by runoff from impervious surfaces. Refer to Section 32 71 00 (02670)—Constructed Wetlands for information regarding natural treatment of water.

Toxicity/IEQ: Chlorine is routinely added to municipal water supplies and may be a required additive for water collected/treated in situ and destined for potable use. Where such additives are necessary, iodine is considered to be a less toxic alternative. Ozonation may also be effective. Ozone oxidizes bacteria, viruses, and other contaminants without undesirable odors or byproducts. Ozone is ph neutral. Ozone reduces chemical usage up to 95 percent. Ozone oxidizes contaminants up to 3,000 times faster than chlorine. Rainwater is generally of better quality than well and municipal tap water. The exception is near industrial sites where rainwater may be extremely acid. Also, rainwater may wash many types of bacterial, molds, algae, protozoa, particulates, and other contaminants from the collection area into storage. If

you plan to use rainwater for drinking water, have it tested by a laboratory certified by the State.

Performance: Performance is comparable for green methods and standard methods. In many instances, rainwater and water treated via constructed wetlands have tested better than the available municipal water. Rainwater is soft (hardness of zero) and can significantly reduce the quantity of detergents and soaps needed for cleaning. Ozonation reduces chemical costs, chemical storage requirements, and labor expenses. It requires weekly, rather than daily, chemical check. Also, it prolongs life of equipment by reducing calcium and scale buildup. The American Water Works Association (AWWA) is an international nonprofit scientific and educational society dedicated to the improvement of drinking water quality and supply. Founded in 1881, AWWA is the largest organization of water supply professionals in the world. AWWA also runs Water Wiser website, which provides comprehensive information on water efficiency to consumers and utilities.

33 47 00 (02660) PONDS AND RESERVOIRS

Resource Management: This section includes not only decorative ponds and retention basins, but also leaching pits (simple biofiltration and graywater filtration systems).

Toxicity/IEQ: It is imperative to understand the local ecosystem, the local climate, and the local drainage patterns before installing a pond. Water in decorative ponds and detention basins may become stagnant, and breed mosquitoes. Conversely, when appropriately designed and managed, it may contribute to the health of the local habitat as well as perform the decorative and practical functions for which it was intended. Pond liners are typically fabricated from synthetic chemicals and petroleum-based products. Consider using natural, expanding clay soils where possible. Graywater filtration systems rely primarily on mechanical processes to treat water. Water is filtered through carbon, sand, rock, and so on. Water can be treated to advanced secondary standards.

Performance: Performance is comparable for green methods and standard methods.

DIVISION 40 PROCESS INTEGRATION

40 90 00 (13400) MEASUREMENT AND CONTROL INSTRUMENTATION

Resource Management: The systems specified for energy and water use in a building can dramatically impact both the quantity and the quality of such resources. Monitors and controls that regulate use of electricity, gas, and water can help improve efficiencies.

Toxicity/IEQ: Various monitor and control equipment that maintains indoor air quality is available.

Performance: Monitoring and control systems can help prolong the life of energy and water equipment by preventing "spikes" in demand and by warning of potential problems. Increasingly, green rating programs are incorporating some level of monitoring requirements, and, these requirements are becoming more sophisticated. Version 3 of the first draft of the International Green commercial Code (IgCC), for example, includes requirements

for separate monitoring of various energy demands in 15-minute intervals with reporting in hourly, daily, monthly, and yearly formats. It requires storage of data minimum 36 months and the ability to examine both total power usage and peak power usage.

DIVISION 44 POLLUTION CONTROL EQUIPMENT

44 40 10 (11202) WATER REUSE SYSTEMS

Resource Management: Water reuse offers a climate independent water source that is locally controlled and generally beneficial to the environment. Water reuse allows communities to become less dependent on groundwater and surface water sources and can decrease the diversion of water from sensitive ecosystems. Additionally, water reuse may reduce the nutrient loads from wastewater discharges into waterways, thereby reducing and preventing pollution.

Toxicity/IEQ: Through the natural water cycle, the earth has recycled and reused water for millions of years. Water utilities use technology to speed up these natural processes. Utilities generally describe the various stages of treatment rather than the technologies utilized when referring to water quality, as there are multiple treatment techniques for achieving essentially the same result. Generally speaking, the four core stages of treatment are: Primary Treatment, Secondary Treatment, Tertiary or Advanced Treatment, and Disinfection. Reclaimed water is highly engineered for safety and reliability so that the quality of reclaimed water is more predictable than many existing surface and groundwater sources. Reclaimed water is considered safe when appropriately used. Although reclaimed water is of very high quality, it is not used directly for drinking water in the United States. Reclaimed water is often distributed with a dual piping network that keeps reclaimed water pipes completely separate from potable water pipes. In the United States, reclaimed water is always distributed in lavender (light purple) pipes to distinguish it from potable water.

Performance: Within the federal sector, it is estimated that expenditures for water and sewer services reach up to $1 billion annually. Further, it is estimated that through moderate gains in water efficiency the federal government could save as much as $240 million per year. Water savings at these levels, approximately 40 percent, could provide enough water to supply a population of approximately 1.8 million. Water reuse is a proven technology that has been used for more than 40 years across the U.S. Reclaimed water can be used in numerous applications to satisfy most water demands, depending on the level of treatment. The water is treated to meet regulatory guidelines for the intended end use. Typical uses for reclaimed water include:

- Irrigation
- Groundwater recharge
- Industrial cooling processes
- Toilet flushing
- Vehicle washing

The U.S. Environmental Protection Agency regulates many aspects of wastewater treatment and drinking water quality, and the majority of states in the United States have established criteria or guidelines for the beneficial use of reclaimed water. In 2004, the EPA developed a technical document entitled "Guidelines for Water Reuse," which contains such information as a summary of state requirements, and guidelines for the treatment and uses of recycled water, EPA/625/R-92/004.

DIVISION 48 ELECTRICAL POWER GENERATION

48 14 00 (13600) SOLAR ENERGY ELECTRICAL POWER GENERATION EQUIPMENT

Resource Management: Once energy efficiency is maximized for a project, providing the required energy via clean, renewable resources is more sustainable than using fossil fuels which are finite in supply and incur environmental impacts throughout their life cycle. The Federal Energy Management Program (FEMP) provides information on technologies that have been proven in field testing or recommended by reliable sources. The U.S, federal government is one of the largest energy users; it purchases $10–20 billion in energy-related products annually. With ownership of more than 500,000 buildings, including 422,000 housing structures, the federal government has a tremendous interest in energy efficiency in buildings. The Energy Policy Act of 1992 and Executive Order 13123 set goals for energy reduction and provide some guidelines for implementing conservation measures and renewable energy measures. Annual energy use in Federal buildings has dropped from 140,000 Btu/sq ft (1,600 MJ/m2) in 1985 to 116,000 Btu/sq ft (1,300 MJ/m2) in 1997. To meet the Executive Order 13123 requirements, annual energy use must drop to 90,800 Btu/sq ft (1,000 MJ/m2) by 2010. EO13123 also directs agencies to significantly increase the use of renewable energy and to install 20,000 solar energy systems by 2010. Agencies have set a goal of 2.5 percent of Federal energy use from renewables by 2010 from green power purchases, on-site renewable energy projects, or other projects developed on federal land. Executive Order 13514, Federal Leadership in Environmental, Energy, and Economic Performance, was signed on October 5, 2009. It expands upon the energy and environmental performance requirements of previous Executive Orders. In particular, it requires that all new federal buildings entering the design phase in 2020 or later be designed to achieve zero net energy by 2030.

Toxicity/IEQ: Some renewable energy technologies such as photovoltaics are available to generate power on-site with no toxics or emissions. Nontoxic alternatives should be specified for all system components where available, such as food-grade propylene glycol as the heat transfer fluid in solar water heating systems. Electric renewables systems include battery storage if off-grid, and safeguards should be used while installing and maintaining the electrolyte and batteries shall be properly recycled at the end of their useful life. While there are well-known concerns regarding the toxic components of batteries, overall the systems that utilize renewable energy sources are generally considered to be less hazardous to human health and environmental health because they do not involve the combustion of a fossil fuel.

Performance: This is a rapidly changing field. DOE—Energy Efficiency and Renewable Energy (EERE) and the National Renewable Energy

Laboratory (NREL) offer resources for renewable energy, green power, and high-performance buildings.

- Photovoltaic, or PV, cells are semiconductor devices that convert sunlight into electricity. They have no moving parts. While expensive, they are expected to have very long lifetimes (25 years) with little or no maintenance. PV products are often integrated into building materials such as standing seam metal roofing, window or overhead glazing, or shingles. While PV cells are often deployed on buildings connected to the utility, they have a higher value in remote locations where they displace more expensive and more polluting diesel generators. Energy storage in remote applications, if needed, is provided with batteries. The U.S. EPA has developed a solar environmental benefits calculator, which computes, based on the amount of electricity produced by a PV system and the geographic location of that system, the amount of nitrogen oxide (NOx), sulfur dioxide (SO_2), and carbon dioxide (CO_2) that is prevented from being emitted each year.
- Fuel cells generate electricity by converting chemical energy into electrical power with few moving parts. Fuel cells produce no noxious gases that produce acid rain, no particulate pollutants, no unburned hydrocarbons, and proportionately less carbon dioxide (CO_2) than other, less efficient technologies. The U.S. Department of Energy has launched a major initiative, the "Solid State Energy Conversion Alliance," to bring about dramatic reductions in fuel cell costs. The goal is to cut costs to as low as $400/kW by 2010. It should be pointed out that fuel cells utilize hydrogen fuel, often derived by reforming natural gas, and thus are not renewable energy sources. However, because of their reduced emissions, they will be favored over heat engines as they become cost-effective and reliable.
- Combined heat and power, or CHP, is the joint production of both heat (usually steam or hot water) and electricity from a single fuel source. Conventional U.S. power production converts roughly one-third of the Btu from the primary energy source (e.g., coal or natural gas) into electricity; most of the rest is lost as waste heat. Collecting and making productive use of that waste heat can result in total efficiencies over 70 percent. Combined heat and power is often referred to as cogeneration. Technologies for cogeneration include gas turbines, steam turbines, and reciprocating engines.

Other options for renewable energy include contracting for "green power" generated and supplied by a utility. Refer to Section 01 81 30—Green Power Requirements.

48 15 00 (13600) WIND ENERGY ELECTRICAL POWER GENERATION EQUIPMENT

Resource Management: Once energy efficiency is maximized for a project, providing the required energy via clean, renewable resources is more sustainable than using fossil fuels, which are finite in supply and incur environmental impacts throughout their life cycle. The Federal Energy Management Program (FEMP) provides information on technologies that have been proven in field testing or recommended by reliable sources. The U.S. federal government is one of the largest energy users; it purchases $10–20 billion in energy-related products annually. With ownership of more than 500,000 buildings, including 422,000 housing structures, the federal government has

a tremendous interest in energy efficiency in buildings. The Energy Policy Act of 1992 and Executive Order 13123 set goals for energy reduction and provide some guidelines for implementing conservation measures and renewable energy measures. Annual energy use in federal buildings has dropped from 140,000 Btu/sq ft (1,600 MJ/m2) in 1985 to 116,000 Btu/sq ft (1,300 MJ/m2) in 1997. To meet the Executive Order 13123 requirements, annual energy use must drop to 90,800 Btu/sq ft (1,000 MJ/m2) by 2010. EO13123 also directs agencies to significantly increase the use of renewable energy and to install 20,000 solar energy systems by 2010. Agencies have set a goal of 2.5 percent of federal energy use from renewables by 2010 from green power purchases, on-site renewable energy projects, or other projects developed on Federal land. Executive Order 13514, Federal Leadership in Environmental, Energy, and Economic Performance, was signed on October 5, 2009. It expands upon the energy and environmental performance requirements of previous Executive Orders. In particular, it requires that all new federal buildings, entering the design phase in 2020 or later, are designed to achieve zero net energy by 2030.

Toxicity/IEQ: Some renewable energy technologies, such as wind generators, are available to generate power on-site with no toxics or emissions. Electric renewables systems include battery storage if off-grid, and safeguards should be used while installing and maintaining the electrolyte and batteries shall be properly recycled at the end of their useful life. While there are well-known concerns regarding the toxic components of batteries, overall the systems that utilize renewable energy sources are generally considered to be less hazardous to human health and environmental health because they do not involve the combustion of a fossil fuel.

Performance: This is a rapidly changing field. DOE—Energy Efficiency and Renewable Energy (EERE) and the National Renewable Energy Laboratory (NREL) offer resources for renewable energy, green power, and high-performance buildings. Wind turbines range in capacity from small turbines—500 watts to 100 kW— to large, utility-scale turbines—250 kW to 3.5 MW. Over the past 20 years, the cost of producing wind energy has come down from approximately 40 cents per kWh to approximately 3 to 5 cents per kWh for bulk power. NREL's National Wind Technology Center researchers predict that near-future design improvements will lower production costs to as little as 2.5 cents per kWh, making wind energy cost-competitive with conventional fuels. Other options for renewable energy include contracting for "green power" generated and supplied by a utility. Refer to Section 01 81 30—Green Power Requirements.

48 30 00 (13600) BIOMASS ENERGY ELECTRICAL POWER GENERATION EQUIPMENT

Resource Management: Once project, providing the required energy via clean, renewable resources is more sustainable than using fossil fuels, which are finite in supply and incur environmental impacts throughout their life cycle. The Federal Energy Management Program (FEMP) provides information on technologies energy efficiency is maximized for a that have been proven in field testing or recommended by reliable sources. The U.S. federal government is one of the largest energy users; it purchases $10–20 billion in energy-related products annually. With ownership of more than 500,000

buildings, including 422,000 housing structures, the federal government has a tremendous interest in energy-efficiency in buildings.

The Energy Policy Act of 1992 and Executive Order 13123 set goals for energy reduction and provide some guidelines for implementing conservation measures and renewable energy measures. Annual energy use in federal buildings has dropped from 140,000 Btu/sq ft (1,600 MJ/m2) in 1985 to 116,000 Btu/sq ft (1,300 MJ/m2) in 1997. To meet the Executive Order 13123 requirements, annual energy use must drop to 90,800 Btu/sq ft (1,000 MJ/m2) by 2010. EO13123 also directs agencies to significantly increase the use of renewable energy and to install 20,000 solar energy systems by 2010. Agencies have set a goal of 2.5 percent of federal energy use from renewables by 2010 from green power purchases, on-site renewable energy projects, or other projects developed on federal land. Executive Order 13514, Federal Leadership in Environmental, Energy, and Economic Performance, was signed on October 5, 2009. It expands upon the energy and environmental performance requirements of previous Executive Orders. In particular, it requires that all new federal buildings, entering the design phase in 2020 or later, are designed to achieve zero net energy by 2030.

Toxicity/IEQ: Electric renewables systems include battery storage if off-grid, and safeguards should be taken while installing and maintaining the electrolyte and batteries shall be properly recycled at the end of their useful life. While there are well-known concerns regarding the toxic components of batteries, overall the systems that utilize renewable energy sources are generally considered to be less hazardous to human health and environmental health because they do not involve the combustion of a fossil fuel.

Performance: This is a rapidly changing field. DOE—Energy Efficiency and Renewable Energy (EERE) and the National Renewable Energy Laboratory (NREL) offer resources for renewable energy, green power, and high-performance buildings. Energy can be derived from biomass by burning it directly, by converting it into energy-rich gases (gasification) that can fuel advanced gas turbines or fuel cells, and by converting it into liquid fuels (biofuels) that can fuel vehicles and other power-supply equipment. Biomass power systems range in size from a few kW (enough for an average U.S. home) up to 80 MW for power plants. In today's "direct-fired" biomass power plants, generation costs are about $0.09/kWh. DOE estimates that future, advanced technologies such as gasification-based systems could generate power for as little as $0.05/kWh. Other options for renewable energy include contracting for "green power" generated and supplied by a utility. Refer to Section 01 81 30—Green Power Requirement.

APPENDIX C

Sample Sections and Forms

To address the need for a comprehensive guide for procuring green building products and construction/renovation services within the U.S. federal government, the EPA partnered with the Federal Environmental Executive and the *Whole Building Design Guide* to develop the *Federal Green Construction Guide for Specifiers*. Under the direction of this partnership, the *Federal Green Construction Guide for Specifiers* was authored by *theGreenTeam, Inc.*

The *Federal Green Construction Guide for Specifiers* contain more than 70 sections that have been peer reviewed by governmental agencies, building industry professional organizations, and the public. Sample sections are included in this appendix as follows:

- SECTION 01 81 30 (Section 13600)—Green Power Requirements
- SECTION 01 92 00 (Section 01800)—Facility Operation (for monitoring and reporting energy/water usage)
- SECTION 07 33 63 (Section 02930)—Vegetated Roof Covering
- SECTION 07 55 63 (Section 07530)—Vegetated Protected Membrane Roofing
- SECTION 33 16 20 (Section 11201)—Rainwater Harvesting
- SECTION 44 40 10 (Section 11202)—Water Reuse Systems

Since the inception of this project in 2000, the EPA has worked with numerous federal construction and facility staff and managers directly and, more generally, has coordinated agency input via the Interagency Sustainability Working Group, the *Whole Building Design Guide*, the Federal Facilities Council of the National Academies of Sciences, the USGBC Federal Summit, and the major subscriber-based email lists serving the federal building community (reaching 10,000+ individuals). The EPA has received numerous technical comments from these stakeholders. Convinced of the importance of this work in assisting agencies in meeting their Greening of Government mandates, the Office of the Federal Environmental Executive signed on as an early partner to this effort. The Department of Defense Naval Facilities Command has been using the *Guide* to green the *Unified Facilities Guide Spec*, which governs DOD, NASA, and VA construction projects.

The *Federal Green Construction Guide for Specifiers* provides sample specification language intended to be inserted into project specifications as appropriate to the agency's environmental goals. Certain provisions, where indicated, are required for U.S. federal

agency projects. It addresses only environmental aspects in support of the federal government's green mandates and related programs. It does not include complete specifications. It is intended to supplement other model construction specifications and to provide guidance in developing project construction specifications.

The *Federal Green Construction Guide for Specifiers* is available on the *Whole Building Design Guide* website: http://fedgreenspecs.wbdg.org.

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Whole Building Design Guide
Federal Green Construction Guide for Specifiers

This is a guidance document with sample specification language intended to be inserted into project specifications on this subject as appropriate to the agency's environmental goals. Certain provisions, where indicated, are required for U.S. federal agency projects. Sample specification language is numbered to clearly distinguish it from advisory or discussion material. Each sample is preceded by identification of the typical location in a specification section where it would appear using the SectionFormat™ of the Construction Specifications Institute; the six digit section number cited is per CSI Masterformat™ 2004 and the five digit section number cited parenthetically is per CSI Masterformat™ 1995.

SECTION 01 81 30 (SECTION 13600) – GREEN POWER REQUIREMENTS

SPECIFIER NOTE:

resource management: Once energy efficiency is maximized for a project, providing the required energy via clean, renewable resources is more sustainable than using fossil fuels which are finite in supply and incur environmental impacts throughout their lifecycle. The Federal Energy Management Program (FEMP) provides information on technologies that have been proven in field testing or recommended by reliable sources.
The US Federal Government is one of the largest energy users; it purchases $10–20 billion in energy-related products annually. With ownership of more than 500,000 buildings, including 422,000 housing structures, the Federal Government has a tremendous interest in energy efficiency in buildings.
The Energy Policy Act of 1992 and Executive Order 13123 set goals for energy reduction and provide some guidelines for implementing conservation measures and renewable energy measures. Annual energy use in Federal buildings has dropped from 140,000 Btu/sq ft (1,600 MJ/m2) in 1985 to 116,000 Btu/ sq ft (1,300 MJ/m2) in 1997. To meet the Executive Order 13123 requirements, annual energy use must drop to 90,800 Btu/sq ft (1,000 MJ/m2) by 2010. EO13123 also directs agencies to significantly increase the use of renewable energy and to install 20,000 solar energy systems by 2010. Agencies have set a goal of 2.5 percent of Federal energy use from renewables by 2010 from green power purchases, on-site renewable energy projects, or other projects developed on Federal land. Executive Order 13514; *Federal Leadership in Environmental, Energy, and Economic Performance*; was signed on October 5, 2009. http://www.ofee.gov/execorders.asp It expands upon the energy and environmental performance requirements of previous Executive Orders. In particular, it requires that all new Federal buildings, entering the design phase in 2020 or later, are designed to achieve zero net energy by 2030.
http://www1.eere.energy.gov/femp/regulations/printable_versions/eo13423.html
Refer to “Greening Federal Facilities: An Energy, Environmental, and Economic Resource Guide for Federal Facility Managers and Designers" http://www.eere.energy.gov/femp/pdfs/29267-0.pdf
Renewables are characterized by a high initial cost and low operating cost, and are often designed to minimize life cycle cost.

toxicity/IEQ: Electric renewables systems include battery storage if off-grid, and safeguards should be taken while installing and maintaining the electrolyte and batteries shall be properly recycled at the end of their useful life.
While there are well-known concerns regarding the toxic components of batteries, overall the systems that utilize renewable energy sources are generally considered to be less hazardous to human health and environmental health because they do not involve the combustion of a fossil fuel.

performance: This is a rapidly changing field. DOE – Energy Efficiency and Renewable Energy (EERE) and the National Renewable Energy Laboratory (NREL) offer resources for renewable energy, green power, and high performance buildings. Refer to http://www.nrel.gov/ and to http://www.eere.energy.gov

Other options for renewable energy include contracting for “green power” generated and supplied by a utility. Buying green power contributes to the renewable energy goals and encourages utilities to invest in these promising resources. With the deregulation of the electric utilities, many new procurement options are becoming available, including the possibility of buying green energy from nonpolluting, renewable sources. While many utilities charge a premium for green power, a trend is for regulators to require utilities to include wind power in their resource planning without a premium because it is not more expensive that conventional plants.

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Green Power contracting requirements.

1.2 DEFINITIONS

A. Definitions pertaining to sustainable development: As defined in ASTM E2114 and as specified herein.

SPECIFIER NOTE:
“Green Power” as defined by Green-e means "eligible renewable electricity product" in the Green-e Renewable Electricity Certification program. Through this program, certified Green Power will meet the following requirements:
- 25% or more of the electricity supply comes from one or more of the eligible renewable resources
- if a portion of the electricity is non-renewable, the air emissions are equal to or lower than those produced by conventional electricity,
- there are no specific purchases of nuclear power

USGBC-LEED states that “Renewable sources are as defined by the Center for Resource Solutions (CRS) Green-e products certification requirements.”

B. Green Power: Electrical power generated using renewable resources such as solar or wind.

SPECIFIER NOTE:
A renewable resource can be exhausted if improperly managed. However, a renewable resource can last indefinitely with proper stewardship. Examples include: trees in forests, grasses in grasslands, and fertile soil. USGBC-LEED uses the term in reference to plants.

C. Renewable resource: a resource that is grown, naturally replenished, or cleansed, at a rate which exceeds depletion of the usable supply of that resource.
1. Rapidly renewable material: Material made from plants that are typically harvested within a ten-year cycle.

1.3 SUBMITTALS

A. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:

SPECIFIER NOTE:
USGBC-LEED™ v3 includes credit for using on-site renewable energy for minimum 1 percent of the building’s total annual energy. Credit is also offered for green power contracting. The contract must provide minimum 2-years of renewable energy for a minimum 35 percent of the building’s total energy.

FEMP references green power as per the Center for Resource Solutions Green-e program. USGBC-LEED™ v3 also cites the Center for Resource Solutions Green-e program. Refer to http://www.green-e.org/

1. Renewable Energy:
   a. Baseline Energy Usage: Submit calculations for estimated electricity use per the U.S. Department of Energy (DOE) Commercial Buildings Energy Consumption Survey (CBECS) database or other program as acceptable to Owner.
   b. Green Power Certification: Submit copy of certification for Green Power in accordance with the Center for Resource Solutions Green-e Standard for Electricity Products. Indicate type and percentage mix of renewable energy provided.

1.4 QUALITY ASSURANCE

A. Green Power: Arrange for Green Power sufficient to provide minimum **[35] [xxxx]** percent of the project's total energy needs.

B. Comply with renewable energy requirements in accordance with the Center for Resource Solutions (CRS) Green-e Standard for Electricity Products.

1.5 MAINTENANCE

A. Green Power: Provide service contract for **[2] [xxxx]** years with options for annual renewal thereafter.
   1. Comply with the Center for Resource Solutions (CRS) Green-e Standard for Electricity Products for the duration of the contract. Comply with requirements of the CRS Green-e Annual Verification Protocol.
      a. Immediately notify Owner if electricity product fails to comply with Green-e certification criteria during contract period.
   2. On an annual basis for during contract period, submit:
      a. Annual report that includes data on the resources used to generate the past year's electricity purchased.
      b. Disclosure statement lists the resources or fuel sources from which the electricity in the product will be generated in the following year.

PART 2 PRODUCTS

SPECIFIER NOTE:
EO 13423 includes requirements for Federal Agencies to "… improve energy efficiency and reduce greenhouse gas emissions … by (i) 3 percent annually through the end of fiscal year 2015, or (ii) 30 percent by the end of fiscal year 2015, relative to the baseline of … year 2003" and to "…ensure that (i) at least half of the statutorily required renewable energy consumed … comes from new renewable sources [sources of renewable energy placed into service after January 1, 1999] and (ii) … the agency implements renewable energy generation … for agency use"
Under EO 13423, renewable energy means "energy produced by solar, wind, biomass, landfill gas, ocean (including tidal, wave, current and thermal), geothermal, municipal solid waste, or new hydroelectric generation capacity achieved from increased efficiency or additions of new capacity at an existing hydroelectric project"
EO 13514; *Federal Leadership in Environmental, Energy, and Economic Performance*; was signed on October 5, 2009. http://www.ofee.gov/execorders.asp It expands upon the energy and environmental performance requirements of previous Executive Orders. In particular, it requires that all new Federal buildings, entering the design phase in 2020 or later, are designed to achieve zero net energy by 2030.

http://www1.eere.energy.gov/femp/regulations/printable_versions/eo13423.html

2.1 EQUIPMENT

SPECIFIER NOTE:
Decisions as to appropriateness of system requirements and design are dependent upon project goals and location. Coordinate with Divisions 22, 23, and 26 (15 and 16).

PART 3 - EXECUTION

3.1 SITE ENVIRONMENTAL PROCEDURES

A. Resource Management:
1. Energy Efficiency: Verify equipment is properly installed, connected, and adjusted. Verify that equipment is operating as specified.

END OF SECTION

This is a guidance document with sample specification language intended to be inserted into project specifications on this subject as appropriate to the agency's environmental goals. Certain provisions, where indicated, are required for U.S. federal agency projects. Sample specification language is numbered to clearly distinguish it from advisory or discussion material. Each sample is preceded by identification of the typical location in a specification section where it would appear using the SectionFormat™ of the Construction Specifications Institute; the six digit section number cited is per CSI Masterformat™ 2004 and the five digit section number cited parenthetically is per CSI Masterformat™ 1995.

SECTION 01 92 00 (SECTION 01800) – FACILITY OPERATION

SPECIFIER NOTE:
performance: Operation of facilities directly impacts the performance of the facilities. Even the best of designs, if poorly operated, will fail to achieve the intended efficiencies.
Different systems will require different maintenance and operation procedures. Such instructions should be collected in the Operations and Maintenance Manuals; refer to Section 01 78 23 (01830) Operation and Maintenance Data.
All facilities should be monitored to assess how closely actual operation conforms to the intended design. This Section includes requirements for monitoring and reporting the performance of energy systems and water systems.

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:
1. Administrative and procedural requirements for operation of the project after commissioning.
a. Monitoring and reporting energy usage.
b. Monitoring and reporting water usage.

B. Related Sections:
1. 01 78 23 (01830) Operation and Maintenance Data
2. 01 90 00 (01810) – Commissioning
3. 22 05 00 (15050) – Common Work Results for Plumbing
4. 23 05 00 (15050) – Common Work Results for HVAC
5. 26 05 00 (16050) – Common Work Results for Electrical

1.2 DEFINITIONS

A. Basis of Design - The basis of design is the documentation of the primary thought processes and assumptions behind design decisions that were made to meet the Owner's Project Requirements. The basis of design describes the systems, components, conditions and methods chosen to meet the intent. Some reiterating of the Owner's Project Requirements may be included.

B. Owner's Project Requirements - a dynamic document that provides the explanation of the ideas, concepts and criteria that are considered to be very important to the Owner. It is initially the outcome of the programming and conceptual design phases.

1.3 COORDINATION

A. Coordinate with commissioning of facility.
1. Basis of Design and Owner's Project Requirements: Identify Owner's Project Requirements and Basis of Design utilized in commissioning for comparison with actual energy and water usage data.

2. Final Commissioning Report: Review the final Commissioning Report to confirm initial actual performance of the building systems in reference to the Owner's Project Requirements and contract documents. Identify discrepancies, if any.
3. Operation and Maintenance Records: Review operation and maintenance records to identify problems, if any, with routine operation of energy and water systems.

SPECIFIER NOTE:
USGBC - LEED v3.0 requires that certified projects commit to sharing with USGBC all available actual whole-project energy and water usage data for a period of at least 5 years. Sharing this data includes supplying information on a regular basis in a free, accessible, and secure online tool or, if necessary, taking any action to authorize the collection of information directly from service or utility providers.

[B. Coordinate with USGBC. Submit actual energy and water usage data to USGBC for minimum 5 years after LEED certification is awarded.]

1.4 QUALITY CONTROL

SPECIFIER NOTE:
Portfolio Manager is an interactive management tool that allows the user to track and assess energy and water consumption of a building in a secure online environment. Portfolio Manager calculates the building's greenhouse gas emissions (including carbon dioxide, methane, and nitrous oxide) from on-site fuel combustion and purchased electricity and district heating and cooling. Portfolio Manager also enables tracking of avoided emissions from any Renewable Energy Certificates. Refer to https://www.energystar.gov/istar/pmpam/ to access Portfolio Manager.
The methodology for calculating greenhouse gas emissions in Portfolio Manager was designed to be consistent with the Greenhouse Gas Protocol developed by the World Resources Institute and World Business Council for Sustainable Development, and is compatible with the accounting, inventory and reporting requirements of EPA's Climate Leaders program, as well as other state and NGO registry and reporting programs. For more detailed information on emissions calculations, refer to the Technical Description of Greenhouse Gas Emission Calculations
The building performance is not compared to the other buildings entered into Portfolio Manager. Instead, statistically representative models are used for comparison against similar buildings from a national survey conducted by the Department of Energy's Energy Information Administration. This national survey, known as the Commercial Building Energy Consumption Survey (CBECS), is conducted every four years, and gathers data on building characteristics and energy use from thousands of buildings across the United States.

Commercial buildings eligible to receive a rating, representing over 50 percent of US commercial floor space, are:
- Bank/Financial Institution
- Courthouse
- Hospital (acute care and children's)
- Hotel
- House of Worship
- K–12 School
- Medical Office
- Municipal Wastewater Treatment Plant
- Office
- Residence Hall/Dormitory
- Retail Store
- Supermarket
- Warehouse (refrigerated and non-refrigerated)

For those buildings that are not eligible to receive a rating, EPA has created a list of reference energy performance targets. These are based on average energy use calculated across different types of buildings. These energy performance targets are not normalized for climate nor adjusted for activities

which may affect energy use. All targets are expressed in energy use intensity and are derived from the Commercial Buildings Energy Consumption Survey.

A. EPA Portfolio Manager: Utilize Portfolio Manager to compile and report:
   1. Energy:
      a. Actual annual whole-building energy usage.
      b. Estimated annual whole-building greenhouse gas emissions.
      c. National average comparison of energy performance to buildings of similar type.
      d. Energy Performance rating.
   2. Water:
      a. Actual annual whole-building water usage.
      b. Actual annual water usage by category for: Indoor Use, Outdoor Use, Combined Indoor/Outdoor Use, and Wastewater.
      c. National average comparison of water performance to buildings of similar type.
      d. Water Performance rating.

1.5 SUBMITTALS

SPECIFIER NOTE:
EO 13423 directs Federal agencies to "provide reports on agency implementation of this order to the Chairman of the Council [on Environmental Quality] on such schedule and in such format as the Chairman of the Council may require; and … provide information and assistance to the Director of the Office of Management and Budget, the Chairman of the Council, and the Federal Environmental Executive.
Refer to http://www.wbdg.org/sustainableEO
Additionally, under the Sustainable Building requirements per Guiding Principle #2 Optimize Energy Performance, EO 13423 directs Federal agencies to "Enter data and lessons learned from sustainable buildings into the High Performance Buildings Database."

Executive Order 13514; *Federal Leadership in Environmental, Energy, and Economic Performance*; was signed on October 5, 2009. http://www.ofee.gov/execorders.asp It expands upon the environmental performance requirements of EO 13423.
http://www1.eere.energy.gov/femp/regulations/printable_versions/eo13423.html
EO 13514 sets numerous Federal requirements in several areas, including:

- Federal agency heads must designate a senior management official to serve as Senior Sustainability Officer accountable for agency conformance, reporting to the Chair of the Council on Environmental Quality (CEQ) and the Director of the Office of Management and Budget (OMB). The Senior Sustainability Officer shall prepare targets for agency-wide reductions in 2020 for greenhouse gas (GHG) emissions and shall prepare and submit a multi-year Strategic Sustainability Performance Plan.
- Agency efforts and outcomes in implementing EO 13514 must be transparent and disclosed on publicly available Federal Web sites.
- OMB must prepare scorecards providing periodic evaluation of Federal agency performance. Scorecard results must be published on a publicly available Web site.

Documentation of environmental procedures can assist in required Agency reports.

A. Energy Data: Compile annual energy usage. Include data from all energy meters such that data accounts for all energy use in the building regardless of fuel type. Include data as follows:
   1. Tabulate minimum 11 full consecutive calendar months of energy data for all active meters. If there are multiple meters, there must be 11 consecutive and overlapping months.
   2. No individual electrical meter data entry can be for a period longer than 65 days.

B. Water Data: Compile annual water usage. Include data from all water meters such that data accounts for all water use in the building. Include data as follows:
   1. Categorize data four major categories: Indoor Use, Outdoor Use, Combined Indoor/Outdoor Use, and Wastewater.

2. Tabulate minimum 11 full consecutive calendar months of water data for all active meters. If there are multiple meters, there must be 11 consecutive and overlapping months.
3. No individual water meter data entry can be for a period longer than 65 days.

C. Statement of Energy Performance:
1. EPA Portfolio Manager: Enter energy data into the Portfolio Manager to produce a Statement of Energy Performance. Refer to Appendix A for a sample.
2. Provide copy of Basis of Design. Indicate deviations, if any, as evidenced in the final commissioning report, operation and maintenance records, and previous Portfolio Manager Statements.

SPECIFIER NOTE:
USGBC - LEED v3.0 requires that certified projects share actual whole-project energy and water usage data for a period of at least 5 years via an online tool or directly from service or utility providers. As of November 2009, USGBC has not published a required format or designated an approved online tool for submittal.

[3. USGBC-LEED v3.0: Enter energy data into USGBC-approved reporting template and submit to USGBC.]

D. Statement of Water Performance:

SPECIFIER NOTE:
Portfolio Manager tracks water use in four major categories: Indoor Use, Outdoor Use, Combined Indoor/Outdoor Use, and Wastewater. As of November 2009, EPA is still developing this program to parallel the Energy program. EPA will add the ability to benchmark water use in other ways (e.g., Indoor Use per Occupant). Data is entered in the same way as for energy meters. Water usage entered into Portfolio Manager does not affect the energy performance rating.

1. EPA Portfolio Manager: Enter energy data into the Portfolio Manager to produce a Statement of Water Performance.
2. Provide copy of Basis of Design. Indicate deviations, if any, as evidenced in the final commissioning report, operation and maintenance records, and previous Portfolio Manager Statements.

SPECIFIER NOTE:
USGBC - LEED v3.0 requires that certified projects share actual whole-project energy and water usage data for a period of at least 5 years via an online tool or directly from service or utility providers. As of November 2009, USGBC has not published a required format or designated an approved online tool for submittal.

[3. USGBC-LEED v3.0: Enter water data into USGBC-approved reporting template and submit to USGBC.]

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION – NOT USED

END OF SECTION

OMB No. 2060-0347

STATEMENT OF ENERGY PERFORMANCE
Office Sample Facility

Building ID: 1678984
For 12-month Period Ending: May 31, 2009[1]
Date SEP becomes ineligible: September 28, 2009
Date SEP Generated: August 27, 2009

Facility
Office Sample Facility
1234 Main Street
Charlotte, NC 28227

Facility Owner
Sample Owner
1500 Test Avenue
Charlotte, NC 28227
555-555-5555

Primary Contact for this Facility
Jane Smith
1500 Test Avenue
Charlotte, NC 28227
555-555-5555
jsmith@jsmith.com

Year Built: 2000
Gross Floor Area (ft²): 53,232

Energy Performance Rating[2] (1-100) 85

Site Energy Use Summary[3]

Electricity - Grid Purchase(kBtu)	2,288,770
Natural Gas (kBtu)[4]	1,162,996
Total Energy (kBtu)	3,451,766

Energy Intensity[5]

Site (kBtu/ft²/yr)	65
Source (kBtu/ft²/yr)	166

Emissions (based on site energy use)

Greenhouse Gas Emissions ($MtCO_2e$/year)	409

Electric Distribution Utility
Duke Energy Carolinas, LLC

National Average Comparison

National Average Site EUI	102
National Average Source EUI	261
% Difference from National Average Source EUI	-36%
Building Type	Office



Professional Engineer Stamp

Signature: _____

Based on the conditions observed at the time of my visit to this building, I certify that the information contained within this statement is accurate and in accordance with the PE Guide.

Meets Industry Standards[6] **for Indoor Environmental Conditions:**

Ventilation for Acceptable Indoor Air Quality	**Yes**
Acceptable Thermal Environmental Conditions	**Yes**
Adequate Illumination	**Yes**

Professional Engineer
License Number: 0000203
State: NC
John Doe
33 Country Lane
Charlotte, NC 28227
555-555-7788

Notes:
1. Application for the ENERGY STAR must be submitted to EPA within 4 months of the Period Ending date. Award of the ENERGY STAR is not final until approval is received from EPA.
2. The EPA Energy Performance Rating is based on total source energy. A rating of 75 is the minimum to be eligible for the ENERGY STAR.
3. Values represent energy consumption, annualized to a 12-month period.
4. Natural Gas values in units of volume (e.g. cubic feet) are converted to kBtu with adjustments made for elevation based on Facility zip code.
5. Values represent energy intensity, annualized to a 12-month period.
6. Based on Meeting ASHRAE Standard 62 for ventilation for acceptable indoor air quality, ASHRAE Standard 55 for thermal comfort, and IESNA Lighting Handbook for lighting quality.

The government estimates the average time needed to fill out this form is 6 hours (includes the time for entering energy data, PE facility inspection, and notarizing the SEP) and welcomes suggestions for reducing this level of effort. Send comments (referencing OMB control number) to the Director, Collection Strategies Division, U.S. EPA (2822T), 1200 Pennsylvania Ave., NW, Washington, D.C. 20460.

EPA Form 5900-16

Tracking Number: SEP20090827000103716 2

This is a guidance document with sample specification language intended to be inserted into project specifications on this subject as appropriate to the agency's environmental goals. Certain provisions, where indicated, are required for U.S. federal agency projects. Sample specification language is numbered to clearly distinguish it from advisory or discussion material. Each sample is preceded by identification of the typical location in a specification section where it would appear using the SectionFormat™ of the Construction Specifications Institute; the six digit section number cited is per CSI Masterformat™ 2004 and the five digit section number cited parenthetically is per CSI Masterformat™ 1995.

SECTION 07 33 63 (SECTION 02930) – VEGETATED ROOF COVERING

SPECIFIER NOTE:

resource management: Green roofing systems offer an excellent opportunity to incorporate renewable resources into the built environment. Some systems are available with drainage layers manufactured from recycled plastic.
Green Roofs for Healthy Cities, a non-profit provides information related to the economic, social, and environmental benefits of green roof infrastructure across North America; refer to http://www.greenroofs.org/

toxicity/IEQ: Green roofing systems have the capacity to improve environmental quality. Plants process carbon dioxide (carbon sinking). They can process certain types of toxins through their leaves and roots. Green roofing systems can provide biofiltration of rainwater.

performance: Modern systems have evolved from traditional building techniques and include membranes and drainage layers appropriate to modern building needs. Warranted garden roof systems have been used in Europe for decades.
Green roofing systems, when properly detailed and installed, can provide excellent thermal and acoustic insulation. Refer to the U.S. EPA options for “What Can Be Done” in respect to the Heat Island Effect, http://www.epa.gov/heatisland/index.htm

The plants contribute to carbon sinking and can provide wildlife corridors, urban agriculture, and recreational areas. By using water in situ, they also help minimize stormwater runoff and improve local hydrologic cycle functions. Care must be taken to design for anticipated live and dead loads.

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Vegetation for roof covering.
2. Growth media for roof covering.
3. Accessories and components as necessary for a complete installation of the vegetated roof covering.

B. Related Sections:
1. Section 07 55 63 (07530): Membrane Roofing for Green Roofing Systems.

1.2 DEFINITIONS

A. Definitions pertaining to sustainable development: As defined in ASTM E2114.

B. Drain Access Chamber: Open-ended box or cylinder that covers drains and/or scuppers. The chamber must be designed to admit water freely at the base. It must also have a removable lid to prevent debris from entering the chamber.

C. Growth Media Layer: An engineered soil-like material designed to retain moisture, manage plant nutrients, and support vigorous growth of the foliage.

D. Manning formula for conveyance (ft^3/s): $K = (1.49 \times A \times R^{(2/3)})/n$; A=area ($ft^2$), R=hydraulic radius (ft), n=Manning's roughness coefficient (dimensionless).

E. System Installer: Entity approved by System Provider to install vegetated roof covering system.

F. System Provider: Entity that provides all materials required for installation of the vegetated roof covering system.

G. Roofing Membrane Provider: Entity that provides all materials required for installation of the waterproofing/roofing system below the vegetated roof covering. Refer to Section 07 55 63 (07530).

1.3 SYSTEM DESCRIPTION

SPECIFIER NOTE:
Green roofs can be extensive or intensive.
Extensive Green Roof -- Low maintenance landscaping consisting of shallow soil depths (< 6 inches (150mm) with plant varieties restricted to primarily succulent plants, herbs and some grasses capable of withstanding harsh growing conditions. Extensive assemblies are typically un-irrigated and are constructed to achieve specific benefits.
Intensive Green Roof -- Landscaping requiring regular maintenance, consisting of deeper soil depths (> 10 inches (250mm) with a wider variety of plant species possible including turf grass, meadow perennials, shrubs and small trees. Intensive green roofs are typically irrigated and can furnish significant aesthetic and habitat value.
Following is an example of an extensive installation with 2.5 to 4.0 inches of media and an under drain component.

A. Design Requirements:
1. The vegetated cover shall be a single-media system, consisting of a **[2.5 to 4.0] [xxxx]** inch growth media layer installed over a layer designed to promote drainage and distribute moisture.

SPECIFIER NOTE:
The density of media correlates to the cost of the media. As a guide, typical growing media weighs about 74 pounds per cubic foot.

2. The weight of this system at Maximum Water Capacity as per ASTM E2399 and with rainfall runoff occurring, shall be less than or equal to **[18] [xxxx]** pounds per square foot.
3. The system dead load, measured according to ASTM D2397, when added to the weight of the roofing membrane system, shall not exceed the maximum allowable dead load for the roof.

B. Performance Requirements: Vegetated roof covering system shall:
1. Support a perennial vegetated ground cover;
2. Provide efficient drainage of moisture that is in excess of that required for the vigorous growth of the installed vegetation;
3. Protect roof waterproofing materials from damage caused by exposure to ultraviolet radiation, physical abuse, and rapid temperature fluctuations;

SPECIFIER NOTE:

Maximum Water Capacity is a design consideration that will depend on the depth of the media and the type of media selected. As a guide, typical growing media offers 35% water retention by volume.

4. Retain **[1] [xxxx]** inches of moisture at Maximum Water Capacity, in accordance with ASTM E2398.

1.4 SUBMITTALS

A. Product Data: Unless otherwise indicated, submit the following for each type of product provided under work of this Section:
   1. Product data for material and components of vegetated roof covering indicating compliance with specified requirements.

SPECIFIER NOTE:
Specifying local materials may help minimize transportation impacts; however it may not have a significant impact on reducing the overall embodied energy of a building material because of efficiencies of scale in some modes of transportation.
Green building rating systems frequently include credit for local materials. Transportation impacts include: fossil fuel consumption, air pollution, and labor.
USGBC-LEED™ v3 includes credits for materials extracted/harvested and manufactured within a 500 mile radius from the project site. Green Globes US also provides points for materials that are locally manufactured.

   2. Local/Regional Materials:
      a. Sourcing location(s): Indicate location of extraction, harvesting, and recovery; indicate distance between extraction, harvesting, and recovery and the project site.
      b. Manufacturing location(s): Indicate location of manufacturing facility; indicate distance between manufacturing facility and the project site.
      c. Product Value: Indicate dollar value of product containing local/regional materials; include materials cost only.
      d. Product Component(s) Value: Where product components are sourced or manufactured in separate locations, provide location information for each component. Indicate the percentage by weight of each component per unit of product.

SPECIFIER NOTE:
The Food, Conservation, and Energy Act of 2008 (also known as the 2008 U.S. Farm Bill) largely continues programs of the Farm Security and Rural Investment Act of 2002 (2002 Farm Bill) http://www.usda.gov/farmbill/ Section 9002 requires each Federal Agency to develop a procurement program which will assure that items composed of biobased products will be purchased to the maximum extent practicable and which is consistent with applicable provisions of Federal procurement law. USDA designates biobased products for preferred Federal procurement and recommends biobased content levels for each designated product.
USGBC-LEED™ v3, for example, includes credits for use of rapidly renewable materials, which USGBC describes as plants harvested within a ten-year cycle.
Green Globes – US, provides credit for integration of materials from renewable sources that have been selected based on life-cycle assessment.

   3. Biobased materials:
      a. Indicate type of biobased material in product.
      b. Indicate the percentage of biobased content per unit of product.
      c. Indicate relative dollar value of biobased content product to total dollar value of product included in project.

B. Shop Drawings: Submit Shop Drawings showing:
   1. Details of installation with conditions at terminations, transitions, and penetrations;
   2. Layout for the internal drain conduit;

3. A profile schematic, in 1/2 scale, showing thickness of all materials;
4. Fabrication details or System Provider's information for drain access chambers.
   a. Coordinate with Roofing Membrane Provider details for roof drains, scuppers and overflows, including accurate dimensions and geometric configurations. Verify that standard drain access chambers, deck drains and scuppers conform to System Provider's written recommendations.

C. Samples: Submit samples as follows:
1. 6-ounce sample of growth medias for initial approval.
2. **[2] [20] [xxxx]** pound sample of the growth media as delivered for each 100 cubic yards for verification.

D. Plant list: Identify species, size, and source for each type of plant. Indicate planting method, planting density, and quantity conditions for care during the establishment period. Where selected species are not indigenous, describe reasons for preference.

E. Certifications:
1. System Provider's statement indicating that:
   a. Proposed use is appropriate for each product, material and component.
   b. System Provider has reviewed and approved the details for the associated Roofing Membrane system, including deck drains, flashings, penetrations, and coping.
   c. System Installer is approved by System Provider.
   d. Proposed system is eligible for the specified warranty required of the System Provider.

F. Closeout Submittals:
1. Warranty.
2. Maintenance Agreement.

1.5 QUALITY ASSURANCE

SPECIFIER NOTE: Single Source Responsibility for the full system – membrane and vegetated roof covering - may not be available from roofing suppliers. However, most membrane suppliers will work with approved vegetated roof covering system suppliers. This is important in order to maintain the warranty of the membrane.

A. Single-Source Responsibility: Installation of the vegetated roof covering system components and vegetation, shall be **[provided by] [coordinated by]** a single-source. Components include but are not limited to:
1. Drain layer underlayment.
2. Growth Media.
3. Drainage panels.
4. Border units.
5. Separation fabric.
6. Drain and scupper access chambers.
7. Protection layer.
8. Paths and walkways.
9. Vegetation.

B. Roofing Inspection: As specified in Section 07 55 63 (07530) and as follows:
1. The **[Owner] [System Provider]** shall furnish a quality control specialist to observe critical aspects of the installation and testing of the work.

C. Pre-Construction Meeting: After award of Contract and prior to the commencement of the Work of this Section, schedule and conduct meeting to discuss the Work of this Section and to coordinate with related Work. Coordinate with pre-construction meeting specified

in Section 07 55 63 (07530). Convene pre-construction meeting to comply with requirements of Division 01 (1) and as follows:

1. Notify all attendees at least two weeks prior to the conference.
2. Require attendance of parties directly affecting Work of this Section, including, but not limited to:
   a. Owner,
   b. Contractor,
   c. Architect,
   d. System Provider,
   e. System Installer,
   f. Roofing Membrane Provider,
   g. Roofing Membrane Installer, and
   h. Mechanical and Plumbing Installers.
3. Review methods and procedures related to installation and operation of Work of this Section, including coordination with related Work.
4. Document proceedings, including corrective measures or actions required, and furnish copy of record to each participant.

1.6 SEQUENCING AND SCHEDULING

A. Coordinate the Work with installation of associated roofing, waterproofing, flashings, and roof accessories specified under other sections as the Work of this Section proceeds.

B. Sequence the Work with attention to preventing deterioration of installed roofing by minimizing the use of newly constructed roof deck for storage, walking surface, and equipment.

1.7 WARRANTY

A. Green Roof System Components: Provide a warranty signed by System Provider against failure of components in vegetated roof covering system, except vegetation. Warranty shall include repair of flaws which impair the functioning of the green roof system, provided the flaws originate from errors in design, material defects, improper assembly, incompatibility between components, or deterioration. Failure of components shall include:

1. Loss or dislocation of media due to wind scour (during the establishment period).
2. Persistent ponding of water after rainfalls.
3. Anaerobic conditions developed in the media due to inadequate drainage.
4. Cracking or deterioration of drain access chambers and border units, clogging of roof drains or scuppers.
5. Cracking or exfoliation of concrete pavers.

B. Green Roof System Vegetation: Provide a warranty signed by System Installer against failure of vegetation in vegetated roof covering system, including but not limited to failure of the plants to thrive due to compression or decomposition of the media. Warranty shall provide for the following:

1. Overseeding of plant cover after 12 months if the surface coverage rate is less than 60 percent. If overseeding is required, the deficient grids shall be manually re-seeded and stabilized. Cover rates shall be estimated separately for each 400 square-foot grid of the vegetated surface.
2. Overseeding of plant cover after the 24-month establishment period as necessary to provide a minimum plant cover of 80 percent. Cover rates shall be estimated separately for each 400 square-foot grid of the vegetated surface.
3. Emendation of media, if required to provide a viable growing medium for the vegetation.

C. Warranties shall include cost of labor and materials to inspect, repair, remove, and replace components in vegetated roof covering system without financial limit.
   1. Warranties shall include removing and replacing vegetated roof covering to access and repair waterproofing/roofing below vegetated roof covering.

D. Warranty Period:
   1. Green Roof System Components: 15 years.
   2. Green Roof System Vegetation: 2 years.

1.8 MAINTENANCE

A. System Installer shall execute with Owner a 2-year establishment period maintenance contract for plantings.

B. Maintenance shall include cultivation, weeding, disease and insect pest control. Procedures shall be consistent with good horticultural practice necessary to ensure vigorous, healthy growth of plant material.
   1. Provide hand weeding and organic fertilization, as required to maintain the health and vigor of the plants.
   2. Clean up: During course of maintenance, excess and waste materials shall be promptly removed at end of each workday.

C. Maintenance schedule of activities:
   1. Schedule: Include minimum 6 maintenance visits to project in 24 month period.
   2. Provide schedule to Owner that details planned maintenance activities including names of subcontractors.

D. Maintenance reports:
   1. Provide reports to Owner summarizing activities, observations, necessary corrections and recommended changes to maintenance routine, if any.

PART 2 – PRODUCTS

SPECIFIER NOTE:
EO 13423 includes requirements for Federal Agencies to use “sustainable environmental practices, including acquisition of biobased, environmentally preferable, energy-efficient, water-efficient, and recycled-content products”

Specifically, under the Sustainable Building requirements per Guiding Principle #5 Reduce Environmental Impact of Materials, EO13423 directs Federal agencies to “use products meeting or exceeding EPA's recycled content recommendations” for EPA-designated products and for other products to “use materials with recycled content such that the sum of post-consumer recycled content plus one-half of the pre-consumer content constitutes at least 10% (based on cost) of the total value of the materials in the project.”

Executive Order 13514; *Federal Leadership in Environmental, Energy, and Economic Performance*; was signed on October 5, 2009. http://www.ofee.gov/execorders.asp It expands upon the environmental performance requirements of EO 13423.
http://www1.eere.energy.gov/femp/regulations/printable_versions/eo13423.html

EO 13514 sets numerous federal requirements in several areas, including sustainable buildings and communities. Federal agencies must implement high performance sustainable federal building design, construction, operation and management, maintenance, and deconstruction, including:
- Ensuring all new Federal buildings, entering the design phase in 2020 or later, are designed to achieve zero net energy by 2030.

- Ensuring all new construction, major renovations, or repair or alteration of Federal buildings comply with the Guiding Principles of Federal Leadership in High Performance and Sustainable Buildings http://www1.eere.energy.gov/femp/pdfs/mouhighperfsustainfedfacs.pdf
- Ensuring at least 15% of existing agency buildings and leases (above 5,000 gross square feet) meet the Guiding Principles by fiscal year 2015 and that the agency makes annual progress towards 100% compliance across its building inventory.

Additionally, for USDA-designated biobased products, Federal agencies must use products meeting or exceeding USDA's biobased content recommendations; and for other products, biobased products made from rapidly renewable resources and certified sustainable wood products.

2.1 GREEN ROOFING SYSTEM COMPONENTS

A. Synthetic drain layer underlayment: Mat or Geocomposite drainage layer with minimum performance characteristics as follows:

SPECIFIER NOTE:
Effective transmissivity equals the underlayment transmissivity plus the hydraulic conveyance of internal conduit that may be supplied to augment flow. Effective transmissivity is a design parameter that must be adjusted for climate, roof size, geometry and pitch. The value provided is only a guideline.

Underlayment Transmissivity (gpm/ft), measured at i=1 and confining pressure ≥ 20 psf according to ASTM D4716
Conduit Conveyance (gal/min/ft), measured as $K = 669 \times A \times R^{(2/3)} / (L \times n)$;
A=conduit area (ft^2), R=hydraulic radius (ft), n=Manning's roughness coefficient (dimensionless), L=conduit spacing (ft).

Effective Transmissivity, referred to i=1	≥ 20 gal/min/ft
Permittivity as per ASTM D4491	≥ $1.5sec^{-1}$
Puncture Resistance, as per ASTM D4833	≥ 200 lb

B. Growth Media Layer: Mixture of mineral and organic components with minimum performance characteristics as follows:

Non-Capillary Pore Space at Field Capacity, 0.333 bar as per TMECC 03.01 A	≥ 15% (vol)
Maximum Water Capacity as per ASTM E2399	≥ 35% (vol)
Saturated Hydraulic Conductivity as per ASTM 2399	≥ 0.05 in/min
Alkalinity, $CaCO_3$ equivalents, as per MSA	≤ 2.5%
Total Organic Matter, by loss on ignition method as per MSA	4 - 8% (dry wt.);
pH as per RCSTP	6.5 – 8.0
Soluble Salts, DPTA saturated media extraction as per RCSTP	≤ 6 mmhos/cm
Cation exchange capacity as per MSA	≥ 8 meq/100g
Grain-size distribution of the mineral fraction as per ASTM-D422	
Clay fraction (2 micron)	≤ 2
Pct. Passing US#200 sieve (i.e., silt fraction)	≤ 10%
Pct. Passing US#60 sieve	≤ 15%
Pct. Passing US#18 sieve	10 - 40%
Pct. Passing 1/8-inch sieve	20-70%
Pct. Passing 3/8-inch sieve	75 -100%

Organic supplements (compost, peat, etc.): Provide as follows. Other macro- and micro-nutrients may be incorporated in the formulation in initial proportions suitable for support the specified planting. Thoroughly blend at a batch facility. Moisten, as required, to prevent separation and excessive "dusting" during installation.

Combined respiration rate as per TMECC 05.08, B	≤ 1 mg CO^2/gTOM/d
Total Nitrogen, TKN as per MSA	25-100 ppm
Phosphorus, P_2O_5 as per RCSTP	20-200 ppm
Potassium, K_2O as per RCSTP	≥ 150 ppm

C. Drainage Panel: For use under border units and drain chambers, to promote free flow across boundaries. Polyethylene or Polystyrene panels with minimum performance characteristics as follows:

Compressive strength	≥ 5,200 lb/ft^2
Transmissivity, as per ASTM D4716	≥ 15 gal/min/ft

D. Border Units:
1. Edge Elements: Aluminum, plastic, stainless steel, or enamel-coated galvanized steel cantilever edge units. Size and shape as indicated on drawings.
2. Scupper Fences: Aluminum, plastic, stainless steel, or enamel-coated galvanized steel cantilevered fences Used in lieu of scupper chambers. Size and shape as indicated on drawings.

E. Separation fabric: For use to prevent media loss at seams, boundaries and openings. Non-woven polypropylene or polyester fabric with minimum performance characteristics as follows:

Permittivity as per ASTM-D4491	≥1.5 sec -1
Weight as per ASTM –D5261	≥ 6 oz/yd2
Puncture Resistance as per ASTM-D4833	≥ 130 lb
Mullen Burst Strength as per ASTM-D3786	≥ 350 lb/in2
Grab Tensile as per ASTM D-4632	≥ 150 lb

F. Drain and Scupper Access Chambers: Provide chambers with lids for inspection of drains and scuppers. The chambers shall have perforations on the sides and be mounted on drain panel. Chambers may be fabricated from plastic, aluminum, stainless steel, fiber-reinforced cement, or enamel coated galvanized steel

G. Protection Layer: Provide as required for protection of the roofing membrane in critical areas and as follows:

Thickness, core only as per ASTM-D5199	≥ 200 mil
Puncture Resistance of each fabric as per ASTM D-4833	≥ 110 lbs

H. Paths and Walkways: Concrete Pavers; swept or textured finish; with minimum performance characteristics as follows:

Thickness	≥ 1.75 in
Size	2 ft x 2 ft (nominal)
Weight	≥ 23 lb/ft^2
Compressive Strength	≥ 7,500 psi
Flexural Strength	≥ 2,000 lb
Water Absorbtion	≤ 5%

2.2 VEGETATION

A. Plants: Provide plants in accordance with ASTM E2400 and as follows:

SPECIFIER NOTE:

In extensive green roof design, it is almost never possible to include a majority of indigenous plants. Currently, plant lists for un-irrigated extensive green roofs in non-temperate climates are experimental. Until reliable regional plant lists are available, it is important to allow the green roof System Provider to recommend plants.

1. Provide vegetation consistent with a xeriscaping approach that minimizes or eliminates irrigation requirements.
2. The use of indigenous plant species is encouraged. However, this value is secondary to providing a plant community that can provide a dense groundcover capable of withstanding climatic conditions, holding the growth medium in place, and minimizing weed pressure.
3. The plant list shall include a minimum of 5 species with a record of success in similar installations and conditions.
4. Plants selected for extensive green roofs shall be low-growing, with maximum heights of 18 inches.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions under which roofing will be applied, with System Installer and Roofing Membrane Installer present, for compliance with requirements
   1. Correct any deficiencies to the satisfaction of the System Installer.
   2. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare Surface:
   1. Clean surface of the Roofing Membrane as recommended by Roofing Membrane Provider/Installer and by System Provider.

B. Protect Roofing Membrane:
   1. Until the drainage media course is installed, traffic over the working area shall be strictly controlled and limited to essential personnel only.
   2. Protect heavily traveled areas, including but not limited to corridors for transporting media to the working areas, as recommended by the Roofing Membrane Provider.
   3. Protect laydown areas using ½-inch plywood or particle board over 1-inch sheets of expanded polystyrene (EPS), or similar sheathing material.

C. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction.

3.3 INSTALLATION

A. Install vegetated roof covering system according to System Provider's written instructions, applicable regulations, approved shop drawings, and as specified.

B. Install drain layer underlayment:
   1. Lay out the mat smoothly, with joints abutting tightly, at all areas to receive vegetated roof cover.
   2. Cover joints between adjacent panels with separation fabric, allowing an overlap on either side of minimum 6 inches.

C. Install drain access chambers and border units:

1. Assemble border units directly on top of the drainage panel. Cover the edge elements and sheet drain with separation fabric to prevent intrusion of media.
2. Layout drain access boxes. Wrap drain access chambers with separation fabric to prevent intrusion of media.

D. Install Walkways:
1. Install a second layer of drainage panel at areas to receive walkways.
2. Locate as shown in the drawings.
3. Edge the walkways with separation fabric.

E. Place Growth Media:
1. Place the growth media layer at the roof level in a manner that will not suddenly increase the load to the roof. Immediately after placement, spread to the specified thickness, plus 10 percent after compaction with lawn roller delivering 100 lbs/linear foot.
2. Thoroughly soak with water using a sprinkler or hand sprayer.

3.4 PLANT VEGETATION

A. If more than 72 hours have elapsed since the media was last watered, soak the media again prior to installation of plant vegetation.

B. Install plants as per the approved Plant List. Distribute cuttings evenly across the surface of the media at a rate of **[30 lb/1,000 square feet] [xxxx].** Distribute the seed mixture at rate as indicated by the System Provider. Cuttings shall be applied **[August 15-October 1 and April 15-June 1] [xxxx]** unless otherwise approved by Owner.

END OF SECTION

This is a guidance document with sample specification language intended to be inserted into project specifications on this subject as appropriate to the agency's environmental goals. Certain provisions, where indicated, are required for U.S. federal agency projects. Sample specification language is numbered to clearly distinguish it from advisory or discussion material. Each sample is preceded by identification of the typical location in a specification section where it would appear using the SectionFormat™ of the Construction Specifications Institute; the six digit section number cited is per CSI Masterformat™ 2004 and the five digit section number cited parenthetically is per CSI Masterformat™ 1995.

SECTION 07 55 63 (SECTION 07530) – VEGETATED PROTECTED MEMBRANE ROOFING

SPECIFIER NOTE:

resource management: Refer to Sections 07 33 63 (02930) and 07 50 00 (07500).

toxicity/IEQ: Refer to Sections 07 33 63 (02930) and 07 50 00 (07500).

performance: Refer to Sections 07 33 63 (02930) and 07 50 00 (07500).

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Membrane Roofing Systems for use in Green Roofing Systems.

B. Related Sections:
1. Section 07 33 63 (02930) –Vegetated Roof Covering for Green Roofing Systems.

1.2 SUBMITTALS

A. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:

SPECIFIER NOTE:
Green building rating systems often include credit for materials of recycled content. USGBC-LEED™ v3, for example, includes credit for materials with recycled content, calculated on the basis of pre-consumer and post-consumer percentage content, and it includes credit for use of salvaged/recovered materials.
Green Globes US also provides points for reused building materials and components and for building materials with recycled content.

1. Recycled Content:
   a. Indicate recycled content; indicate percentage of pre-consumer and post-consumer recycled content per unit of product.
   b. Indicate relative dollar value of recycled content product to total dollar value of product included in project.

SPECIFIER NOTE:
Specifying local materials may help minimize transportation impacts; however it may not have a significant impact on reducing the overall embodied energy of a building material because of efficiencies of scale in some modes of transportation.
Green building rating systems frequently include credit for local materials. Transportation impacts include: fossil fuel consumption, air pollution, and labor.
USGBC-LEED™ v3 includes credits for materials extracted/harvested and manufactured within a 500 mile radius from the project site. Green Globes US also provides points for materials that are locally manufactured.

2. Local/Regional Materials:
   a. Sourcing location(s): Indicate location of extraction, harvesting, and recovery; indicate distance between extraction, harvesting, and recovery and the project site.
   b. Manufacturing location(s): Indicate location of manufacturing facility; indicate distance between manufacturing facility and the project site.
   c. Product Value: Indicate dollar value of product containing local/regional materials; include materials cost only.
   d. Product Component(s) Value: Where product components are sourced or manufactured in separate locations, provide location information for each component. Indicate the percentage by weight of each component per unit of product.

SPECIFIER NOTE:
Green building rating systems may include credit for low emitting materials. USGBC-LEED™ v3, for example, includes credits for low-emitting materials, including: adhesives and sealants, paints and coatings, carpets, and composite wood and agrifiber products. Under LEED™ v3, adhesives and sealants are to comply with California's South Coast Air Quality Management District (SCAQMD) #1168; aerosol adhesives are to comply with Green Seal GS-36; interior architectural paints are to comply with Green Seal GS-11; anti-corrosive paints are to comply with Green Seal GS-03 (note – Green Seal has withdrawn GS-03; as of November 2008, anti-corrosive paints are included in a revised GS-11); clear wood finishes are to comply with SCAQMD #1113; carpet with the Carpet and Rug Institute (CRI) Green Label Plus; carpet cushion with CRI Green Label program; and, composite wood and agrifiber products are to contain no added urea-formaldehyde.
As per USGBC published Credit Interpretations, the credits for low-emitting materials are directed towards interior, site-installed (i.e. not prefabricated) products. Verify project requirements for low VOC roofing products.
Both the Adhesive and Sealant Council (ASC) and the SCAQMD have indicated that low VOC adhesives may have performance difficulties in extreme temperature and humidity conditions.
Green Seal, an independent, non-profit organization, certifies low-emitting products using internationally recognized methods and procedures. Green Seal certification meets the criteria of ISO 14020 and 14024, the environmental standards for ecolabeling set by the International Organization for Standardization (ISO); the U.S. Environmental Protection Agency's criteria for third-party certifiers of environmentally preferable products; and the criteria for bona fide ecolabeling bodies of the Global Ecolabeling Network.

3. VOC data:
   a. Adhesives:
      1) Submit manufacturer's product data for adhesives. Indicate VOC limits of the product. Submit MSDS highlighting VOC limits.

B. Submit environmental data in accordance with Table 1 of ASTM E2129 for products provided under work of this Section.

C. Operating And Maintenance Manuals Submittals:

Society of Plastic Inc. resin codes are easily recognized by the consumer. These are the numerical designations within chasing arrows. At the present time there is not a separate resin code for PLA (bio-resins). PLA (bio-resins) are classified as #7 (Other). Nor are there specific indications for additives or blends. The Society of Plastics resin code symbols are common for plastic packaging materials; for example:



ASTM D1972 standard specifies a resin code that provides substantially more information regarding the plastic resin, including blends and additives. ASTM D1972 labeling protocols are not common for packaging materials; however, they are recognized and utilized in the construction industry and other industry sectors. Many construction products are labeled according to ASTM D1972. Such detailed information is anticipated to be necessary data for future deconstruction (and recycling) efforts. Therefore, plastic construction products and plastic components of assemblies should be labeled in accordance with ASTM D1972. Example for a polypropylene containing 30 mass percentage of mineral powder use:

>PP-MD30<

a. Verify that plastic products, including plastic components in assemblies, to be incorporated into the Project are labeled in accordance with ASTM D1972. Where products are not labeled, provide product data indicating polymeric information in Operation and Maintenance Manual.

1) Products made from compositions containing a single filler, reinforcing, or other modifying material in a concentration of more than one percent by mass shall be marked with the abbreviated term for the polymer, followed by a dash, then the abbreviated term or symbol for the additive, with its percentage by mass, arranged as shown in the example and set off with brackets. For example, a polypropylene containing 30 mass percentage of mineral powder use would be labeled: >PP-MD30<

D. Closeout Submittals:
1. Roof Inspection Reports: Submit reports and certification for Inspections.
2. Results of EFVM surveys: Submit report of results of EFVM surveys and corrective actions taken.
3. Warranty.

1.3 QUALITY ASSURANCE

A. Roofing Inspection:
1. **[The Owner's Independent Roofing Inspector will conduct] [Provide]** roof construction inspections as follows:
a. Provide full time inspection during roof installation and vegetated roof covering installation.
b. Conduct EFVM (Electric Field Vector Mapping) surveys. Conduct one EFVM survey after installation of roofing system and before installation of vegetated roof covering. Conduct one EFVM survey after installation of vegetated roof covering. The compatibility of EFVM with a specific waterproofing system must be established in advance of roofing membrane installation by the EFVM service provider. Identify and repair leaks in accordance with roofing system manufacturer's written recommendations and in a manner so as not to void and/or limit the Warranty.
c. Complete Roof Inspection Report once prior to installation of vegetated roof covering and once after installation of vegetated roof covering.
d. Issue Certification of Quality of Roof Construction upon completion of roof installation.

B. Pre-Construction Meeting: After award of Contract and prior to the commencement of the Work of this Section, schedule and conduct meeting to discuss the Work of this Section and to coordinate with related Work. Coordinate with pre-construction meeting

specified in Section 07 33 63 (02930). Convene pre-construction meeting to comply with requirements of Division 01 (1) and as follows:

1. Notify all attendees at least two weeks prior to the conference.
2. Require attendance of parties directly affecting Work of this Section, including, but not limited to:
   a. Owner,
   b. Contractor,
   c. Architect,
   d. Vegetated Green Roof System Provider/Installer,
   e. Roofing Membrane Provider,
   f. Roofing Membrane Installer, and
   g. Mechanical and Plumbing Installers.
3. Review methods and procedures related to installation and operation of Work of this Section, including coordination with related Work.
4. Document proceedings, including corrective measures or actions required, and furnish copy of record to each participant.

1.4 SEQUENCING AND SCHEDULING

A. Contractor shall coordinate the Work with installation of vegetated roof covering as specified in Section 07 33 63 (02930).

1.5 WARRANTY

A. Warranty: Manufacturer's standard form, without monetary limitation, in which manufacturer states compatibility of roofing membrane with specified vegetated roof covering and agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period. Failure includes roof leaks.
   1. Warranty Period: [**10**] [**15**] [**20**] years from date of Substantial Completion.

B. Under no circumstances will Manufacturer remove or replace vegetated roof covering. Vegetated roof covering shall be removed and replaced as necessary to access Roofing System by Owner under separate Warranty provisions.

C. Specifically excluded from this Warranty is any and all failure of the Vegetated Roof Covering.

D. The Manufacturer verifies that the Vegetated Roof Covering and Walkways have been furnished and installed in accordance with Manufacturer's recommendations for their use with the Roofing System. None of the provisions of this Warranty are limited by the Vegetated Roof Covering and/or Walkways.

PART 2 - PRODUCTS

SPECIFIER NOTE:
EO 13423 includes requirements for Federal Agencies to use "sustainable environmental practices, including acquisition of biobased, environmentally preferable, energy-efficient, water-efficient, and recycled-content products"

Specifically, under the Sustainable Building requirements per Guiding Principle #5 Reduce Environmental Impact of Materials, EO13423 directs Federal agencies to "use products meeting or exceeding EPA's recycled content recommendations" for EPA-designated products and for other products to "use materials with recycled content such that the sum of post-consumer recycled content plus one-half of the pre-consumer content constitutes at least 10% (based on cost) of the total value of the materials in the project."

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http://www1.eere.energy.gov/femp/regulations/printable_versions/eo13423.html

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- Ensuring all new construction, major renovations, or repair or alteration of Federal buildings comply with the Guiding Principles of Federal Leadership in High Performance and Sustainable Buildings http://www1.eere.energy.gov/femp/pdfs/mouhighperfsustainfedfacs.pdf
- Ensuring at least 15% of existing agency buildings and leases (above 5,000 gross square feet) meet the Guiding Principles by fiscal year 2015 and that the agency makes annual progress towards 100% compliance across its building inventory.

2.1 MATERIALS

A. Membrane: Compatible with specified Vegetated Roof Covering and EFVM system.

SPECIFIER NOTE:
Green building rating systems often include credit for materials of recycled content and may distinguish allowable credit for post-consumer and post-industrial (or pre-consumer) recycled content. USGBC-LEED™ v3, for example, factors 100 percent of post-consumer recycled content but only 50 percent of pre-consumer (post-industrial) recycled content into calculations for its recycled content materials credit. LEED v3 grants one credit to a project for using materials with recycled content such that the sum of post-consumer recycled content plus one-half of the post-industrial content constitutes at least 10 percent of the total value of the materials in the project; 10% (post-consumer + 1/2 post-industrial). It grants an additional point for 20% (post-consumer + 1/2 post-industrial).
Green Globes US also provides points for reused building materials and components and for building materials with recycled content.
Recycled content is typically determined by calculating the weight of the recycled material divided by the total weight of the product and expressed as a percentage by weight. (The recycled content "value" of a product as assessed under LEED is determined by multiplying the recycled content percentage and the cost of the product.)
Verify with manufacturer for product availability and recycled content.

1. Recycled Content: Minimum **[5] [10] [xxxx]** percent post-consumer recycled content, or minimum **[20] [40] [xxxx]** percent pre-consumer recycled content at contractor's option.

2.2 BALLAST

A. Vegetated Roof Covering as specified in Section 07 33 63 (02930).

PART 3 - EXECUTION

3.1 MAINTENANCE AND REPAIR DURING CONSTRUCTION

A. The Contractor shall maintain the entire roofing system and related work from the time of roofing completion until occupancy. Repair material and installation defects and damage resulting from any subsequent work on the roof, including installation of vegetated roof covering as specified in Section 07 33 63 (02930), and from weather related damage.

B. Maintain the roof system in a watertight condition.

END OF SECTION

Whole Building Design Guide
Federal Green Construction Guide for Specifiers

This is a guidance document with sample specification language intended to be inserted into project specifications on this subject as appropriate to the agency's environmental goals. Certain provisions, where indicated, are required for U.S. federal agency projects. Sample specification language is numbered to clearly distinguish it from advisory or discussion material. Each sample is preceded by identification of the typical location in a specification section where it would appear using the SectionFormat™ of the Construction Specifications Institute; the six digit section number cited is per CSI Masterformat™ 2004 and the five digit section number cited parenthetically is per CSI Masterformat™ 1995.

Section 33 16 20 (SECTION 11201) – RAINWATER HARVESTING

SPECIFIER NOTE:

resource management: Rainwater harvesting systems are available for irrigation and potable water. The system can be as simple as a barrel under a downspout or as complex as a system with filters, settling tanks, pumps, UV radiation and water purification treatment. Rainwater harvesting keeps rainwater on site. It lessens the burden to municipal water facilities and decreases erosion and flooding caused by runoff from impervious surfaces. Refer to Section 32 71 00 (02670) - Constructed Wetlands for information regarding natural treatment of water.

toxicity/IEQ: Chlorine is routinely added to municipal water supplies and may be a required additive for water collected/treated in situ and destined for potable use. Where such additives are necessary, iodine is considered to be a less toxic alternative. Ozonation may also be effective. Ozone oxidizes bacteria, viruses, and other contaminants without undesirable odors or by-products. Ozone is ph neutral. Ozone reduces chemical usage up to 95%. Ozone oxidizes contaminants up to 3,000 times faster than chlorine. Rainwater is generally of better quality than well and municipal tap water. The exception is near industrial sites where rainwater may be extremely acid. Also, rainwater may wash many types of bacterial, molds, algae, protozoa, particulates and other contaminants from the collection area into storage. If you plan to use rainwater for drinking water, have it tested by a laboratory certified by the State; for a list of State Certification Officers for drinking water laboratories, refer to http://www.epa.gov/safewater/labs/index.html

performance: Performance is comparable for green methods and standard methods. In many instances, rainwater and water treated via constructed wetlands have tested better than the available municipal water. Rainwater is soft (hardness of zero) and can significantly reduce the quantity of detergents and soaps needed for cleaning.
Ozonation reduces chemical costs, chemical storage requirements, and labor expenses. It requires weekly, rather than daily, chemical check. And, it prolongs life of equipment by reducing calcium and scale buildup.
The American Water Works Association (AWWA) is an international nonprofit scientific and educational society dedicated to the improvement of drinking water quality and supply. Founded in 1881, AWWA is the largest organization of water supply professionals in the world. AWWA also runs Water Wiser web site, which provides comprehensive information on water efficiency to consumers and utilities. For information related to rainwater harvesting studies and related links, refer to http://www.awwa.org/waterwiser/

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes engineering, fabricating, furnishing, and installing:
1. Rainwater Harvesting System**[s]**.
[a. Roof collection system.]
[b. Site collection system.]

B. Related Sections:
1. Divisions 31 – 33 (2) – landscaping and irrigation sections.
2. Division 07 (7) – roofing section(s).
3. Division 22 (15) – plumbing.

1.2 DEFINITIONS

A. Rainwater Harvesting System: An assembly that collects, stores, and distributes rain water for use in situ; including water treatment as appropriate to intended use.

1.3 SUBMITTALS

A. Product Data: Submit product data on all components of the rainwater harvesting system**[s]**. Unless otherwise indicated, include the following for each type of product provided under work of this Section:
1. Manufacturer's brochure indicating equipment model(s).

SPECIFIER NOTE:
Green building rating systems often include credit for materials of recycled content. USGBC-LEED™ v3, for example, includes credit for materials with recycled content, calculated on the basis of pre-consumer and post-consumer percentage content, and it includes credit for use of salvaged/recovered materials.
Green Globes US also provides points for reused building materials and components and for building materials with recycled content.

2. Recycled Content:
a. Indicate recycled content; indicate percentage of pre-consumer and post-consumer recycled content per unit of product.
b. Indicate relative dollar value of recycled content product to total dollar value of product included in project.
c. If recycled content product is part of an assembly, indicate the percentage of recycled content product in the assembly by weight.
d. If recycled content product is part of an assembly, indicate relative dollar value of recycled content product to total dollar value of assembly.

SPECIFIER NOTE:
Specifying local materials may help minimize transportation impacts; however it may not have a significant impact on reducing the overall embodied energy of a building material because of efficiencies of scale in some modes of transportation.
Green building rating systems frequently include credit for local materials. Transportation impacts include: fossil fuel consumption, air pollution, and labor.
USGBC-LEED™ v3 includes credits for materials extracted/harvested and manufactured within a 500 mile radius from the project site. Green Globes US also provides points for materials that are locally manufactured.

3. Local/Regional Materials:
a. Sourcing location(s): Indicate location of extraction, harvesting, and recovery; indicate distance between extraction, harvesting, and recovery and the project site.
b. Manufacturing location(s): Indicate location of manufacturing facility; indicate distance between manufacturing facility and the project site.
c. Product Value: Indicate dollar value of product containing local/regional materials; include materials cost only.
d. Product Component(s) Value: Where product components are sourced or manufactured in separate locations, provide location information for each component. Indicate the percentage by weight of each component per unit of product.

B. Shop Drawings: **[For each system,] [For roof collection system,] [For site collection system,]** include plans, sections, details, and attachments to other work, for the following:
1. Pumps.
2. Storage.
3. Connection to roofing system.
4. Connection to irrigation system.
5. Connection to plumbing system.

C. Calculations: **[For each system,] [For roof collection system,] [For site collection system,]** submit the following:
1. Maximum water capacity.
2. Collection data: Include the following:
   a. average rainfall rate (inches annually)
   b. total collection area (s.f.)
   c. potential collection (s.f.= gallons)
   d. peak gallons @ 5"/hour
   e. peak gallons @ 5 min. duration
   f. available gallons
3. Water Demand: Include the following:
   a. Landscaping:
      total estimated planted area (acres)
      application rate / week (high) gallons
      application rate /week (low) gallons
      gallons required
   b. Fixture Demand:

SPECIFIER NOTE:
Typical usage is likely to include:
– # toilets/1.6 gallons flush/ # flush per day
– faucets - 10 gallons/day
– dishwasher 10/galls/load/1 load/day

      Fixtures by type, water use per person/day
      Gallons potable water required
      Gallons non-potable water required

D. Designer/Installer Qualifications.

E. Regulatory Requirements Documentation:

SPECIFIER NOTE:
Guidance and regulation specific to rainwater harvesting are limited. In some regions, the Owner does not own the rainwater that falls on his/her property. Some regions do provide guidance. In Texas, for example, contact the Texas Water Development Board http://www.twdb.state.tx.us/assistance/conservation/Alternative_Technologies/Rainwater_Harvesting/rain.asp
Regulations related to potable water stem primarily from the Safe Drinking Water Act (SDWA). The SDWA authorizes the EPA to set national health-based standards for drinking water to protect against both naturally-occurring and man-made contaminants that may be found in drinking water. The law was amended in 1986 and 1996 and requires many actions to protect drinking water and its sources: rivers, lakes, reservoirs, springs, and ground water wells. For additional information, refer to the EPA Office of Ground Water and Drinking Water http://www.epa.gov/safewater/index.html Also, to verify local requirements, contact the Local/State Health Department.

F. Operation and Maintenance Manuals Submittals: Provide the following:

1. Operation and maintenance procedures, including variations of procedures appropriate for normal climatic conditions anticipated throughout an annual cycle of operations.
2. Water testing laboratory contact information.
3. Water testing requirements, schedule, kits, and equipment.

G. Reports for Field Quality Control: Submit test reports and inspection reports to **[Owner] [Architect].**
1. System Inspections.
2. Water Quality Tests.

H. Closeout Submittals:
1. Warranty.

1.4 QUALITY ASSURANCE

A. Designer/Installer Qualifications: For work of this Section, engage an experienced rainwater consultant who has specialized in systems similar to those required for this Project and with a record of successful in-service performance. Consultant shall:

SPECIFIER NOTE:
The American Rainwater Catchment Systems Association (ARCSA) was founded in Austin, Texas in 1994 to promote rainwater catchment systems in the United States. Membership consists of professionals working in city, state, and federal government, academia, manufacturers and suppliers of rainwater harvesting equipment, consultants, and other interested individuals http://www.arcsa-usa.org/default.aspx

1. be a member in good standing of The American Rainwater Catchment Systems Association.
2. have a minimum **[3] [5] [xxxx]** years experience designing and constructing rainwater catchment systems similar to requirements for this Project.

SPECIFIER NOTE:
State law may include requirements for designers/installers of potable water equipment. For example, Texas Water Code Chapter 37, Texas Health & Safety Code Chapter 341, and Title 30 Texas Administrative Code, Chapter 30, Subchapter H, any individual who installs and services fixed or portable equipment in public or private systems in the State of Texas for the analysis and treatment of potable water to alter or purify the water or to add or remove a mineral, chemical, or bacterial content must be a Licensed Water Treatment Specialist. Refer to http://www.tnrcc.state.tx.us/subject_water.html

3. for potable systems, **[comply with agencies having jurisdiction] [have a current Class III Water Treatment Specialist license] [xxxx]**.

B. Single-Source Responsibility: To the greatest extent possible, obtain the system components from one source and from a single manufacturer.

C. Pre-Construction Meeting: After award of Contract and prior to the commencement of the Work of this Section, schedule and conduct meeting to discuss the Work of this Section and to coordinate with related Work. Convene pre-construction meeting to comply with requirements of Division 01 (1) and as follows:
1. Notify all attendees at least two weeks prior to the conference.
2. Require attendance of parties directly affecting Work of this Section, including, but not limited to:
   a. Owner,
   b. Contractor,
   c. Architect,
   d. Civil Engineer

e. System Designer/Installer,
f. Landscape Architect and Irrigation Installer,
g. Roofing Membrane Provider/Installer,
h. Owner's insurer, and if applicable; testing and inspecting agency representative.

3. Review methods and procedures related to installation and operation of Work of this Section, including coordination with related Work.
4. Document proceedings, including corrective measures or actions required, and furnish copy of record to each participant.

1.5 SEQUENCING AND SCHEDULING

A. Coordinate the Work with installation of associated roofing, waterproofing, flashings, and roof accessories specified under other sections as the Work of this Section proceeds.

B. Coordinate the Work with installation of associated irrigation and plumbing systems specified under other sections as the Work of this Section proceeds.

1.6 WARRANTY

A. Warranty: Warrant the system against defects including equipment failure and leakage, except for defects resulting from lack of adequate maintenance, neglect, or abuse by Owner, abnormal weather conditions unusual for warranty period.
1. Warranty Period: One year after date of Substantial Completion,

PART 2 PRODUCTS

SPECIFIER NOTE:
EO 13423 includes requirements for Federal Agencies to use “sustainable environmental practices, including acquisition of biobased, environmentally preferable, energy-efficient, water-efficient, and recycled-content products”

Specifically, under the Sustainable Building requirements per Guiding Principle #5 Reduce Environmental Impact of Materials, EO13423 directs Federal agencies to “use products meeting or exceeding EPA's recycled content recommendations” for EPA-designated products and for other products to “use materials with recycled content such that the sum of post-consumer recycled content plus one-half of the pre-consumer content constitutes at least 10% (based on cost) of the total value of the materials in the project.”

EO 13423 directs Federal Agencies “… beginning in FY 2008, reduce water consumption intensity, relative to the baseline of … year 2007 … by 2 percent annually through the end of fiscal year 2015 or 16 percent by the end of fiscal year 2015”

Specifically, under the Sustainable Building requirements per Guiding Principle #3 Protect and Conserve Water, EO 13423 directs Federal agencies to "Employ strategies that in aggregate use a minimum of 20 percent less potable water than the indoor water use baseline calculated for the building, after meeting the Energy Policy Act of 1992 fixture performance requirements." And, to "Use water efficient landscape and irrigation strategies, including water reuse and recycling, to reduce outdoor potable water consumption by a minimum of 50 percent over that consumed by conventional means (plant species and plant densities)."

Executive Order 13514; *Federal Leadership in Environmental, Energy, and Economic Performance*; was signed on October 5, 2009. http://www.ofee.gov/execorders.asp It expands upon the environmental performance requirements of EO 13423.
http://www1.eere.energy.gov/femp/regulations/printable_versions/eo13423.html

EO 13514 sets numerous federal requirements in several areas, including sustainable buildings and communities. Federal agencies must implement high performance sustainable federal building design, construction, operation and management, maintenance, and deconstruction, including:

- Ensuring all new Federal buildings, entering the design phase in 2020 or later, are designed to achieve zero net energy by 2030.
- Ensuring all new construction, major renovations, or repair or alteration of Federal buildings comply with the Guiding Principles of Federal Leadership in High Performance and Sustainable Buildings http://www1.eere.energy.gov/femp/pdfs/mouhighperfsustainfedfacs.pdf
- Ensuring at least 15% of existing agency buildings and leases (above 5,000 gross square feet) meet the Guiding Principles by fiscal year 2015 and that the agency makes annual progress towards 100% compliance across its building inventory.

Additionally, EO 13514 Federal requirements for water stewardship, including:

- Reducing potable water consumption intensity 2% annually through fiscal year 2020, or 26% by the end of fiscal year 2020, relative to a fiscal year 2007 baseline.
- Reducing agency industrial, landscaping, and agricultural water consumption 2% annually, or 20% by the end of fiscal year 2020, relative to a fiscal year 2010 baseline.
- Identifying, promoting, and implementing water reuse strategies consistent with state law that reduce potable water consumption.

2.1 SYSTEM COMPONENTS

SPECIFIER NOTE:
Rainwater harvest systems should be designed with consideration for the project location, climate, and regulatory requirements. Following is an example.

A. Catchment Area:
   1. Roofing as indicated.

B. Conveyance:
   1. Pump(s), sized as appropriate to water demands of facility.
      a. Roof collection system: **[Electric] [Wind powered] [xxxx]**.
      b. Site collection system: **[Electric] [Wind powered] [xxxx]**.
   2. Piping. Overflow pipe shall empty into a non-flooding area. Include separate inlet for intermittent treatment as is deemed necessary on basis of regular inspection/testing.

C. Storage:
   1. Tank(s), sized as appropriate to water demands of facility. Above ground design. System design shall indicate load requirements for tank foundation. Tanks shall be accessible for routine maintenance.
      a. Potable systems: **[Tank shall be fabricated from FDA-approved materials.] [Tank shall be state-approved as a vessel for potable water storage.]**

SPECIFIER NOTE:
For current designations under the Federal Biobased Products Preferred Procurement Program (FB4P), refer to www.biobased.oce.usda.gov. As of January 4, 2010, the Federal Register includes designations for approximately 60 product types. The requirements for purchasing biobased items apply to those items directly purchased by the federal agency. Under a construction contract, the contractor's use of hydraulic fluid in its bulldozers and backhoes is incidental to the purpose of its contract, so the contractor is not required to use biobased hydraulic fluids. The Office of the Federal Environmental Executive (OFEE) recommends that agencies encourage the use of these items, however.
Currently designated items that affect construction include:

- Roof Coatings

- Water Tank Coatings
- Adhesive and Mastic Removers
- Composite Panels
- Fertilizers
- Plastic Insulating Foam
- Carpet and Upholstery Cleaners
- Carpets
- Dust Suppressants
- Packaging Films
- Glass Cleaners
- Hydraulic Fluids – Stationary Equipment
- Wood and Concrete Sealers
- Cleaners

The USDA currently has identified about 150 items for which it is collecting test data needed for the additional designations of items that will extend preferred procurement status to include all qualifying biobased products.

b. Biobased content:
1) Water Tank Coatings : Coatings formulated for use in potable water storage systems. Provide minimum 59% biobased content.

2. Cisterns. Below ground design; accessible for cleaning and maintenance. Provide screens for all openings.
3. Ponds. Provide soil liner or synthetic liner.

SPECIFIER NOTE:
Soils that contain more than 15% clay are generally suitable.
Bentonite, as well as other clays, provide adsorption/ reaction sites and contribute alkalinity.

a. Where on-site soils or clay provide an adequate seal, compaction of these materials may be sufficient to line the pond.
1) On-site soils may be used if they can be compacted to permeability of <108 ft/sec (<10-6 cm/sec).
b. Synthetic liners: Asphalt liners are not permitted. Synthetic liners may be fabricated from synthetic butyl rubber or 0.5 to 10.0 mil high density polyethylene.
1) If the site soils contain angular stones, place sand bedding or geotextile cushions under the liner to prevent punctures.
2) Cover the liner with 3 - 4 inches of soil to prevent the roots of the vegetation from penetrating the liner.

D. Water Treatment:
1. Filtration. Include automatic catchment tank/pump system to prefilter water prior to entry to storage tank. Carbon is not permitted.
2. Disinfection: Provide disinfection acceptable to agencies having jurisdiction. Provide disinfection necessary to attain **[Advanced Secondary Wastewater] [Advanced Tertiary Wastewater] [Potable Water]** quality.
[a. Chlorine: Where acceptable to agencies having jurisdiction, prohibit use of chlorine treatment. Verify acceptability of iodine.]
[b. Potable system shall include automatic ozonation treatment.]

E. Accessories:
1. Joint Sealants: Non-toxic and as specified in Division 07 (7).
2. Fasteners: Non-corrosive and compatible with materials being fastened.

F. Lead components are not permitted.

2.2 FABRICATION

A. Design prefabricated components and necessary field connections required for installation to permit easy assembly, repair and maintenance, and disassembly.

B. Design and construct to comply with applicable regulatory requirements.
1. Potable system(s): Provide piping and accessories necessary to operate as a potable water system capable of utilizing municipal water as a supplementary source.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions under which system will be installed, with Designer/Installer present, for compliance with requirements.

B. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install in accordance with manufacturer's written instructions, approved shop drawings, and applicable regulatory requirements.

3.3 FIELD QUALITY CONTROL

A. General: Comply with requirements of agencies having jurisdiction and as specified herein.

B. System Inspection: System Designer/Installer shall inspect system installation and submit reports to Architect. Notify **[Architect] [Owner]** 48 hours in advance of the date and time of inspection.
1. Provide site inspection of system **[at Substantial Completion] [two weeks prior to Occupancy]**.
2. Provide site inspection of system immediately after storm event that may be severe enough to affect the system; provide inspection services for minimum **[12] [xxxx]** months after Final Completion.
3. Provide site inspection of system seasonally, and not less than once every three months; provide inspection services for minimum **[12] [xxxx]** months after Final Completion.

SPECIFIER NOTE:
ASTM D4840 specifies chain of custody documentation for laboratory samples.
ASTM D3864 provides guidance for the selection, establishment, application, and validation and verification of monitoring systems for determining water characteristics by continual sampling, automatic analysis, and recording or otherwise signaling of output data. If on-line monitoring equipment is utilized for water testing, reference ASTM D3864.

C. Water Quality tests: Comply with requirements of agencies having jurisdiction and as specified herein. Comply with ASTM D4840 for chain of custody of water samples. **[Provide on-line monitoring consistent with ASTM D3864.]**
1. Provide data on the following immediately after plants are established and **[weekly] [monthly] [xxxx]** thereafter for minimum **[6] [12] [xxxx]** months:
a. Biochemical oxygen demand (BOD_5).
b. Total Suspended Solids (TSS).

c. Fecal coliform.
d. **[xxxx].**

2. Establish baseline water quality for rainwater harvesting systems for both influent and effluent.
3. Provide comparison of test results with municipal water quality, and maintenance of system.
4. Water testing shall be performed by a laboratory in compliance with agencies having jurisdiction.

END OF SECTION

This is a guidance document with sample specification language intended to be inserted into project specifications on this subject as appropriate to the agency's environmental goals. Certain provisions, where indicated, are required for U.S. federal agency projects. Sample specification language is numbered to clearly distinguish it from advisory or discussion material. Each sample is preceded by identification of the typical location in a specification section where it would appear using the SectionFormat™ of the Construction Specifications Institute; the six digit section number cited is per CSI Masterformat™ 2004 and the five digit section number cited parenthetically is per CSI Masterformat™ 1995.

SECTION 44 40 10 (SECTION 11202) – WATER REUSE SYSTEMS

SPECIFIER NOTE:

resource management: Water reuse offers a climate independent water source that is locally-controlled and generally beneficial to the environment. Water reuse allows communities to become less dependent on groundwater and surface water sources and can decrease the diversion of water from sensitive ecosystems. Additionally, water reuse may reduce the nutrient loads from wastewater discharges into waterways, thereby reducing and preventing pollution.

toxicity/IEQ: Through the natural water cycle, the earth has recycled and reused water for millions of years. Water utilities use technology to speed up these natural processes. Utilities generally describe the various stages of treatment rather than the technologies utilized when referring to water quality, as there are multiple treatment techniques for achieving essentially the same result. Generally speaking, the four core stages of treatment are: Primary Treatment, Secondary Treatment, Tertiary or Advanced Treatment, and Disinfection.
Reclaimed water is highly engineered for safety and reliability so that the quality of reclaimed water is more predictable than many existing surface and groundwater sources. Reclaimed water is considered safe when appropriately used. Although reclaimed water is of very high quality, it is not used directly for drinking water in the United States.
Reclaimed water is often distributed with a dual piping network that keeps reclaimed water pipes completely separate from potable water pipes. In the United States, reclaimed water is always distributed in lavender (light purple) pipes to distinguish it from potable water.

performance: Within the federal sector, it is estimated that expenditures for water and sewer services reach up to $1 billion annually. Further, it is estimated that through moderate gains in water efficiency the federal government could save as much as $240 million per year. Water savings at these levels, approximately 40%, could provide enough water to supply a population of approximately 1.8 million.
Water reuse is a proven technology that has been used for more than 40 years across the U.S. Reclaimed water can be used in numerous applications to satisfy most water demands, depending on the level of treatment. The water is treated to meet regulatory guidelines for the intended end use. Typical uses for reclaimed water include:

- Irrigation
- Groundwater recharge
- Industrial cooling processes
- Toilet flushing
- Vehicle washing

The US Environmental Protection Agency regulates many aspects of wastewater treatment and drinking water quality, and the majority of states in the US have established criteria or guidelines for the beneficial use of reclaimed water. In 2004, EPA developed a technical document entitled "Guidelines for Water Reuse," which contains such information as a summary of state requirements, and guidelines for the treatment and uses of recycled water. EPA/625/R-92/004; http://www.epa.gov/region09/water/recycling/

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes water reuse systems for:
   1. municipal-supplied reclaimed water
   2. in situ water reclamation
      a. rain water
      b. gray water
      c. black water

SPECIFIER NOTE:
Coordinate requirements specified under this section with work specified under related sections. Edit below to suit project.

B. Related Sections:
   1. 01 41 00 (01411) Regulatory Requirements
   2. 33 16 20 (11201) Rainwater Harvesting

1.2 DEFINITIONS

A. Definitions pertaining to sustainable development: As defined in ASTM E2114 and as specified herein.

B. Definitions pertaining to water reuse: As defined in ASTM E2635 and as specified herein.

C. Black water: untreated wastewater from urinals and water closets.

D. Gray water: untreated wastewater from bathtubs, showers, bathroom wash basins, clothes washing machines, and laundry tubs. It may also include condensation pan water from refrigeration equipment and air-conditioners, hot tub drain water, pond and fountain drain water, and cistern drain water.

E. Reclaimed water: Water that is used more than one time before it passes back into the natural water cycle. Reclaimed water is considered nonpotable but may be highly treated and used for approved purposes other than drinking water.

F. Recycled water: See reclaimed water.

G. Water reuse: cycling water one or more times for beneficial use as reclaimed water.

1.3 SUBMITTALS

A. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:

SPECIFIER NOTE:
USGBC-LEED™ v3 includes credit for water use reduction and innovative wastewater technologies, including water reuse.
Federal Water Efficiency Best Management Practices (BMPs) provide guidance for water efficient facility design, construction, and operation. http://www1.eere.energy.gov/femp/program/waterefficiency_bmp.html
According to FEMP BMP #14, “Many Federal facilities may have water uses that can be met with non-potable water from alternate water sources. Potentially available alternative water sources for Federal sources include municipal-supplied reclaimed water, treated gray water from on-site sanitary sources, and storm water.”
FEMP originally developed the BMPs in response to EO 13123 requirements, which required Federal agencies to reduce water use through cost-effective water efficiency improvements. EO 13423

supersedes EO 13123. To account for the superseded requirement changes, water use patterns, and advancing technologies, the Environmental Protection Agency's WaterSense Office updated the original BMPs.

1. Water efficiency:
   a. Indicate water reuse rates in gallons per day (gpd) per unit for the following:
      1) municipal-supplied reclaimed water
      2) in situ water reclamation
   b. Water Budget: Submit water budget statement; **[include calculations used in development of water budget]**. Indicate how approved water budget increases water efficiency over baseline; and, indicate how water reuse system(s) complies with approved water budget.
      1) Baseline: Calculate baseline water budget using occupancy rate and **[EPAct 1992 standards for water fixtures] [xxxxx].**

B. Designer/Installer Qualifications.

1.4 QUALITY ASSURANCE

SPECIFIER NOTE:
The National Environmental Services Center (NESC) assists small and rural communities with their drinking water, wastewater, environmental training, infrastructure resilience, and utility management needs and helps them find solutions to problems they face. The NESC provides a database of Onsite Wastewater Regulations and System Resources; refer to http://www.nesc.wvu.edu/subpages/onsite_systems.cfm

Gray water is regulated locally. An example of best practices is the Arizona gray water regulations which use a three-tiered system.
Tier 1 - Reclaimed Water General Permit allows private residential direct reuse of gray water for a flow of less than 400 gallons per day if certain conditions limiting human contact with the gray water are met.
Tier 2 -Systems that process over 400 gpd, don't meet the list of requirements, and/or commercial, multi-family, and institutional systems require a standard permit under the second tier.
Tier 3 - Systems over 3,000 gpd are given attention by regulators on an individual basis.

The National Database of Water Reuse Facilities is a comprehensive web database of U.S. water reuse facilities and programs. The database is segregated into key topic areas including Utilities, Facilities, Treatment Technologies, and End Use with the capability to query information by individual states as well as nationwide. http://watereuse.org/info/nwrdb

The International Plumbing Code 2009 includes an Appendix on Gray Water Systems for flushing of water closets and urinals and subsurface landscape irrigation.

A. Regulatory Requirements: Conform to **[the International Plumbing Code and]** applicable codes, rules, and regulations.

B. Designer/Installer Qualifications: For work of this Section, engage an experienced licensed plumbing contractor who has specialized in systems similar to those required for this Project and with a record of successful in-service performance. Contractor shall:
   1. have a minimum **[3] [5] [xxxx]** years experience designing, constructing, and installing water reuse systems similar to requirements for this Project.

C. Pre-Installation Meetings:
   1. Convene a pre-installation meeting minimum one week prior to commencing work of this Section.
   2. Require attendance of parties directly affecting Work of this Section.
      a. Coordinate with installation of plumbing fixtures, equipment, and piping.
      b. Coordinate with rainwater harvesting system.

c. Coordinate with municipal supplier.
3. Review conditions of operations, procedures and coordination with related Work.
4. Agenda:
a. Tour, inspect, and discuss conditions of work.
b. Review installation schedule.
c. Review required permits and inspections.
d. Review monitoring and maintenance.
e. Review environmental procedures.

D. Operation and Maintenance Manuals Submittals:
1. Instructions indicating procedures for routine operation and maintenance of the water reuse system(s) as appropriate to:
a. municipal-supplied reclaimed water
b. in situ water reclamation utilizing:
1) rain water
2) gray water
3) black water
2. Instructions indicating procedures for normal and peak loading conditions, and periods of shutdown.
a. Peak loading conditions shall include peak hydraulic loading and pollutant loading conditions.
b. Periods of shutdown shall include: power failures, equipment failure, and normal maintenance shutdowns.
3. Instructions indicating procedures for emergency response in the event of a failure of the system.

1.4 MONITORING AND MAINTENANCE

A. Provide regular maintenance for minimum one year from date of **[Substantial Completion] [initial acceptance] [xxxx].**
1. Monitor system **[daily] [weekly] [monthly] [quarterly] [xxxx]** to assess performance.
a. Verify components are adjusted and functioning properly.
b. Verify water quality is satisfactory for intended use. If in situ water reuse systems are used, monitor and test water quality in accordance with ASTM E2635.
c. Verify water reuse rate is consistent with water budget.
2. Make minor adjustments, if any, as necessary.
3. Document system performance including:
a. Rate and amount of water reuse.
b. Quality of reclaimed water. If in situ water reuse systems are used, document quality of reclaim water before and after treatment.
c. Adjustments, if any, to system.
4. Provide recommendations for improvements to the system.

PART 2 - PRODUCTS

SPECIFIER NOTE:
EO 13423 includes requirements for Federal Agencies to use “sustainable environmental practices, including acquisition of biobased, environmentally preferable, energy-efficient, water-efficient, and recycled-content products”

EO 13423 directs Federal Agencies “… beginning in FY 2008, reduce water consumption intensity, relative to the baseline of … year 2007 … by 2 percent annually through the end of fiscal year 2015 or 16 percent by the end of fiscal year 2015”

Specifically, under the Sustainable Building requirements per Guiding Principle #3 Protect and Conserve Water, EO 13423 directs Federal agencies to "Use water efficient landscape and irrigation strategies, including water reuse and recycling, to reduce outdoor potable water consumption by a minimum of 50 percent over that consumed by conventional means (plant species and plant densities)."

Executive Order 13514; *Federal Leadership in Environmental, Energy, and Economic Performance*; was signed on October 5, 2009. http://www.ofee.gov/execorders.asp It expands upon the energy reduction and environmental performance requirements of EO 13423.
http://www1.eere.energy.gov/femp/regulations/printable_versions/eo13423.html
EO 13514 sets numerous Federal requirements in several areas, including:

- Reducing potable water consumption intensity 2% annually through fiscal year 2020, or 26% by the end of fiscal year 2020, relative to a fiscal year 2007 baseline.
- Reducing agency industrial, landscaping, and agricultural water consumption 2% annually, or 20% by the end of fiscal year 2020, relative to a fiscal year 2010 baseline.
- Identifying, promoting, and implementing water reuse strategies consistent with state law that reduce potable water consumption.

2.1 WATER REUSE SYSTEM

SPECIFIER NOTE:
GSA developed guidelines for water conservation in buildings. The guidelines, Water Management: A Comprehensive Approach for Facilities Managers, include a chapter describing basic design components of onsite wastewater recycling, reclaimed water, and rainwater harvesting.
http://www.gsa.gov/gsa/cm_attachments/GSA_DOCUMENT/waterguide_new_R2E-c-t-r_0Z5RDZ-i34K-pR.pdf

A. General:
   1. Provide system design with easy access for effective monitoring program and for effective maintenance and process control program.
   2. Provide dual distribution systems to prevent cross-connections of reclaimed water and potable water lines and the misuse of reclaimed water.
      a. Marking: Clearly mark distribution piping and use lavender (light purple) pipes to distinguish it from potable water. Provide piping certified and labeled “NSF-rw” in accordance with NSF Pipe Certification for Reclaimed Water End Use protocols.
      [b. Dye gray water blue or green with a food-grade vegetable dye.]
   3. Provide backflow prevention devices on reclaimed water lines to preclude the likelihood of incidental human misuse.

SPECIFIER NOTE:
Municipal supplied reclaimed water has been treated and recycled for non-potable use. This water is often available at a significantly lower rate than potable water; however, use of reclaimed water may be restricted by local codes.
Traditionally, centralized municipal sewage treatment facilities have been the primary source of water disposal for Federal facilities. However, heightened concerns about water supply availability have encouraged facility managers to consider on-site recycling of wastewater or gray water.

B. Municipal-supplied reclaimed water:
   1. Provide system design so that the pressure of reclaimed water 10 psi lower than potable water mains to prevent backflow and siphonage in case of accidental cross-connection.
   2. Run reclaimed water mains at least 12 inches lower in elevation than potable water mains and horizontally at least five feet away.
   3. Review the quality of reclaimed water to ensure there will be no harmful effects, such as salt buildup, to piping or equipment from long-term use. Adjust design as necessary.

SPECIFIER NOTE:
ASTM E2635, Standard Practice for Water Conservation in Buildings Through In-Situ Water Reclamation, specifies parameters for substituting reclaimed water in place of potable water supplies where potable water quality is not required.

C. In situ water reclamation: Comply with requirements of ASTM E2635 and as follows:
   1. Water reclamation system shall be designed and implemented to provide for reliability and redundancy. System design shall take into account operations and treatment during normal and peak loading conditions, and periods of shutdown.
   2. Source water: Water captured from one or more of the following:
      a. rain water, including snowmelt and stormwater runoff.
      b. gray water
      c. black water

PART 3 - EXECUTION

3.X FIELD QUALITY CONTROL

A. Water: Coordinate with work specified in Section 01 57 19.13 (01354) – Environmental Management to provide water monitoring for surface and groundwater.

B. Field Inspection: Verify installation conforms with approved system design and applicable codes, rules, and regulations.
   1. Confirm the reclaim water is disinfected by an approved method that employs one or more disinfectants such as chlorine, iodine, or ozone.
   2. Confirm the distribution piping and reservoirs are identified as containing nonpotable water.
   [3. Confirm the gray water is dyed blue or green with a food-grade vegetable dye.]

END OF SECTION

APPENDIX D

Sample Contracts

The growth in the number of projects requiring green building design and construction services has led to the issuance of the first contract forms to address this specialized area of expertise. In response to the demand, the American Institute of Architects (AIA) has issued two new contract forms for use by architects. The contract forms included in this appendix are:

- AIA Document B211-2007, Standard Form of Architect's Services: Commissioning
- AIA Document B214-2007, Standard Form of Architect's Services: LEED® Certification

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The contract forms are available for purchase from the American Institute of Architects or your local AIA component.

The American Institute of Architects
1735 New York Avenue NW
Washington, DC 20006-5292
Phone (800) AIA-3837; (202) 626-7300; fax (202) 626-7547
www.aia.org

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APPENDIX E

Examples of Sector-Specific Initiatives Toward Sustainability

The following information was compiled by theGreenTeam, Inc., and is the result of its ongoing work with building owners, product manufacturers, trade/professional organizations, standards development organizations, and environmental organizations. No warranty is made as to completeness or accuracy of information contained herein. References to organizations do not represent a guaranty, warranty, or endorsement thereof.

theGreenTeam, Inc., provides strategic environmental consulting with a focus on building industry and sustainable development.

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Examples of sustainability standards can be found in virtually every industry sector. Examples of sector-specific sustainability standards are listed below for the following industries:

- Agriculture
- Building
- Carbon
- Consumer Products
- Corporate/Business
- Education
- Energy
- Financial

- Health
- Hospitality
- Packaging
- Water

Each example identifies the organization by name and type. It summarizes the organization's standard and/or standards program. Also, it identifies the primary objective(s) for the standard or standards program relative to sustainability as environmental, economic, and/or social.

Agriculture

Conventional standards for food and agriculture are developed primarily by Codex Alimenarius. The Codex Alimenarius Commission was created in 1963 by the Food and Agriculture Organization of the United Nations (FAO) and the World Health Organization (WHO) to develop food standards, guidelines, and related texts such as codes of practice under the Joint FAO/WHO Food Standards Programme.

Sustainability standards for agriculture are being developed primarily by various NGOs, although corporate, trade, and government standards also exist. Sustainability standards for agriculture focus on organic, genetically modified organisms (GMO), and fair trade issues. Increasingly, ecosystem protection is being standardized.

Organization Type					Organization	Standard and/or Program Examples	Primary Objective		
Consumer NGO	Standards Developer	Corporate	Government	Trade / Professional			Environmental	Economic	Social
√				√	Demeter USA	Demeter USA BioDynamic Certification to standards set by Demeter International. These standards are offered to farms and handlers. Four certification types are offered: Demeter Certified Biodynamic®, In-Conversion to Demeter Biodynamic®, Aurora Certified Organic®, and/or Stellar NOP Organic.	√		

Organization Type					Organization	Standard and/or Program Examples	Primary Objective		
Consumer NGO	Standards Developer	Corporate	Government	Trade / Professional			Environmental	Economic	Social
✓					Fair Trade Certification	The Fair Trade Certified™ label is an independent, third-party certification for products that meet strict economic, social, and environmental criteria for particular products. Principal criteria are: direct trade with farmer organizations; fair prices for farmers, decent working and living conditions; free association of workers and farmers, with structures for democratic decision-making; access to pre-financing, premiums for community and business development; and sustainable agricultural practices, including restricted use of agrochemicals and no GMOs.	✓	✓	✓
✓					Forest Stewardship Council	FSC- Principles and Criteria for forest management include: 10 Principles and 57 Criteria that address legal issues, indigenous rights, labor rights, multiple benefits, and environmental impacts surrounding forest management.	✓		✓
		✓			Horizon Organic	Animal Welfare, Agricultural Sustainability and Environmental Stewardship standards for care; company example of operation/facility standards.	✓		

Organization Type					Organization	Standard and/or Program Examples	Primary Objective		
Consumer NGO	Standards Developer	Corporate	Government	Trade / Professional			Environmental	Economic	Social
				✓	Humane Farm Animal Care	Certified Humane Raised & Handled Label means that an egg, dairy, meat, or poultry product has been produced with the welfare of the farm animal in mind.	✓		
✓					Marine Stewardship Council	MSC Principles and Criteria for Sustainable Fishing. Certification by MSC-accredited certifiers.	✓		
				✓	Organic Trade Association	Develops standards and provides information on standards developed by others. Current effort on American Organic Standards Fiber: Post Harvest Handling, Processing, Record Keeping, & Labeling	✓		
✓					Smithsonian Migratory Bird Center	Bird Friendly® Coffee Certification (shade grown coffee).	✓		

Building

Conventional standards for the building industry are primarily developed by ASTM International and various trade/professional organizations.

Sustainability standards are being developed by these same organizations as well as numerous other organizations both public and private. Sustainability standards for building products have tended to focus on single attributes (such as energy-efficient or recycled content); however, increasingly they are encompassing multi-attributes and life cycle protocols.

Organization Type					Organization	Standard and/or Program Examples	Primary Objective		
Consumer NGO	Standards Developer	Corporate	Government	Trade / Professional			Environmental	Economic	Social
	✓			✓	ASHRAE	The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) founded in 1894, is an international organization of 51,000 persons. ASHRAE has several standards on ventilation and energy management. ASHRAE standard 189.1 addresses whole building and sustainability.	✓		✓
✓				✓	ASLA	The American Society of Landscape Architects (ASLA), the Lady Bird Johnson Wildflower Center at The University of Texas at Austin and the United States Botanic Garden developed the Sustainable Sites Initiative, a rating system for the design, construction, and maintenance of sustainable landscapes, with or without buildings.	✓		
	✓				ASTM International	ASTM develops standards relative to building sustainability and sustainability in numerous other industry sectors. Also, ASTM maintains a Sustainability Database of Standards (all industry sectors) inclusive of ASTM and non-ASTM standards.	✓	✓	✓
		✓			Air Quality Sciences	Provides testing and consulting services. Certification testing for the GREENGUARD Indoor Air Quality Certified label.	✓		

Organization Type					Organization	Standard and/or Program Examples	Primary Objective		
Consumer NGO	Standards Developer	Corporate	Government	Trade / Professional			Environmental	Economic	Social
✓					Bat Conservation International	Bat Conservation International created the Bat House Certification Program to help manufacturers build high-quality houses that bats will accept.	✓		
				✓	BOMA	Building Owners and Managers Association International. BOMA has “100 Days, 100 Ways,” a list of tips and strategies to help property professionals make going green a priority on Earth Day and every day.	✓		
		✓			Brendle Group, Inc.	Sustainability Management System (SMS) for small professional offices; branded as “the next generation of environmental management systems, an SMS moves beyond mere environmental compliance toward a vision of integrated sustainability.”	✓	✓	✓
				✓	BIFMA	The Business and Institutional Furniture Manufacturer’s Association. BIFMA develops product and industry standards that support safe, healthy and sustainable environments; publishes industry statistics; advocates for legislation and regulation that have a direct impact on the health of the industry.	✓	✓	✓

Organization Type					Organization	Standard and/or Program Examples	Primary Objective		
Consumer NGO	Standards Developer	Corporate	Government	Trade / Professional			Environmental	Economic	Social
			✓		California Department of General Services	California Gold Sustainable Carpet Standard is based on life cycle assessment principles, and provides benchmarks for continuous improvement. The standard identifies six levels of sustainable attribute performance and four levels of achievement.	✓	✓	✓
				✓	Carpet and Rug Institute (CRI)	Green Label and Green Label Plus are independent testing programs that identifies carpet with very low emissions of VOCs to help improve indoor air quality.	✓		
✓					Cascadia Region Green Building Council	Cascadia offers the Living Building Challenge Certification, whose purpose is to: define a measure of sustainability in the built environment, using a benchmark of what is currently possible and given the best knowledge available today.	✓	✓	✓
		✓			Chicago Climate Exchange (CCX)	A financial institution whose objectives are to apply financial innovation and incentives to advance social, environmental, and economic goals through the following platforms: the Chicago Climate Exchange and the Chicago Climate Futures Exchange.	✓	✓	✓
			✓		EPA	EPA has several eco-label programs applicable to building products and/or buildings; including: Design for the Environment (DfE) label. Energy Star. WaterSense.	✓		✓

Organization Type					Organization	Standard and/or Program Examples	Primary Objective		
Consumer NGO	Standards Developer	Corporate	Government	Trade / Professional			Environmental	Economic	Social
	✓	✓			Leonardo Academy	Cleaner and Greener Building Certification - Certifies buildings energy use meets certain criteria, principally LEED Energy and Atmosphere credit 5.4.	✓		
	✓			✓	Green Building Initiative	Green Globes green building rating program is a system that includes an assessment protocol, rating system, and guide for integrating environmentally friendly design into commercial buildings.	✓		
✓		✓			Green Guard Environmental Institute	GreenGuard, established by Air Quality Sciences, provides certifications for: Indoor Air Quality (emissions from products), Children and Schools (educational building materials), and Building Construction (to minimize mold generation).	✓		
		✓			theGreenTeam	theGreenTeam manages GreenPLUS and GreenR standards. GreenPLUS is a free home-rating system for homeowners and others; focus is on environmental stewardship and disaster resilience. Scores are provided for health, safety, and welfare. GreenR is an eco-label for products that provide responsible closing-the-loop measures such as a take-back program.	✓	✓	✓

Organization Type					Organization	Standard and/or Program Examples	Primary Objective		
Consumer NGO	Standards Developer	Corporate	Government	Trade / Professional			Environmental	Economic	Social
	✓				ICC	International Code Council develops National Green Building Standard and is developing a green commercial building standard, the IGCC targeting 2011 for publication.	✓		
✓					Integrated Pest Management (IPM) Institute	The IPM Star Certification Program recognizes IPM practitioners who meet a high standard for IPM in schools, childcare centers, and school-age programs. Green Shield Certification is for pest control companies and for buildings.	✓		✓
		✓			MBDC	Cradle-to-Cradle certification for products. Criteria evaluated includes: materials, material reutilization/design for environment, energy, water, and social responsibility.	✓		✓
			✓		National Institute of Building Sciences	National Building Information Model Standard (BIMS) is intended to be an open standards based repository of information for the facility owner/operator to use and maintain throughout the life cycle of a facility. NIBS and the International Alliance for Interoperability coined term buildingSMART to describe this entire effort.	✓	✓	

Organization Type					Organization	Standard and/or Program Examples	Primary Objective		
Consumer NGO	Standards Developer	Corporate	Government	Trade / Professional			Environmental	Economic	Social
				√	PERSI	Practice, Education and Research for Sustainable Infrastructure (PERSI), initiated by American Society of Civil Engineers, does not itself produce standards and practices, but will help its member organizations address sustainability consistently in their practices and standards.	√	√	√
	√			√	U.S. Green Building Council	USGBC-LEED green building rating program is a system that includes an assessment protocol, rating system, and guide for integrating environmentally friendly design into buildings.	√		
			√		*Whole Building Design Guide* (website operated by National Institute of Building Sciences)	Federal Green Construction Guide for Specifiers. Developed to address the need for a comprehensive guide for procuring green building products and construction/ renovation services within the Federal government. Provides guidance and model documents per Executive Order 13423, "Strengthening Federal Environmental, Energy and Transportation Management," and the Federal Leadership in High Performance and Sustainable Buildings Memorandum of Understanding (MOU).	√	√	√

Carbon

Conventional standards have not addressed carbon directly.

Sustainability standards for carbon accounting (carbon footprinting, GHG emissions, etc.) are increasingly in demand to satisfy governmental regulations and/or to respond to environmental initiatives. The standards include metrics for measurement as well as certification protocols for auditing and reporting. The evolution of carbon standards is directly linked to the market drivers for the standards. There are several drivers. Wal-Mart's Sustainability Index, for example, asks manufacturers, "Have you opted to report your greenhouse gas emissions to the Carbon Disclosure Project (CDP)?" The CDP is an NGO that collects climate change information from organizations around the world. Carbon trading systems, such as the Chicago Climate Exchange (CCX) or the European Climate Exchange, establish monetary value for carbon reduction and sequestration. For instance, National Farmers Union's Carbon Credit Program is a multi-state program that allows farmers and landowners to earn income by storing carbon in their soil through no-till crop production and long term grass seeding practices. Farmers Union has earned approval from the CCX to aggregate carbon credits for trade on the Exchange, much like other agricultural commodities are traded.

The exchange trades in emissions of six gases: carbon dioxide, methane, nitrous oxide, sulfur hexafluoride, perfluorocarbons and hydrofluorocarbons.

Organization Type					Organization	Standard and/or Program Examples	Primary Objective		
Consumer NGO	Standards Developer	Corporate	Government	Trade / Professional			Environmental	Economic	Social
		✓			BeGreen	Carbon offset provider whose projects include renewable energy and reforestation initiatives.	✓		
✓					Bonneville Environmental Foundation (BEF)	Carbon offset provider whose projects include renewable energy development and watershed restoration.	✓		
✓					The Climate Trust	The Climate Trust provides carbon offsets, customized voluntary offset programs, and consulting services.	✓		

Organization Type					Organization	Standard and/or Program Examples	Primary Objective		
Consumer NGO	Standards Developer	Corporate	Government	Trade / Professional			Environmental	Economic	Social
✓					Conservation International	Carbon offset provider that features forest-based projects.	✓		
✓					Cool It!	Carbon offset provider whose projects include renewable energy initiatives.	✓		
			✓		Environmental Protection Agency	Household Emissions Calculator. Educational website; includes a calculator to assess carbon emissions generated at home and on the road.	✓		
✓					National Wildlife Federation	Website provides a calculator that helps to assess carbon emissions generated at home, on the road and in the air.	✓		
		✓			Native Energy	Carbon offset provider whose projects include renewable energy and methane abatement.	✓		
		✓			TerraPass	Carbon offset provider whose projects include farm power and renewable energy initiatives.	✓		

Consumer Products

Conventional standards for consumer products are typically product safety standards developed by governmental agencies (such as the U.S. Consumer Product Safety Commission) or by mainstream standard development organizations (such as ASTM International).

Sustainability standards are being developed by these same organizations as well as numerous other organizations both public and private. Increasingly, retailers are developing their own proprietary standards for labeling or otherwise recognizing a product as "green."

Sustainability standards for consumer products have tended to focus on single attributes (such as energy efficient or recycled content); however, increasingly are encompassing multi-attributes and life cycle protocols.

Organization Type					Organization	Standard and/or Program Examples	Primary Objective		
Consumer NGO	Standards Developer	Corporate	Government	Trade / Professional			Environmental	Economic	Social
✓					Basel Action Network	Created the e-Stewards program, independently audited and accredited electronic waste recycling certification program. Certifies recyclers; targets communication to consumers.	✓		✓
			✓		Blue Angel	Blue Angel is the first and oldest environment-related label in the world for products and services. It was created in 1978 on the initiative of the German Federal Minister of the Interior and approved by the Ministers of the Environment.	✓		
			✓		Canada's Environmental Choice Program	EcoLogo. Canadian environmental labeling program for consumer and industrial products, including building products (works in collaboration with the Canada Green Building Council and the Green Building Initiative on building products).	✓		✓
				✓	Consumer Electronics Retailers Coalition	Developed list of positions that advocate how consumer electronic products should be collected for reuse, refurbishment, and recycling. Positions based on retailers' economic considerations and expected effectiveness in recovering products.	✓	✓	

Organization Type					Organization	Standard and/or Program Examples	Primary Objective		
Consumer NGO	Standards Developer	Corporate	Government	Trade / Professional			Environmental	Economic	Social
				✓	Electronic Components, Assemblies & Materials Association	Electronic Components, Assemblies & Materials Association (part of Electronics Industry Alliance, EIA). ECA/ECCB-954 - Electrical and Electronic Components and Products Hazardous Substance Free Standard and Requirements. Guidance relative to Directive 2002/95/EC of the European Parliament on the restriction of the use of certain hazardous substances in electrical and electronic equipment.	✓		
			✓	✓	EPEAT	EPEAT helps purchasers evaluate, compare and select computers based on their environmental attributes. The EPEAT Registry includes products declared by their manufacturers in conformance with the environmental performance standard for electronics: IEEE 1680-2006 (Institute of Electrical and Electronics Engineers). Registered products are rated Gold, Silver, or Bronze.	✓		
✓					GoodGuide	GoodGuide is a free system that rates products for environmental, social, and health impacts, and health. It collects data on chemical ingredients, products, companies, industrial sectors, and countries. A goal is to let consumers screen data according to their own preferences.	✓		✓

Organization Type					Organization	Standard and/or Program Examples	Primary Objective		
Consumer NGO	Standards Developer	Corporate	Government	Trade / Professional			Environmental	Economic	Social
✓	✓				Green Seal	Green Seal develops standards and provides eco-label for compliant products.	✓		✓
✓					Greener Choices	Web-based initiative from Consumer Reports. Provides calculators standardizing comparisons for energy usage of various consumer appliances and equipment, carbon foot printing, etc. Also, provides de facto third-party endorsement of various eco-labels.	✓		
				✓	International Council of Chemical Associations	Provides Responsible Care outreach, checklists, performance indicators, and verification procedures to enable industry to demonstrate how its health, safety and environmental performance has improved, and to develop policies for further improvement; has common set of Fundamental Features that all associations must meet.	✓		
	✓				International Electrotechnical Commission	IECQ 080000 Quality Assessment System for Electronic Components (IECQ) - Electrical and Electronic Components and Products — Hazardous Substance Process Management System Requirements (HSPM). This supplements the ISO 9001-2000 Quality Management System (QMS). It is based on the EIA/ECCB Standard 954 *Electrical and Electronic Components and Products Hazardous Substance Free Standard and Requirements*.	✓		

Organization Type					Organization	Standard and/or Program Examples	Primary Objective		
Consumer NGO	Standards Developer	Corporate	Government	Trade / Professional			Environmental	Economic	Social
✓					Nordic Swan Label	Uses sustainability criteria to label product sustainability. International example of consumer product labeling program.	✓	✓	✓
✓					Product Stewardship Institute	PSI works with stakeholders to reduce the health and environmental impacts of consumer products. PSI is involved in the following priority product categories: carpet, electronics, fluorescent lighting, gas cylinders, medical sharps, mercury products, paint, pesticides, pharmaceuticals, phone books, radioactive devices, thermostats, and tires.	✓		✓
			✓		European Chemicals Agency (ECHA)	The EU REACH (Registration, Evaluation and Authorization of Chemicals, EU regulation) Regulation gives greater responsibility to industry to manage the risks from chemicals and to provide safety information on the substances. Manufacturers and importers will be required to gather information on the properties of their chemical substances, which will allow their safe handling, and to register the information in a central database run by the European Chemicals Agency (ECHA) in Helsinki. The agency will act as the central point in the REACH system: it will manage the			

Organization Type					Organization	Standard and/or Program Examples	Primary Objective		
Consumer NGO	Standards Developer	Corporate	Government	Trade / Professional			Environmental	Economic	Social
						databases necessary to operate the system, coordinate the in-depth evaluation of suspicious chemicals, and run a public database in which consumers and professionals can find hazard information. The regulation also calls for the progressive substitution of the most dangerous chemicals when suitable alternatives have been identified.	✓		✓
		✓			The Home Depot	Home Depot has launched the EcoOptions product line, which offers more eco-efficient products. Follows corporate environmental principles.	✓		
		✓			The Institute for Market Transformation to Sustainability	MTS develops sustainability standards of interest to its members.	✓		
		✓			Walmart	The Walmart Sustainability Index collects information from venders on: energy and climate, material efficiency, natural resources, and people and community. Information will be compiled in a life cycle database and, eventually, provided to customers.	✓		✓
✓					Worldwide Responsible Apparel Production (WRAP)	WRAP Certification. For factories achieving full compliance with the WRAP Production Principles for lawful, humane, and ethical manufacturing.			✓

Corporate/Business

Conventional standards for corporate/business operations typically address business ethics and relate to fiscal responsibility. They are primarily crested by governmental agencies such as the International Accounting Standards Board and the U.S. Financial Accounting Standards Board. The Securities and Exchange Commission (SEC), an independent agency of the U.S. government, currently has oversight of the U.S. Financial Accounting Standards Board.

Sustainability standards for corporate/business operations examine not just economic issues but also environmental and social issues.

Organization Type					Organization	Standard and/or Program Examples	Primary Objective		
Consumer NGO	Standards Developer	Corporate	Government	Trade / Professional			Environmental	Economic	Social
				√	B Corporation	B Corporation label for companies that meet social and environmental performance standards.	√		√
				√	Global Environmental Management Initiative (GEMI)	GEMI Metrics Navigator™ a sustainability management and reporting toolset.	√	√	√
√					Global Reporting Initiative	GRI created the Sustainability Reporting Framework for disclosure on economic, environmental, and social performance.	√	√	√
√	√				International Social and Environmental Accreditation and Labeling (ISEAL) Alliance	ISEAL Code of Good Practice for Setting Social and Environmental Standards; it is intended primarily for application to standards that fulfill social and environmental policy objectives.	√		√
				√	International Society of Sustainability Professionals (ISSP)	ISSP offers a certificate program in Sustainability meant for practitioners who need to fill in “gaps” in their education or for displaced professionals looking for a new career.	√	√	√

Organization Type					Organization	Standard and/or Program Examples	Primary Objective		
Consumer NGO	Standards Developer	Corporate	Government	Trade / Professional			Environmental	Economic	Social
	✓				International Organization for Standardization	ISO is a network of the national standards institutes of 162 countries, one member per country. ISO develops standards on a range of topics.	✓		
✓					MBA Oath	The oath is a voluntary pledge for graduating MBAs and current MBAs to "create value responsibly and ethically." The MBA Oath mission is to facilitate a widespread movement of MBAs who aim to lead in the interests of the greater good and who have committed to living out the principles articulated in the oath. Starting as a group of Class of 2009 Graduates of Harvard Business School and expanded to a broad coalition of MBA students, graduates and advisors, representing over 250 schools from around the world.	✓	✓	✓
✓					The Natural Step (TNS)	TNS Framework seeks to align business and government practices with natural cycles that support the web of life.	✓		✓
✓					Social Accountability International (SAI)	SAI's mission is to promote human rights for workers around the world. SAI is best known for SA8000, a comprehensive and flexible system for managing ethical workplace conditions throughout global supply chains.			✓

Organization Type					Organization	Standard and/or Program Examples	Primary Objective		
Consumer NGO	Standards Developer	Corporate	Government	Trade / Professional			Environmental	Economic	Social
		✓			Tested Green	Tested Green Certification for small businesses that offer a green product or service, or those who have implemented a green manufacturing process.	✓		
			✓		United Nations	Global Compact is an international initiative that brings companies together with UN agencies, labor and civil society to support universal environmental and social principles. Compacting companies agree to adhere to 10 principles in the areas of human rights, labor, the environment, and anti-corruption.	✓		✓

Education

Conventional education standards are primarily developed by national educational organizations and address major subject areas. For example, the National Standards for Arts Education, developed by the Consortium of National Arts Education Associations, outlines basic arts learning outcomes integral to the comprehensive K-12 education. The National Council of Teacher of Mathematics develops standards for mathematics curriculum.

Sustainability standards for education address both curriculum and facility/program operations. See also the MBA Oath under Corporate/Business standards; a group of student activists who seek to enhance community value, quality of life, and accountability of business leaders; and, who as future business leaders, articulated their goals in the "MBA Oath." With the MBA Oath, business school graduates pledge to practice social, economic, and environmental ethics in their careers.

Sustainability standards for education are developed by various entities, both public and private.

Organization Type					Organization	Standard and/or Program Examples	Primary Objective		
Consumer NGO	Standards Developer	Corporate	Government	Trade / Professional			Environmental	Economic	Social
✓					Association for the Advancement of Sustainability in Higher Education	Campus Sustainability Tracking, Assessment, and Rating System (STARS) measures not only building but also curriculum goals, socially responsible labor practice, food purchasing practices, and other issues.	✓		✓
✓					The Cloud Institute for Sustainability Education	Provides curricula and training on sustainability education; materials may form basis for standard.	✓	✓	✓
✓					Sustainable Endowments Institute	College Sustainability Report Card. Assesses policies and programs of over 100 leading colleges. Categories: administration, climate change & energy, endowment transparency, food & recycling, green building, investment, shareholder engagement, student involvement, and transportation.	✓	✓	✓
			✓		U.S. Environmental Protection Agency (EPA)	HealthySEAT, EPA software tool to help school districts evaluate and manage their school facilities for key environmental, safety and health issues.	✓		
✓					Vermont Community Works	Environmental sustainability standards for education.	✓	✓	✓
			✓		Wisconsin Dept. of Education	Wisconsin Model Academic Standards for Environmental Education	✓		

Energy

Conventional standards for the building industry are primarily developed by ASTM International and various trade/professional organizations. They typically focus on technical specifications for energy generation and processing. Increasingly they address performance, including conservation.

Sustainability standards are being developed by these same organizations as well as numerous other organizations both public and private. Sustainability standards for energy focus on renewable energy, including technical specifications as well as definitions and certifications.

Organization Type					Organization	Standard and/or Program Examples	Primary Objective		
Consumer NGO	Standards Developer	Corporate	Government	Trade / Professional			Environmental	Economic	Social
				√	American Wind Energy Association (AWEA)	AWEA is developing the Small Wind Turbine Performance and Safety Standard for turbines with a swept area of less than 200 square meters.	√		
√					Green E	Green-e National Standard is an independent certification and verification program for renewable energy.	√		
			√		U.S. Dept. of Energy, Energy Building Codes Program	Works to promote and establish strong state and local energy codes for residential and commercial construction.	√	√	

Financial

See also Corporate/Business standards.

Conventional standards for assessing financial performance are typically proprietary and not transparent. They are tools developed and utilized by investment firms.

Sustainability standards are being developed by these same organizations. Most are proprietary and not transparent.

Sustainability standards for finance commonly address socially responsible investing (SRI). SRI is a booming market in both the U.S. and Europe. Assets in SRI portfolios climbed to $2.71 trillion in 2007.

Organization Type					Organization	Standard and/or Program Examples	Primary Objective		
Consumer NGO	Standards Developer	Corporate	Government	Trade / Professional			Environmental	Economic	Social
				✓	Ethibel Sustainability Index	The Ethibel Sustainability Index (ESI) proprietary screening and evaluation of the financial performance of the world's leading companies in terms of sustainability.	✓	✓	✓
				✓	Social Investment Forum	SRI Guides which could become the basis for standards; the Social Investment Forum is the U.S. association for professionals and organizations dedicated to socially responsible investing (SRI).	✓	✓	✓
		✓			Standard Chartered (UK based international bank)	Adopted/adapted World Bank sustainable lending principles called Sustainable Lending and the Equator Principles	✓	✓	✓
		✓			Trucost	Trucost is an environmental research consulting firm which helps clients to understand the environmental impacts of business activities.	✓	✓	
✓			✓		World Bank–International Finance Corporation	Equator Principles establish social and environmental principles for international project finance; principles are for financial companies to adopt.	✓	✓	✓

Health

Conventional standards on health are developed primarily by the World Health Organization (WHO) and governmental agencies. For example, the International Health Regulations, negotiated by WHO's member states, establish protocols that countries must follow to identify disease outbreaks and stop them from spreading.

WHO addresses a broad spectrum of health and quality of life issues. It readily acknowledges sustainability and coordinates with related United Nations programs.

Other sustainability standards related to health address health care facilities. See also Building standards.

Organization Type					Organization	Standard and/or Program Examples	Primary Objective		
Consumer NGO	Standards Developer	Corporate	Government	Trade / Professional			Environmental	Economic	Social
✓					Green Guide for Health Care	Self-certifying metric toolkit of best practices that designers, owners, and operators can use to guide and evaluate their progress towards high performance healing environments.	✓		✓
✓					Health Care Without Harm	Ecological Footprint for the Health Care Industry ecological footprint model/case example for health care operations/ facilities.	✓		✓

Hospitality

Conventional standards are developed primarily by trade/professional organizations and focus on quality control. For example, the "Hospitality Assured" program is the quality standard created by the Institute of Hospitality. The Accepted Practices Exchange (APEX) is an initiative of the Convention Industry Council for the development and implementation of industry-wide standards for meetings and events.

Sustainability standards are being developed by these same organizations as well as ASTM International.

Organization Type					Organization	Standard and/or Program Examples	Primary Objective		
Consumer NGO	Standards Developer	Corporate	Government	Trade / Professional			Environmental	Economic	Social
	✓				ASTM International	ASTM has suite of standards/ work items relative to hospitality and sustainability.	✓	✓	✓
✓		✓			Audubon International and Greenleaf Environmental Communications	Audubon Green Leaf™ Program for the hospitality industry. Provides consulting and rating of eco-efficiency. Jointly managed by Audubon International and Greenleaf Environmental Communications, a for-profit partner.	✓		
		✓			EcoTel	EcoTel Certification for Hotels is based on five separate inspections (each with a three-tiered Numerical Scoring System): Environmental Commitment, Solid Waste Management, Energy Efficiency, Water Conservation, and Employee Education & Community Involvement.	✓		✓
✓	✓				GreenSeal	Lodging Properties (GS-33) Standard. Establishes criteria for certified lodging properties for environmentally sustainable operation.	✓		
✓					Sustainable Tourism Stewardship Council	Network agreed upon a set of baseline criteria for sustainable tourism certification; produces certified tourism products catalog as well.	✓	✓	✓
✓					The International Ecotourism Society (TIES)	TIES is working to promote sustainability certifications in the tourism industry.	✓	✓	✓

Packaging

Conventional standards for packaging are developed primarily by ASTM International, ISO, and other SDOs. They focus on performance specifications.

Sustainability standards are being developed by these same organizations; but, are also a priority for retailers. Sustainability standards address packaging design, including material content.

Organization Type					Organization	Standard and/or Program Examples	Primary Objective		
Consumer NGO	Standards Developer	Corporate	Government	Trade / Professional			Environmental	Economic	Social
		✓			Walmart Stores Inc. (operated through the ECRM)	Sustainable Packaging Scorecard. Raw material suppliers, packaging converters and packaging service providers complete scorecards to make their products and services available to manufacturers.	✓		
✓		✓			Sustainable Packaging Coalition	Indicators and Metrics Project to develop guidelines for measuring the sustainability of packaging and packaging systems. Also has a Labeling for Recovery Project. SPC is a project of GreenBlue, which itself is a project of McDonough Braungart Design Chemistry (MBDC), a for profit design firm.	✓		

Water

Conventional standards are developed primarily by governmental agencies and address health/safety issues related to water and wastewater treatment and delivery systems. Mainstream SDOs, such as ASTM International, develop water testing standards to correspond with government criteria.

Sustainability standards are developed primarily by NGOs although mainstream SDOs, including ASTM Intentional, and governmental agencies, such as the U.S. EPA, are

beginning to develop sustainable water standards as well. The focus is on water stewardship, including both quality and quantity issues. Additionally, social issues are increasingly a focal topic. Whether water is defined as a "right" or a "need" will affect standards and policy development.

Organization Type					Organization	Standard and/or Program Examples	Primary Objective		
Consumer NGO	Standards Developer	Corporate	Government	Trade / Professional			Environmental	Economic	Social
✓					Alliance for Water Stewardship	The Alliance for Water Stewardship (AWS) was established by the Nature Conservancy and others to promote responsible use of fresh water that is both socially beneficial and environmentally sustainable. Aims to create standards for water stewardship and good corporate behavior regarding water use.	✓		✓
			✓		Australia	Water Efficiency Labeling and Standards (WELS) Scheme, Australia Standards for registering water-related products.	✓		
✓					Global Environmental Management Initiative	Water Sustainability Work Group developed Water Sustainability Tool for businesses to better manage water sustainability.	✓	✓	✓
			✓		U.S. EPA	Water Sense label indicates that these products and programs meet water-efficiency and performance criteria.	✓		

GLOSSARY

Note: For additional definitions the authors recommend that readers refer to ASTM E2114, *Standard Terminology for Sustainability Relative to the Performance of Buildings*, published by ASTM International. The standard contains terms and definitions pertaining to sustainable development; and, in particular to sustainability relative to the performance of buildings.

1,1,1-Trichloroethane Included in fabric and carpet manufacture and in a variety of cleaners, it is observed offgassing. 1,1,1-Trichloroethane is considered capable of causing fertility problems and developmental defects, and may also have health impacts on wildlife. Chlorinated solvents such as 1,1,1-Trichloroethane deplete stratospheric ozone.

Abatement Reducing the degree or intensity of, or eliminating, pollution.

Acetone A moderately toxic, highly volatile, and flammable solvent used in nail polish removers, glues, paint strippers, and other products. Considered less toxic than aromatic hydrocarbons such as toluene and xylene, it causes symptoms similar to, but slightly more severe than, those of ethyl alcohol.

Acid Leachates Water that has become acidic after see page through landfills; potentially very damaging to fish habitats, drinking water supplies, and so on.

Acrylics A family of plastics used for fibers, rigid sheets, and paints and caulkings.

Action Levels (1) Regulatory levels recommended by EPA for enforcement by FDA and USDA when pesticide residues occur in food or feed commodities for reasons other than the direct application of the pesticide. As opposed to "tolerances," which are established for residues occurring as a direct result of proper usage, action levels are set for inadvertent residues resulting from previous legal use or accidental contamination. (2) In the Superfund program, the existence of a contaminant concentration in the environment high enough to warrant action or trigger a response under SARA and the National Oil and Hazardous Substances Contingency Plan. The term is also used in other regulatory programs.

Activated Carbon A highly adsorbent form of carbon used to remove odors and toxic substances from liquid or gaseous emissions. In waste treatment, it is used to remove dissolved organic matter from waste drinking water. It is also used in motor vehicle evaporative control systems.

Activated Sludge Product that results when primary effluent is mixed with bacteria-laden sludge and then agitated and aerated to promote biological treatment, speeding the breakdown of organic matter in raw sewage undergoing secondary waste treatment.

Acute Exposure A single exposure to a toxic substance which may result in severe biological harm or death. Acute exposures are usually characterized as lasting no longer than a day, as compared to longer, continuing exposure over a period of time.

Acute Toxicity The ability of a substance to cause severe biological harm or death soon after a single exposure or dose. Also, any poisonous effect resulting from a single short-term exposure to a toxic substance.

Adjacent Site Property or properties the border of which is contiguous or partially contiguous with that of the property, or that would be contiguous or partially contiguous with that of the property but for a street, road, or other public thoroughfare separating them.

Administrative Order A legal document signed by EPA directing an individual, business, or other entity to take corrective action or refrain from an activity. It describes the violations and actions to be taken, and can be enforced in court. Such orders may be issued, for example, as a result of an administrative complaint whereby the respondent is ordered to pay a penalty for violations of a statute.

Adsorption Removal of a pollutant from air or water by collecting the pollutant on the surface of a solid material; for example, an advanced method of treating waste in which activated carbon removes organic matter from wastewater.

Advanced Treatment A level of wastewater treatment more stringent than secondary treatment; requires an 85 percent reduction in conventional pollutant concentration or a significant reduction in nonconventional pollutants. Sometimes called tertiary treatment.

Advanced Wastewater Treatment Treatment of sewage that goes beyond the secondary or biological water treatment stage and includes the removal of nutrients such as phosphorus and nitrogen and a high percentage of suspended solids.

Aerated Lagoon A holding and/or treatment pond that speeds up the natural process of biological decomposition of organic waste by stimulating the growth and activity of bacteria that degrade organic waste.

Aeration A process that promotes biological degradation of organic matter in water. The process may be passive (as when waste is exposed to air) or active (as when a mixing or bubbling device introduces the air).

Aerobic Life or processes that require, or are not destroyed by, the presence of oxygen.

Aerobic Treatment Process by which microbes decompose complex organic compounds in the presence of oxygen and use the liberated energy for reproduction and growth. (Such processes include extended aeration, trickling filtration, and rotating biological contactors.)

Agricultural Pollution Farming wastes, including runoff and leaching of pesticides and fertilizers; erosion and dust from plowing; improper disposal of animal manure and carcasses; crop residues and debris.

Agricultural Waste Poultry and livestock manure, and residual materials in liquid or solid form generated from the production and marketing of poultry, livestock or fur-bearing animals; also includes grain, vegetable, and fruit harvest residue.

Air Changes per Hour (ACH) The movement of a volume of air in a given period of time; if a house has one air change per hour, it means that the air in the house will be replaced in a one-hour period.

Air Cleaning Indoor-air quality-control strategy to remove various airborne particulates and/or gases from the air. Most common methods are particulate filtration, electrostatic precipitation, and gas sorption.

Air Contaminant Particulate matter, gas, or combination thereof, other than water vapor.

Air Exchange Rate The rate at which outside air replaces indoor air in a given space.

Air Pollutant A substance in air that could, in high enough concentration, harm humans, other animals, vegetation, or material. Pollutants may include almost any natural or artificial composition of airborne matter capable of being airborne. They may be in the form of solid particles, liquid droplets, gases, or in combination thereof. Generally, they fall into two main

groups: (1) those emitted directly from identifiable sources and (2) those produced in the air by interaction between two or more primary pollutants, or by reaction with normal atmospheric constituents, with or without photoactivation. Exclusive of pollen, fog, and dust, which are of natural origin, about 100 contaminants have been identified. Air pollutants are often grouped in categories for ease in classification; some of the categories are: solids, sulfur compounds, volatile organic chemicals, particulate matter, nitrogen compounds, oxygen compounds, halogen compounds, radioactive compounds, and odors.

Air Pollution The presence of contaminants or pollutant substances in the air that interfere with human health or welfare or produce other harmful environmental effects.

Air Quality Criteria The levels of pollution and lengths of exposure above which adverse health and welfare effects may occur.

Air Quality Standards The level of pollutants prescribed by regulations that are not to be exceeded during a given time in a defined area.

Air Toxics As defined by the EPA, air pollutant for which a national ambient air quality standard (NAAQS) does not exist (i.e., excluding ozone, carbon monoxide, PM-10, sulfur dioxide, nitrogen oxide) that may reasonably be anticipated to cause cancer; respiratory, cardiovascular, or developmental effects; reproductive dysfunctions, neurological disorders, heritable gene mutations, or other serious or irreversible chronic or acute health effects in humans.

Airborne Particulates Total suspended particulate matter found in the atmosphere as solid particles or liquid droplets. Chemical composition of particulates varies widely, depending on location and time of year. Sources of airborne particulates include: dust, emissions from industrial processes, combustion products from the burning of wood and coal, combustion products associated with motor vehicle or nonroad engine exhausts, and reactions to gases in the atmosphere.

Airborne Release Release of any pollutant into the air.

Algae Simple rootless plants that grow in sunlit waters in proportion to the amount of available nutrients. They can affect water quality adversely by lowering the dissolved oxygen in the water. They are food for fish and small aquatic animals.

Algal Blooms Sudden spurts of algal growth, which can affect water quality adversely and indicate potentially hazardous changes in local water chemistry.

Algicide Substance or chemical used specifically to kill or control algae.

Aliquot A measured portion of a sample taken for analysis. One or more aliquots make up a sample.

Alkaline The condition of water or soil that contains a sufficient amount of alkali substance to raise the pH above 7.0.

Allergen A substance that causes an allergic reaction in individuals sensitive to it.

Alternative Compliance A policy that allows facilities to choose among methods for achieving emission reduction or risk reduction, instead of command-and-control regulations that specify standards and how to meet them. Use of a theoretical emissions bubble over a facility to cap the amount of pollution emitted while allowing the company to choose where and how (within the facility) it complies.

Alternative Fuels Substitutes for traditional liquid, oil-derived motor vehicle fuels like gasoline and diesel. Includes mixtures of alcohol-based fuels with gasoline, methanol, ethanol, compressed natural gas, and others.

Ambient Air Any unconfined portion of the atmosphere: open air, surrounding air.

Ambient Measurement A measurement of the concentration of a substance or pollutant within the immediate environs of an organism; taken to relate it to the amount of possible exposure.

Ambient Medium Material surrounding or contacting an organism (e.g., outdoor air, indoor air, water, or soil) through which chemicals or pollutants can reach the organism.

Ambient Temperature Temperature of the surrounding air or other medium.

Ammonia Substance used extensively in large industrial refrigeration applications, highly poisonous to humans. Ammonia is a gas that is intensely irritating to the skin, eyes, and the respiratory tract, even in low concentrations. Household ammonia is a 5 percent to 10 percent solution of ammonia in water, and like other types of cleaning products with ammonia, it gives off ammonia gas vapors. Environmental impact from household use probably is minimal, although use of ammonia-based fertilizers can lead to groundwater pollution with nitrates. Ammonia reacts with chlorine bleach to produce toxic and irritating chloramines.

Anaerobic A life or process that occurs in, or is not destroyed by, the absence of oxygen.

Anaerobic Decomposition Reduction of the net energy level and change in chemical composition of organic matter caused by microorganisms in an oxygen-free environment.

Aquifer An underground geological formation or group of formations containing water. Aquifers are sources of groundwater for wells and springs.

Asbestos A mineral fiber that can pollute air or water and cause cancer or asbestosis when inhaled. EPA has banned or severely restricted its use in manufacturing.

Asbestos Abatement Procedures to control fiber release from asbestos-containing materials in a building or to remove them entirely, including removal, encapsulation, repair, enclosure, encasement, and operations and maintenance programs.

ASHRAE Standard 62 *Ventilation for Acceptable Indoor Air Quality*. Details two methods for compliance: the Ventilation Rate Procedure and the Indoor Air Quality Procedure. Rapidly becoming the standard of care for building ventilation and indoor air quality.

Assay A test for a specific chemical, microbe, or effect.

Attainment Area An area considered to have air quality as good as or better than the national ambient air quality standards as defined in the Clean Air Act. An area may be an attainment area for one pollutant and a nonattainment area for others.

Background Level (1) The concentration of a substance in an environmental media (air, water, or soil) that occurs naturally or is not the result of human activities. (2) In exposure assessment, the concentration of a substance in a defined control area, during a fixed period of time before, during, or after a data-gathering operation.

Bacteria (Singular: bacterium) Microscopic living organisms that can aid in pollution control by metabolizing organic matter in sewage, oil spills, or other pollutants. However, bacteria in soil, water, or air can also cause human, animal, and plant health problems.

Bactericide A pesticide used to control or destroy bacteria, typically in the home, schools, or hospitals.

Bacteria Sink Porous materials that allow the growth of biological contaminants within the material.

Bake-out A process used to remove VOCs from a building by elevating the temperature in the unoccupied, fully furnished, and ventilated building.

Banking A system for recording qualified emission reductions for later use in bubble, offset, or netting transactions.

BEN EPA's computer model for analyzing a violator's economic gain from not complying with the law.

Bentonite A colloidal clay, expansible when moist, commonly used to provide a tight seal around a well casing.

Benzene A clear, colorless, flammable liquid (CH), derived from petroleum and used to manufacture DDT (a prohibited insecticide), detergents, other strains of insecticides, and motor fuels. Benzene is included in the formulation of paints, adhesives, and resins, and can offgas. Benzene is considered a carcinogen.

Beryllium A metal hazardous to human health when inhaled as an airborne pollutant. It is discharged by machine shops, ceramic and propellant plants, and foundries.

Best Available Control Measures (BACM) A term used to refer to the most effective measures (according to EPA guidance) for controlling small or dispersed particulates and other emissions from sources such as roadway dust, soot and ash from woodstoves and open burning of rush, timber, grasslands, or trash.

Best Available Control Technology (BACT) For any specific source, the currently available technology producing the greatest reduction of air pollutant emissions, taking into account energy, environmental, economic, and other costs.

Best Management Practice (BMP) Methods that have been determined to be the most effective, practical means of facilitating an identified task; frequently used in reference to preventing or reducing pollution.

Bioaccumulants Substances that increase in concentration in living organisms as they take in contaminated air, water, or food, because the substances are very slowly metabolized or excreted.

Bioaccumulation The net accumulation of a substance by an organism as a result of uptake from all environmental sources.

Bioassay A test to determine the relative strength of a substance by comparing its effect on a test organism with that of a standard preparation.

Biochemical Oxygen Demand (BOD) BOD is a chemical procedure for determining how fast biological organisms use up oxygen in a body of water.

Bioconcentration The accumulation of a chemical in tissues of a fish or other organism to levels greater than in the surrounding medium.

Biodegradable Capable of decomposing under natural conditions into elements found in nature.

Biodiversity The variability among living organisms from all sources including: terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are a part; this includes diversity within species, between species, and of ecosystems.

Biological Contaminants Living organisms or derivates (e.g., viruses, bacteria, fungi, and mammal and bird antigens) that can cause harmful health effects when inhaled, swallowed, or otherwise taken into the body.

Biological Control In pest control, the use of animals and organisms that eat or otherwise kill or out-compete pests.

Biological Magnification Refers to the process whereby certain substances such as pesticides or heavy metals move up the food chain, work their way into rivers or lakes, and are eaten by aquatic organisms such as fish, which in turn are eaten by large birds, animals or humans. The substances become concentrated in tissues or internal organs as they move up the chain.

Biomagnification The increase in tissue concentration of poorly depurated materials in organisms along a series of predator-prey associations, primarily through the mechanism of dietary accumulation.

Biological Oxygen Demand (BOD) An indirect measure of the concentration of biologically degradable material present in organic wastes. It usually reflects the amount of oxygen consumed in five days by biological processes breaking down organic waste. The greater the BOD, the greater the degree of pollution.

Biomass (1) All living material in a given area. (2) A material which is or was a living organism or excreted from a microorganism.

Biome Entire community of living organisms in a single major ecological area.

Biomonitoring (1) The use of living organisms to test the suitability of effluents for discharge into receiving waters and to test the quality of such waters downstream from the discharge. (2) Analysis of blood, urine, tissues, etc. to measure chemical exposure in humans.

Bioremediation Use of living organisms to clean up oil spills or remove other pollutants from soil, water, or wastewater; use of organisms such as nonharmful insects to remove agricultural pests or counteract diseases of trees, plants, and garden soil.

Biosphere The portion of Earth and its atmosphere that can support life.

Biostabilizer A machine that converts solid waste into compost by grinding and aeration.

Biota The animal and plant life of a given region.

Blackwater Untreated wastewater from toilets, kitchen sinks, and dishwashers.

Bloom A proliferation of algae and/or higher aquatic plants in a body of water; often related to pollution, especially when pollutants accelerate growth.

BOD5 The amount of dissolved oxygen consumed in five days by biological processes breaking down organic matter. See also *Biological Oxygen Demand*.

Bog A type of wetland that accumulates appreciable peat deposits. Bogs depend primarily on precipitation for their water source, and are usually acidic and rich in plant residue with a conspicuous mat of living green moss.

Borax A sodium salt of boron, used as a laundry whitener and general-purpose cleaner. Slightly less toxic than boric acid.

Boric Acid A boron compound used as an insecticide, particularly against ants and fleas. Although it is considered moderately toxic, boric acid is not volatile and thus does not emit toxic vapors. Formerly used to clean and dress wounds, boric acid is absorbed through broken skin, and deaths have occurred from that use. The major hazard from household use is accidental ingestion or inhalation of dust.

Bottle Bill Proposed or enacted legislation that requires a returnable deposit on beer or soda containers and provides for retail store or other redemption. Such legislation is designed to discourage use of throwaway containers.

Bottom Ash The nonairborne combustion residue from burning pulverized coal in a boiler; the material that falls to the bottom of the boiler and is removed mechanically; a concentration of noncombustible materials, which may include toxics.

British Thermal Unit (BTU) Unit of heat energy equal to the amount of heat required to raise the temperature of 1 pound of water by 1 degree Fahrenheit at sea level.

Bromotrifluoromethane A fire suppression agent (Halon 1301) primarily designed for areas containing delicate, expensive, or irreplaceable equipment; used because of its ability to suppress fires without leaving undesirable residue.

Brownfields Real property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant.

Building Cooling Load The hourly amount of heat that must be removed from a building to maintain indoor comfort (measured in British thermal units, Btus).

Building Department Records Those records of the local government in which the property is located indicating permission of the local government to construct, alter, or demolish improvements on the property.

Building Envelope The exterior surface of a building's construction—the walls, windows, floors, roof, and floor. Also called building shell.

Building product Item manufactured or processed for incorporation in a building or other construction works.

Building-Related Illness Diagnosable illness whose cause and symptoms can be directly attributed to a specific pollutant source within a building (e.g., Legionnaire's disease, hypersensitivity, pneumonitis). Building-related illnesses are generally considered more serious than sick building syndrome (SBS) conditions and are clinically verifiable diseases that can be attributed to a specific source or pollutant within a building. The symptoms of the disease persist after leaving the building, unlike SBS, where the occupant experiences relief shortly after leaving the building. See also *Sick Building Syndrome*.

Butyls Synthetic rubber resins used for flexible sheet products and durable, solvent-based caulkings.

Byproduct Material, other than the principal product, generated as a consequence of an industrial process or as a breakdown product in a living system.

Cadmium (Cd) A heavy metal that accumulates in the environment.

Carbon Adsorption A treatment system that removes contaminants from groundwater or surface water by forcing it through tanks containing activated carbon treated to attract the contaminants.

Carbon Dioxide (CO_2) A colorless, odorless gaseous product of human respiration.

Carbon Monoxide (CO) A colorless, odorless, poisonous gas produced by incomplete fossil fuel combustion. Found in soldering, in gas appliances, and in other combustion sources. Carbon monoxide can slow down your brain and your reflexes and dim your vision. Most people don't realize how little carbon monoxide it takes to be poisonous to the human body. Only 50 parts of CO per million parts of air, by volume, is considered dangerous. Carbon monoxide doesn't suffocate you, it kills you by chemical action. It's an asphyxiant; it combines directly with your blood so the body can't carry oxygen to the tissues.

Carbon Tetrachloride (CCl4) Compound consisting of one carbon atom and four chlorine atoms. Once widely used as an industrial raw material, as a solvent, and in the production of CFCs. Use as a solvent ended when it was discovered to be carcinogenic.

Carboxyhemoglobin Hemoglobin in which the iron is bound to carbon monoxide (CO) instead of oxygen.

Carcinogen A substance that can cause or aggravate cancer.

Carrying Capacity The theoretical maximum population of a biological organism that an ecosystem can sustain indefinitely.

CAS Registration Number A number assigned by the Chemical Abstract Service to identify a chemical.

Catchment Area Surface, including hard roofs, from which rainwater may be collected.

Categorical Exclusion A class of actions that either individually or cumulatively would not have a significant effect on the human environment and therefore would not require preparation of an environmental assessment or environmental impact statement under the National Environmental Policy Act (NEPA).

Chain Of Custody System that tracks a product, its materials, and its components through two or more life cycle stages.

Chemical Compound A distinct and pure substance formed by the union or two or more elements in definite proportion by weight.

Chemical Element A fundamental substance comprising one kind of atom; the simplest form of matter.

Chemical Oxygen Demand (COD) A measure of the oxygen required to oxidize all compounds, both organic and inorganic, in water.

Chemical Stressors Chemicals released to the environment through industrial waste, auto emissions, pesticides, and other human activity that can cause illnesses and even death in plants and animals.

Chemical Treatment A one of a variety of technologies that use chemicals or a variety of chemical processes to treat waste.

ChemNet Mutual aid network of chemical shippers and contractors that assigns a contracted emergency response company to provide technical support if a representative of the firm whose chemicals are involved in an incident is not readily available.

Chilling Effect The lowering of the Earth's temperature because of increased particles in the air blocking the sun's rays.

Chlorinated Hydrocarbons (1) Chemicals containing only chlorine, carbon, and hydrogen. These include a class of persistent, broad-spectrum insecticides that linger in the environment and accumulate in the food chain. Among them are DDT, aldrin, dieldrin, heptachlor, chlordane, lindane, endrin, Mirex, hexachloride, and toxaphene. Other examples include TCE, used as an industrial solvent. (2) A chlorinated organic compounds including chlorinated solvents such as dichloromethane, trichloromethylene, and chloroform.

Chlorinated Solvent An organic solvent containing chlorine atoms (e.g., methylene chloride and 1,1,1-trichloromethane). Chlorinated solvents are found in aerosol spray containers, highway paint, and dry cleaning fluids.

Chlorination The application of chlorine to drinking water, sewage, or industrial waste to disinfect or to oxidize undesirable compounds.

Chlorine A chemical used to purify water and a bleaching agent. A movement begun in Europe to ban products containing chlorine has spread to the United States. Concerns focus on the discharge of organic compounds into oceans and waterways.

Chlorofluorocarbons (CFCs) A family of inert, nontoxic, and easily liquefied chemicals used in refrigeration, air conditioning, packaging, insulation, or as solvents and aerosol propellants. Because CFCs are not destroyed in the lower atmosphere, they drift into the upper atmosphere where their chlorine components destroy ozone.

Chlorophenoxy A class of herbicides that may be found in domestic water supplies and cause adverse health effects.

Chronic Effect An adverse effect on a human or animal whereby symptoms recur frequently or develop slowly over a long period of time.

Chronic Exposure Multiple exposures occurring over an extended period of time or over a significant fraction of an animal's or human's lifetime—usually seven years to a lifetime.

Chronic Toxicity The capacity of a substance to cause long-term poisonous health effects in humans, animals, fish, and other organisms.

Cistern Small tank or storage facility used to store water for a home or farm; often used to store rainwater.

Class I Area Under the Clean Air Act, a Class I area is one in which visibility is protected more stringently than under the national ambient air quality standards; includes national parks, wilderness areas, monuments, and other areas of special national and cultural significance.

Class I Substance One of several groups of chemicals with an ozone depletion potential of 0.2 or higher, including CFCS, halons, carbon tetrachloride, and methyl chloroform (listed in the Clean Air Act), and HBFCs and ethyl bromide (added by EPA regulations).

Class II Substance A substance with an ozone depletion potential of less than 0.2. All HCFCs are currently included in this classification.

Cleaner Technologies Substitutes Assessment A document that systematically evaluates the relative risk, performance, and cost trade-offs of technological alternatives; serves as a repository for all the technical data (including methodology and results) developed by a DfE or other pollution prevention or education project.

Clearcut Harvesting all the trees in one area at one time, a practice that can encourage fast rainfall or snowmelt runoff, erosion, sedimentation of streams and lakes, and flooding, and destroys vital habitat.

Climate Change Also referred to as "global climate change," the term is sometimes used to refer to all forms of climatic inconsistency, but because the Earth's climate is never static, the term is more properly used to imply a significant change from one climatic condition to another. In some cases, "climate change" has been used synonymously with the term "global warming"; scientists, however, tend to use the term in the wider sense to also include natural changes in climate.

Closed-Loop Life Cycle A product and/or constituent material(s) life cycle where the product or constituent material(s) are reused, repurposed (reused for a different purpose), recycled, composted, or otherwise treated as a useful resource that minimizes waste and negative environmental impacts.

Closed-Loop Recycling Reclaiming or reusing wastewater for nonpotable purposes in an enclosed process.

Code of Federal Regulations (CFR) Document that codifies all rules of the executive departments and agencies of the federal government. It is divided into 50 volumes, known as titles. Title 40 of the CFR (referenced as 40 CFR) lists all environmental regulations.

Cogeneration The simultaneous production of electrical or mechanical energy (power) and useful thermal energy from a single energy stream, such as oil, coal, natural or liquefied gas, biomass, or solar.

Coliform Index A rating of the purity of water based on a count of fecal bacteria.

Commercial Waste Management Facility A treatment, storage, disposal, or transfer facility that accepts waste from a variety of sources, as compared to a private facility which normally manages a limited waste stream generated by its own operations.

Commingled Recyclables Mixed recyclables that are collected together.

Comminuter A machine that shreds or pulverizes solids to make waste treatment easier.

Comminution Mechanical shredding or pulverizing of waste. Used in both solid waste management and wastewater treatment.

Commissioning The start-up phase for a new or remodeled building. This phase includes testing and fine-tuning the HVAC and other systems to assure proper functioning and adherence to design criteria. Commissioning also includes preparation of the system operation manuals and instruction of the building maintenance personnel.

Compost A humus or soil-like material created from aerobic, microbial decomposition of organic materials such as food scraps, yard trimmings, and manure.

Composting The controlled biological decomposition of organic material in the presence of air to form a humus.

Compressed Natural Gas (CNG) An alternative fuel for motor vehicles; considered one of the cleanest because of low hydrocarbon emissions and because its vapors are relatively non-ozone-producing. However, vehicles fueled with CNG do emit a significant quantity of nitrogen oxides.

Conservation Preserving and renewing, when possible, human and natural resources. The use, protection, and improvement of natural resources according to principles that will ensure their highest economic or social benefits.

Conservation Easement Easement that restricts a landowner to land uses that are compatible with long-term conservation and environmental values.

Constructed Wetland Any of a variety of designed systems that approximate natural wetlands, using aquatic plants, and can be used to treat wastewater or runoff.

Construction and Demolition Waste Waste building materials, dredging materials, tree stumps, and rubble resulting from construction, remodeling, repair, and demolition of homes, commercial buildings and other structures, and pavements. May contain lead, asbestos, or other hazardous substances.

Contaminant A physical, chemical, biological, or radiological substance or matter that has an adverse effect on air, water, or soil.

Contamination Introduction into water, air, and soil of microorganisms, chemicals, toxic substances, wastes, or wastewater in a concentration that makes the medium unfit for its next intended use. Also applies to surfaces of objects, buildings, and various household and agricultural products.

Copper Naphthenate One of the copper compounds used as a wood preservative. Because of its relatively low acute toxicity to humans, it is considered a safer alternative to pentachlorophenol and creosote. Copper compounds, including copper naphthenate, are highly toxic to aquatic organisms. Copper accumulates in soils, and concentrates in marine and fresh water organisms.

Criteria Pollutants The 1970 amendments to the Clean Air Act required EPA to set National Ambient Air Quality Standards for certain pollutants known to be hazardous to human health. EPA has identified and set standards to protect human health and welfare for six pollutants: ozone, carbon monoxide, total suspended particulates, sulfur dioxide, lead, and nitrogen oxide. The term "criteria pollutants" derives from the requirement that the EPA must describe the characteristics and potential health and welfare effects of these pollutants. It is on the basis of these criteria that standards are set or revised.

Cross-Connection A physical connection between any part of a water system used or intended to supply water for drinking purposes and any source or system containing water or substance that is not or cannot be approved as potable water.

Cryptosporidium A protozoan microbe associated with the disease cryptosporidiosis in humans. The disease can be transmitted through ingestion of drinking water, person-to-person contact, or other pathways, and can cause acute diarrhea, abdominal pain, vomiting, fever, and can be fatal, as it was in the Milwaukee episode.

Cumulative Exposure The sum of exposures of an organism to a pollutant over a period of time.

Custodian A single person with primary responsibility for the care and custody of the product until primary possession of the product is transferred.

Custody Physical possession or control of a product.

Degree-day A rough measure used to estimate the amount of heating required in a given area; is defined as the difference between the mean daily temperature and 65°F. Degree-days are also calculated to estimate cooling requirements.

Department of Energy (DOE) The DOE originated with the race to develop the atomic bomb during World War II, and resulted in the Atomic Energy Commission. By the mid-1970s, the Atomic

Energy Commission was abolished and two new agencies were created: the Nuclear Regulatory Agency, to regulate the nuclear power industry, and the Energy Research and Development Administration, to manage the nuclear weapon, naval reactor, and energy development programs. However, the extended energy crisis of the 1970s soon demonstrated the need for unified energy organization and planning. In 1977, the Department of Energy assumed the responsibilities of the Federal Energy Administration, the Energy Research and Development Administration, the Federal Power Commission, and parts and programs of several other agencies. Today, the DOE mission includes ensuring the energy security of the nation, maintaining the safety of our nuclear stockpile, and developing energy innovations and technology.

Detection Limit The lowest concentration of a chemical that can reliably be distinguished from a zero concentration.

Diatomaceous Earth (Diatomite) A chalklike material (fossilized diatoms) used to filter out solid waste in wastewater treatment plants; also used as an active ingredient in some powdered pesticides. Both natural diatomaceous earth (DE) and swimming pool grade come from the same fossil sources but are processed differently. The pool grade is chemically treated and partially melted, and consequently contains crystalline silica, which can be a respiratory hazard.

Diazinon An insecticide. In 1986, the EPA banned its use on open areas such as sod farms and golf courses because it posed a danger to migratory birds. The ban did not apply to agricultural, home lawn, or commercial establishment uses.

Dibenzofurans A group of organic compounds, some of which are toxic.

Dichloro-Diphenyl-Trichloroethane (DDT) The first chlorinated hydrocarbon insecticide chemical name. It has a half-life of 15 years and can collect in fatty tissues of certain animals. The EPA banned registration and interstate sale of DDT for virtually all but emergency uses in the United States in 1972 because of its persistence in the environment and accumulation in the food chain.

Dinoseb A herbicide that is also used as a fungicide and insecticide. It was banned by the EPA in 1986 because it posed the risk of birth defects and sterility.

Dioxin Any of a family of compounds known chemically as dibenzo-p-dioxins. Concern about them arises from their potential toxicity as contaminants in commercial products. Tests on laboratory animals indicate that it is one of the more toxic anthropogenic (man-made) compounds.

Direct Runoff Water that flows over the ground surface or through the ground directly into streams, rivers, and lakes.

Discharge Flow of surface water in a stream or canal or the outflow of groundwater from a flowing artesian well, ditch, or spring. Can also apply to discharge of liquid effluent from a facility or to chemical emissions into the air through designated venting mechanisms.

Disinfection Destruction, inactivation, or removal of pathogenic microorganisms by chemical, physical, or biological means.

Dissolved Oxygen (DO) The oxygen freely available in water, that is vital to fish and other aquatic life and for the prevention of odors. DO levels are considered a most important indicator of a water body's ability to support desirable aquatic life. Secondary and advanced waste treatment are generally designed to ensure adequate DO in waste-receiving waters.

Disturbance An event or series of events that disrupt ecosystem, community, or population structure and alters the physical environment.

Diversion Rate The percentage of waste materials diverted from traditional disposal such as landfilling or incineration to be recycled, composted, or reused.

Dobson Unit (DU) Units of ozone level measurement. Measurement of ozone levels. If, for example, 100 DU of ozone were brought to the earth's surface they would form a layer one millimeter thick. Ozone levels vary geographically, even in the absence of ozone depletion.

Drinking Water Equivalent Level Protective level of exposure related to potentially noncarcinogenic effects of chemicals that are also known to cause cancer.

Dual Distribution System Reclaimed water distribution systems that parallels a potable water system.

Ecological Entity In ecological risk assessment, a general term referring to a species, a group of species, an ecosystem function or characteristic, or a specific habitat or biome.

Ecological/Environmental Sustainability Maintenance of ecosystem components and functions for future generations.

Ecological Impact Effect that an activity has on living organisms, their nonliving (abiotic) environment, and the ecosystem.

Ecological Indicator A characteristic of an ecosystem that is related to or derived from, a measure of biotic or abiotic variable, that can provide quantitative information on ecological structure and function. An indicator can contribute to a measure of integrity and sustainability.

Ecological Integrity A living system exhibits integrity if, when subjected to disturbance, it sustains and organizes self-correcting ability to recover toward a biomass end-state that is normal for that system. End-states other than the pristine or naturally whole may be viable.

Ecological Risk Assessment The application of a formal framework, analytical process, or model to estimate the effects of human actions(s) on a natural resource and to interpret the significance of those effects in light of the uncertainties identified in each component of the assessment process. Such analysis includes initial hazard identification, exposure and dose-response assessments, and risk characterization.

Ecology The relationship of living things to one another and their environment, or the study of such relationships.

Ecosphere The "bio-bubble" that contains life on earth, in surface waters, and in the air.

Ecosystem A community of biological organisms and their physical environment, functioning together as an interdependent unit within a defined area.

Ecosystem Structure Attributes related to the instantaneous physical state of an ecosystem; examples include species population density, species richness or evenness, and standing crop biomass.

Effluent Limitation Restrictions established by an agency having jurisdiction on quantities, rates, and concentrations in wastewater discharges.

Electric and Magnetic Fields (EMF) See *Electromagnetic Spectrum*.

Electromagnetic Spectrum A continuum of electric and magnetic radiation, encompassing all wavelengths from electricity, radio and microwaves, at the low-frequency end to infrared, visible light, and ultraviolet light in the midrange, to X-rays and gamma rays at the high frequency end of the spectrum. (As defined by the Institute of Electrical and Electronic Engineers, Inc. (IEEE), the spectrum of electromagnetic radiation consists of gamma rays, wavelengths shorter than 0.0006 nm; X-rays, 0.0006–5 nm; ultraviolet rays, 5 nm-0.4 μm; visible light, 04–0.7 μm; infrared, 0.7 μm–0.1 mm; radio, greater than 0.1 mm.).

Embodied Energy The energy used through the life cycle of a material or product to extract, refine, process, fabricate, transport, install, commission, utilize, maintain, remove, and ultimately recycle or dispose of the substances comprising the item.

Emerging Pollutants New chemicals and/or technologies that may cause harm to human health and/or the environment. There are two major categories of emerging pollutants; known

chemicals/technologies to industry and commerce, that are previously unrecognized as pollutants, and new or developing chemicals/technologies. Examples of potential emerging pollutants include: pharmaceuticals, nanotechnologies, and biotechnologies.

Emission Pollution discharged into the atmosphere from smokestacks, other vents, and surface areas of commercial or industrial facilities; from residential chimneys; and from motor vehicle, locomotive, or aircraft exhausts.

Emission Cap A limit designed to prevent projected growth in emissions from occurring and future stationary sources from eroding any mandated reductions. Generally, such provisions require that any emission growth from facilities under the restrictions be offset by equivalent reductions at other facilities under the same cap. See *Emissions Trading*.

Emission Factor The relationship between the amount of pollution produced and the amount of raw material processed. For example, an emission factor for a blast furnace making iron would be the number of pounds of particulates per ton of raw materials.

Emission Inventory A listing, by source, of the amount of air pollutants discharged into the atmosphere of a community; used to establish emission standards.

Emission Standard The maximum amount of air polluting discharge legally allowed from a single source, mobile or stationary.

Emissions Trading The creation of surplus emission reductions at certain stacks, vents, or similar emissions sources, and the use of this surplus to meet or redefine pollution requirements applicable to other emissions sources. This allows one source to increase emissions when another source reduces them, maintaining an overall constant emission level. Facilities that reduce emissions substantially may "bank" their "credits" or sell them to other facilities or industries.

Encapsulation The treatment of asbestos-containing material with a liquid that covers the surface with a protective coating or embeds fibers in an adhesive matrix to prevent their release into the air.

Endangered Species A species that is in danger of extinction throughout all or a significant portion of its habitat range, as determined by the governmental entity having jurisdiction.

Endangerment Assessment A study to determine the nature and extent of contamination at a site on the National Priorities List and the risks posed to public health or the environment. The EPA or the state conducts the study when a legal action is to be taken to direct potentially responsible parties to clean up a site or to pay for it. An endangerment assessment supplements a remedial investigation.

End-of-the-Pipe Technologies Refers to technologies that reduce emissions of pollutants after they have formed.

End User Consumer of products for the purpose of recycling. Excludes products for reuse or combustion for energy recovery.

End-use Product A pesticide formulation for field or other end use. The label has instructions for use or application to control pests or regulate plant growth. The term excludes products used to formulate other pesticide products.

Endrin A pesticide toxic to freshwater and marine aquatic life that produces adverse health effects in domestic water supplies.

Energy Input All forms of energy necessary for the accomplishment of the particular building life cycle process under consideration.

Energy Management System A control system capable of monitoring environmental and system loads and adjusting HVAC operations accordingly in order to conserve energy while maintaining comfort.

Energy Recovery Obtaining usable energy by consuming waste through a variety of processes.

Engineered Controls Method of managing environmental and health risks by placing a barrier between the contamination and the rest of the site, thus limiting exposure pathways.

Enrichment The addition of nutrients (e.g., nitrogen, phosphorus, carbon compounds) from sewage effluent or agricultural runoff to surface water, greatly increases the growth potential for algae and other aquatic plants.

Environment The sum of all external conditions affecting the life, development, and survival of an organism.

Environmental Aspect Element of an organization's activities or products or services that can interact with the environment.

Environmental Assessment An environmental analysis prepared pursuant to the National Environmental Policy Act (NEPA) to determine whether a federal action would significantly affect the environment and thus require a more detailed environmental impact statement.

Environmental Audit An independent assessment of the current status of a party's compliance with applicable environmental requirements or of a party's environmental compliance policies, practices, and controls.

Environmental Chamber A stainless steel, nonreactive testing device, with a known air volume and dynamically controlled air change rate, temperature and humidity. Emission rates are commonly determined by placing materials or furniture into a small or large stainless steel environmental chamber, then measuring the release of volatile vapors from the products over a specified time period. Rates are measured in $\mu g/m^2 \bullet$ hr (micrograms per square meter per hour) or $mg/m^2 \bullet$ hr (milligrams per square meter per hour).

Environmental/Ecological Risk The potential for adverse effects on living organisms associated with pollution of the environment by effluents, emissions, wastes, or accidental chemical releases; energy use; or the depletion of natural resources.

Environmental Exposure Human exposure to pollutants originating from facility emissions. Threshold levels are not necessarily surpassed, but low-level chronic pollutant exposure is one of the most common forms of environmental exposure.

Environmental Medium A major environmental category that surrounds or contacts humans, animals, plants, and other organisms (e.g., surface water, groundwater, soil or air) and through which chemicals or pollutants move.

Environmental Releases Air, water, and/or solid emissions, which are given off by the building life cycle process under consideration that return to the natural environment.

Environmental Equity/Justice Equal protection from environmental hazards for individuals, groups, or communities, regardless of race, ethnicity, or economic status. This applies to the development, implementation, and enforcement of environmental laws, regulations, and policies, and implies that no population of people should be forced to shoulder a disproportionate share of negative environmental impacts of pollution or environmental hazard because of a lack of political or economic strength.

Environmental Fate The destiny of a chemical or biological pollutant after release into the environment.

Environmental Fate Data Data that characterize a pesticide's fate in the ecosystem, considering factors that foster its degradation (light, water, microbes), pathways, and resultant products.

Environmental Impact A change to the environment whether adverse or beneficial, wholly or partially resulting from an organization's environmental aspects.

Environmental Impact Statement A document required of federal agencies by the National Environmental Policy Act for major projects or legislative proposals significantly affecting the environment. A tool for decision making, it describes the positive and negative effects of the undertaking and cites alternative actions.

Environmental Indicator A measurement, statistic, or value that provides a proximate gage or evidence of the effects of environmental management programs or of the state or condition of the environment in a given area.

Environmental Management System (EMS) Procedures for identifying, managing, and improving the environmental impacts of an organization, facility, product, and/or service.

Environmental Protection Agency (EPA) Established in 1970 to consolidate the federal government's environmental regulatory activities under the jurisdiction of a single agency, the mission of the EPA is to protect human health and to safeguard the natural environment. The EPA ensures that federal environmental laws are enforced fairly and effectively.

Environmental Site Assessment The process of determining whether contamination is present on a parcel of real property.

Environmental Sustainability Long-term maintenance of ecosystem components and functions for future generations.

Environmental Tobacco Smoke Mixture of smoke from the burning end of a cigarette, pipe, or cigar, and smoke exhaled by the smoker.

Environmentally Preferable Refers to a product(s) or service(s) that has a lesser or reduced negative effect on human health, the environment, or both, when compared to a product(s) or service(s) in the same product category.

Erosion The wearing away of land surface by wind or water, intensified by land-clearing practices related to farming, residential or industrial development, road building, or logging.

Ethylbenzene A part of paint formulations, and associated with some carpeting, it is observed offgassing in the home, in office furniture products, in office buildings, and in subject's breath. Ethylbenzene is a chronic toxin, capable of causing fertility problems and developmental defects. Ethylbenzene will also potentially have health impacts on wildlife.

Eutrophication The slow aging process during which a lake, estuary, or bay evolves into a bog or marsh and eventually disappears. During the later stages of eutrophication, the water body is choked by abundant plant life because higher levels of nutritive compounds such as nitrogen and phosphorus. Human activities can accelerate the process.

Evapotranspiration The loss of water from the soil both by evaporation and by transpiration from the plants growing in the soil.

Exotic Species An introduced species not native or indigenous to the area where it is found.

Exposure The amount of radiation or pollutant present in a given environment that represents a potential health threat to living organisms.

Exposure Assessment Identifying the pathways by which toxicants may reach individuals, estimating how much of a chemical an individual is likely to be exposed to, and estimating the number likely to be exposed.

Exposure Concentration The concentration of a chemical or other pollutant representing a health threat in a given environment.

Exposure Indicator A characteristic of the environment measured to provide evidence of the occurrence or magnitude of a response indicator's exposure to a chemical or biological stress.

Exposure Level The amount (concentration) of a chemical at the absorptive surfaces of an organism.

Exposure Pathway The path from sources of pollutants via, soil, water, or food to man and other species or settings.

Exposure Route The way a chemical or pollutant enters an organism after contact; that is, by ingestion, inhalation, or dermal absorption.

Exposure-Response Relationship The relationship between exposure level and the incidence of adverse effects.

Extended Producer Responsibility A strategy designed to promote the integration of environmental costs associated with products throughout their life cycles into the market price of the products.

Extremely Hazardous Substances Any of 406 chemicals identified by EPA as toxic and listed under SARA Title III. The list is subject to periodic revision.

Facultative Bacteria Bacteria that can live under aerobic or anaerobic conditions.

Feedstocks The raw material used in manufacturing a product, such as the oil or gas used to make a plastic.

First Flush Filter Device that automatically diverts the first flow of rainwater collected from the catchment area.

Fluorides Gaseous, solid, or dissolved compounds containing fluorine that result from industrial processes. Excessive amounts in food can lead to fluorosis.

Fluorocarbons (FCs) Any of a number of organic compounds analogous to hydrocarbons in which one or more hydrogen atoms are replaced by fluorine. Once used in the United States as a propellant for domestic aerosols, they are now found mainly in coolants and some industrial processes. FCs containing chlorine are called chlorofluorocarbons (CFCs). They are believed to be modifying the ozone layer in the stratosphere, thereby allowing more harmful solar radiation to reach the Earth's surface.

Flush-out A process used to remove VOCs from a building by operating the building's HVAC system at 100 percent outside air for a specific period of time.

Fly ash Noncombustible residual particles expelled by flue gas.

Formaldehyde A colorless, pungent, and irritating gas, CH20, used chiefly as a disinfectant and preservative and in synthesizing other compounds like resins.

Friable Capable of being crumbled, pulverized, or reduced to powder by hand pressure.

Fugitive Emissions Emissions not caught by a capture system.

Fungicide Pesticides which are used to control, deter, or destroy fungi.

Fungus (Fungi) Molds, mildews, yeasts, mushrooms, and puffballs, a group of organisms lacking in chlorophyl (i.e., are not photosynthetic) and that are usually nonmobile, filamentous, and multicellular. Some grow in soil, others attach themselves to decaying trees and other plants whence they obtain nutrients. Some are pathogens, others stabilize sewage and digest composted waste.

Gasification Conversion of solid material such as coal into a gas for use as a fuel.

General Services Administration (GSA) One of the three central management agencies in the federal government (the Office of Personnel Management and the Office of Management and Budget are the others). GSA provides the buildings and supplies that enable federal employees to accomplish their work. It also provides workspace, security, furniture, equipment, supplies, tools, computers, and telephones. GSA negotiates contracts that account for $40 billion of goods and services bought annually from the private sector.

Geothermal/Ground Source Heat Pump Heat pump with underground coils to transfer heat from the ground to the inside of a building.

Global Warming An increase in the near-surface temperature of the Earth. Global warming has occurred in the distant past as the result of natural influences, but the term is most often used to refer to the warming predicted to occur as a result of increased emissions of greenhouse gases. Scientists generally agree that the Earth's surface has warmed by about 1°F in the past 140 years. The Intergovernmental Panel on Climate Change (IPCC) recently concluded that increased concentrations of greenhouse gases are causing an increase in the Earth's surface temperature and that increased concentrations of sulfate aerosols have led to relative cooling in some regions, generally over and downwind of heavily industrialized areas.

Global Warming Potential The ratio of the warming caused by a substance to the warming caused by a similar mass of carbon dioxide. CFC-12, for example, has a GWP of 8,500, while water has a GWP of zero.

Grab Sample A single sample collected at a particular time and place that represents the composition of the water, air, or soil only at that time and place.

Graywater Water that is found beneath the surface of the ground, usually in porous rock known as an aquifer.

Greenhouse Effect The warming of the Earth's atmosphere attributed to a buildup of carbon dioxide or other gases; some scientists think that this buildup allows the sun's rays to heat the Earth, while making the infrared radiation atmosphere opaque to infrared radiation, thereby preventing a counterbalancing loss of heat.

Greenhouse Gas A gas, such as carbon dioxide or methane, that contributes to potential climate change.

Greenwash Misinformation disseminated by an organization so as to present an environmentally responsible public image.

Groundwater Water that is found beneath the surface of the ground, usually in porous rock known as an aquifer.

Groundwater Disinfection Rule A 1996 amendment of the Safe Drinking Water Act requiring the EPA to promulgate national primary drinking water regulations requiring disinfection for all public water systems, including surface waters and groundwater systems.

Habitat The place where a population of organisms lives and their surroundings, both living and nonliving.

Habitat Indicator A physical attribute of the environment measured to characterize conditions necessary to support an organism, population, or community.

Hazard The adverse effect(s) that may result from exposure(s).

Hazard Assessment Evaluation of the effects of a stressor or the determination of a margin of safety for an organism conducted by comparing the concentration that causes toxic effects with an estimate of exposure to the organism.

Hazard Communication Standard An OSHA regulation that requires chemical manufacturers, suppliers, and importers to assess the hazards of the chemicals that they make, supply, or import, and to inform employers, customers, and workers of these hazards through MSDS information.

Hazard Evaluation A component of risk evaluation that involves gathering and evaluating data on the types of health injuries or diseases that may be produced by a chemical and on the conditions of exposure under which such health effects are produced.

Hazardous Air Pollutants Air pollutants that are not covered by ambient air quality standards but that, as defined in the Clean Air Act, may present a threat of adverse human health effects or adverse environmental effects. Such pollutants include asbestos, beryllium, mercury, benzene, coke oven emissions, radionuclides, and vinyl chloride.

Hazardous Chemical An EPA designation for any hazardous material requiring an MSDS under OSHA's Hazard Communication Standard. Such substances are capable of producing fires and explosions or adverse health effects like cancer and dermatitis. Hazardous chemicals are distinct from hazardous waste.

Hazardous Ranking System The principal screening tool used by the EPA to evaluate risks to public health and the environment associated with abandoned or uncontrolled hazardous waste sites. The HRS calculates a score based on the potential of hazardous substances spreading from the site through the air, surface water, or groundwater, and on other factors such as density and proximity of human population. This score is the primary factor for determining whether the site should be on the National Priorities List, and if so, the ranking it should have compared to other sites on the list.

Hazardous Substance (1) Any material that poses a threat to human health and/or the environment. Typical hazardous substances are toxic, corrosive, ignitable, explosive, or chemically reactive. (2) Any substance designated by the EPA to be reported if a designated quantity of the substance is spilled in the waters of the United States or is otherwise released into the environment.

Hazardous Waste Byproducts of society that can pose a substantial or potential hazard to human health or the environment when improperly managed. Possesses at least one of four characteristics (ignitability, corrosivity, reactivity, or toxicity), or appears on special EPA lists.

Hazardous Waste Landfill An excavated or engineered site where hazardous waste is deposited and covered.

Hazards Analysis Procedures used to (a) identify potential sources of release of hazardous materials from fixed facilities or transportation accidents; (b) determine the vulnerability of a geographical area to a release of hazardous materials; and (c) compare hazards to determine which present greater or lesser risks to a community.

Hazards Identification Providing information on which facilities have extremely hazardous substances, what those chemicals are, how much there is at each facility, how the chemicals are stored, and whether they are used at high temperatures.

Heat Island Effect A "dome" of elevated temperatures over an urban area caused by structural and pavement heat fluxes and pollutant emissions.

Heat Pump An electric device with both heating and cooling capabilities. It extracts heat from one medium (the heat source) at a lower temperature and transfers it to another (the heat sink) at a higher temperature, thereby cooling the first and warming the second.

Heavy Metals Metallic elements with high atomic weights (e.g., mercury, chromium, cadmium, arsenic, and lead) that can damage living things at low concentrations and tend to accumulate in the food chain.

Heptachlor An insecticide that was banned from use on some food products in 1975 and from all of them 1978. It was allowed for use in seed treatment until 1983. More recently, it was found in milk and other dairy products in Arkansas and Missouri where dairy cattle were illegally fed treated seed.

Herbicide A chemical pesticide designed to control or destroy plants, weeds, or grasses.

High Efficiency Particulate Arrestance (HEPA) A designation for very fine air filters (usually exceeding 98 percent atmospheric efficiency), typically used only in surgeries, clean rooms, or other specialized applications.

High End Exposure (Dose) Estimate An estimate of exposure, or dose level received anyone in a defined population that is greater than the 90th percentile of all individuals in that population, but less than the exposure at the highest percentile in that population. A high-end risk descriptor is an estimate of the risk level for such individuals. Note that risk is based on a combination of exposure and susceptibility to the stressor.

High-Risk Community A community located within the vicinity of numerous sites of facilities or other potential sources of environmental exposure/health hazards, which may result in high levels of exposure to contaminants or pollutants.

High-to-Low-Dose Extrapolation The process of predicting the low exposure risk to humans and animals from the measured high-exposure-high-risk data involving laboratory animals.

Hydrocarbons (HC) Chemical compounds that consist entirely of carbon and hydrogen.

Hydrogen Sulfide (H_2S) Gas emitted during organic decomposition. Also a byproduct of oil refining and burning. Smells like rotten eggs and, in heavy concentration, can kill or cause illness.

Hydrogeological Cycle The natural process recycling water from the atmosphere down to (and through) the Earth and back to the atmosphere again.

Hydrologic Cycle Movement or exchange of water between the atmosphere and Earth.

Hydrology The science dealing with the properties, distribution, and circulation of water.

Hydrolysis The decomposition of organic compounds by interaction with water.

Immediately Dangerous to Life and Health (IDLH) The maximum level to which a healthy individual can be exposed to a chemical for 30 minutes and escape without suffering irreversible health effects or impairing symptoms. Used as a "level of concern."

Indicator Quantitative value or qualitative information derived from a set of parameters that provides information about the state of a phenomenon.

Indoor Air The breathable air inside a habitable structure or conveyance.

Indoor Air Pollution The level of air pollution in an enclosed environment.

Indoor Air Quality (IAQ) The composition and characteristics of the air in an enclosed space that affect the occupants of that space.

Indoor Climate Temperature, humidity, lighting, air flow, and noise levels in a habitable structure or conveyance. Indoor climate can affect indoor air pollution.

Integrated Design A process used to design a building in such a manner so as to promote sustainability. The process encourages all members of the building team to work together from the earliest stages of project development to achieve high performance and sustainability in the design. Also called "whole building" design.

Internal Dose In exposure assessment, the amount of a substance penetrating the absorption barriers (e.g., skin, lung tissue, gastrointestinal tract) of an organism through either physical or biological processes.

Integrated Pest Management (IPM) (1) The judicious use and integration of various pest control tactics of the associated environment of the pest in ways that complement and facilitate the biological and other natural controls of pests to meet economic, public health, and environmental goals. (2) An environmentally sound system of controlling landscape pests, which includes understanding of the pest's life cycle and well-timed nontoxic treatments.

Interstate Commerce Clause A clause of the U.S. Constitution that reserves to the federal government the right to regulate the conduct of business across state lines. Under this clause, for example, the U.S. Supreme Court has ruled that states may not inequitably restrict the disposal of out-of-state wastes in their jurisdictions.

Invasive Commonly used to refer to an exotic plant adapted to very similar growing conditions as those found in the region to which it is imported. Because such a species usually has no natural enemies (pests, diseases, or grazers), it flourishes so strongly that it disrupts the native ecosystem and forces out native plant species, resulting in habitat loss, water-table modification, and other serious problems.

Invasive Species An exotic species that alters the native ecosystem and negatively impacts native species, resulting in habitat loss, water-table modification, or other disruptions.

IRIS EPA's Integrated Risk Information System, an electronic database containing the Agency's latest descriptive and quantitative regulatory information on chemical constituents.

Irradiation Exposure to radiation of wavelengths shorter than those of visible light (gamma, x-ray, or ultraviolet), for medical purposes, to sterilize milk or other foodstuffs, or to induce polymerization of monomers or vulcanization of rubber.

Irritant A substance that can cause irritation of the skin, eyes, or respiratory system. Effects may be acute from a single high-level exposure, or chronic from repeated low-level exposures to such compounds as chlorine, nitrogen dioxide, and nitric acid.

Isotope A variation of an element that has the same atomic number of protons but a different weight because of the number of neutrons. Various isotopes of the same element may have different radioactive behaviors, some are highly unstable.

Joint and Several Liability Under CERCLA, this legal concept relates to the liability for Superfund site cleanup and other costs on the part of more than one potentially responsible party (i.e., if there were several owners or users of a site that became contaminated over the years, they could all be considered potentially liable for cleaning up the site).

Lagoon (1) A shallow pond where sunlight, bacterial action, and oxygen work to purify wastewater; also used for storage of wastewater or spent nuclear fuel rods. (2) Shallow body of water, often separated from the sea by coral reefs or sandbars.

Land Ban Phasing out of land disposal of most untreated hazardous wastes, as mandated by the 1984 RCRA amendments.

Land Disposal Restrictions Rules that require hazardous wastes to be treated before disposal on land to destroy or immobilize hazardous constituents that might migrate into soil and groundwater.

Landfills (1) Sanitary landfills are disposal sites for nonhazardous solid wastes spread in layers, compacted to the smallest practical volume, and covered by material applied at the end of each operating day. (2) Secure chemical landfills are disposal sites for hazardous waste, selected and designed to minimize the chance of release of hazardous substances into the environment.

Langelier Index (LI) An index reflecting the equilibrium pH of water with respect to calcium and alkalinity; used in stabilizing water to control both corrosion and scale deposition.

Large Quantity Generator Regulatory term referring to a person or facility generating more than 2200 pounds of hazardous waste per month. Such generators produce about 90 percent of the nation's hazardous waste and are subject to all RCRA requirements.

Latency Time from the first exposure of a chemical until the appearance of a toxic effect.

LC 50/Lethal Concentration Median-level concentration, a standard measure of toxicity that tells how much of a substance is needed to kill half of a group of experimental organisms in a given time.

LD 50/Lethal Dose The dose of a toxicant or microbe that will kill 50 percent of the test organisms within a designated period. The lower the LD 50, the more toxic the compound.

Ldlo Lethal dose low; the lowest dose in an animal study at which lethality occurs.

Leachate Water that collects contaminants as it trickles through wastes, pesticides, or fertilizers. Leaching may occur in farming areas, feedlots, and landfills, and may result in hazardous substances entering surface water, groundwater, or soil.

Leachate Collection System A system that gathers leachate and pumps it to the surface for treatment.

Leaching The process by which soluble constituents are dissolved and filtered through the soil by a percolating fluid.

Lead (Pb) A heavy metal that is hazardous to health if breathed or swallowed. Its use in gasoline, paints, and plumbing compounds has been sharply restricted or eliminated by federal laws and regulations. It was once used in oil-based paints and printing inks, and still is used in some motor fuels, some pigments, and solders. Older homes may contain layers of lead-bearing paint, which pose a toxic hazard if disturbed. Many lead compounds cause cancer. Like other metals, lead is not biodegraded in the environment.

Legionella A genus of bacteria, some species of which have caused a type of pneumonia called Legionnaires Disease.

Lethal Dose Low (Ldlo) The lowest dose in an animal study at which lethality occurs.

Level of Concern (LOC) The concentration in air of an extremely hazardous substance above which there may be serious immediate health effects to anyone exposed to it for short periods.

Life Cycle (1) in economic impact management, the length of time over which an investment is analyzed. (2) in environmental impact management, consecutive and interlinked stages of a product system, from raw material acquisition or generation from natural resources to final disposal.

Life Cycle Assessment (LCA) A method of evaluating a product by reviewing the ecological impact over the life of the product.

Life Cycle Cost An accounting method that extends beyond capital cost into maintenance and replacement costs, environmental costs, and so on.

Life Cycle Cost (LCC) Method A technique of economic evaluation that sums over a given study period the costs of initial investment (less resale value), replacements, operations (including energy use), and maintenance and repair of an investment decision (expressed in present or annual value terms).

Life Cycle of a Product All stages of a product's development, from extraction of fuel for power to production, marketing, use, and disposal.

Lifetime Average Daily Dose Figure for estimating excess lifetime cancer risk.

Lifetime Exposure Total amount of exposure to a substance that a human would receive in a lifetime (usually assumed to be 70 years).

Light-Emitting Diode A long-lasting illumination technology used for exit signs which requires very little power.

Limit of Detection (LOD) The minimum concentration of a substance being analyzed that has a 99 percent probability of being identified.

Lindane A pesticide that causes adverse health effects in domestic water supplies and is toxic to freshwater fish and aquatic life.

Low Density Polyethylene (LDPE) Plastic material used for both rigid containers and plastic film applications.

Low Emissivity (low-E) Windows Window technology that reduces the amount of energy loss through windows by inhibiting the transmission of radiant heat while allowing sufficient light to pass through.

Lower Detection Limit The smallest signal above background noise an instrument can reliably detect.

Lower Explosive Limit (LEL) The concentration of a compound in air below which the mixture will not catch on fire.

Lowest Acceptable Daily Dose The largest quantity of a chemical that will not cause a toxic effect, as determined by animal studies.

Lowest Achievable Emission Rate Under the Clean Air Act, the rate of emissions that reflects (1) the most stringent emission limitation in the implementation plan of any state for such source unless the owner or operator demonstrates such limitations are not achievable, or (2) the most stringent emissions limitation achieved in practice, whichever is more stringent. A proposed new or modified source may not emit pollutants in excess of existing new source standards.

Lowest Observed Adverse Effect Level (LOAEL) The lowest level of a stressor that causes statistically and biologically significant differences in test samples as compared to other samples subjected to no stressor.

Margin of Safety Maximum amount of exposure producing no measurable effect in animals (or studied humans) divided by the actual amount of human exposure in a population.

Margin of Exposure (MOE) The ratio of the no-observed-adverse-effect level to the estimated exposure dose.

Material Safety Data Sheet (MSDS) A compilation of information required under the OSHA Communication Standard on the identity of hazardous chemicals, health, and physical hazards, exposure limits, and precautions. Section 311 of SARA requires facilities to submit MSDSs under certain circumstances.

Materials Recovery Facility (MRF) A facility that processes residentially collected, mixed recyclables into new products available for market.

Maximum Acceptable Toxic Concentration For a given ecological effects test, the range (or geometric mean) between the no observable adverse effect level and the lowest observable adverse effects level.

Maximum Contaminant Level The maximum permissible level of a contaminant in water delivered to any user of a public system. MCLs are enforceable standards.

Maximum Contaminant Level Goal (MCLG) Under the Safe Drinking Water Act, a nonenforceable concentration of a drinking water contaminant, set at the level at which no known or anticipated adverse effects on human health occur and which allows an adequate safety margin. The MCLG is usually the starting point for determining the regulated Maximum Contaminant Level.

Maximum Exposure Range Estimate of exposure or dose level received by an individual in a defined population that is greater than the 98th percentile dose for all individuals in that population but less than the exposure level received by the person receiving the highest exposure level.

Maximum Tolerated Dose The maximum dose that an animal species can tolerate for a major portion of its lifetime without significant impairment or toxic effect other than carcinogenicity.

Measure of Effect/Measurement Endpoint A measurable characteristic of ecological entity that can be related to an assessment endpoint; for example, a laboratory test for eight species meeting certain requirements may serve as a measure of effect for an assessment endpoint, such as survival of fish, aquatic, invertebrate, or algal species under acute exposure.

Measure of Exposure A measurable characteristic of a stressor (such as the specific amount of mercury in a body of water) used to help quantify the exposure of an ecological entity or individual organism.

Media Specific environments—air, water, soil. Note, individual media are the subject of regulatory concern and activities.

Mercury (Hg) Heavy metal that can accumulate in the environment, and is highly toxic if breathed or swallowed. See also *Heavy Metals*.

Methane A colorless, nonpoisonous, flammable gas created by anaerobic decomposition of organic compounds. A major component of natural gas used in the home.

Microbial Growth The amplification or multiplication of microorganisms such as bacteria, algae, diatoms, plankton, and fungi.

Microenvironments Well-defined surroundings such as the home, office, or kitchen that can be treated as uniform in terms of stressor concentration.

Microclimate Uniform localized climate conditions within a given area.

Montreal Protocol Treaty, signed in 1987, that governs stratospheric ozone protection and research and the production and use of ozone-depleting substances. It provides for the end of production of ozone-depleting substances such as CFCS. Under the protocol, various research groups continue to assess the ozone layer. The Multilateral Fund provides resources to developing nations to promote the transition to ozone-safe technologies.

Moratorium During the negotiation process, a period of 60 to 90 days during which the EPA and potentially responsible parties may reach settlement but no site response activities can be conducted.

Multiple Chemical Sensitivity (MCS) A diagnostic label for people who suffer multi-symptom illnesses as a result of contact with, or proximity to, a variety of airborne agents and other substances.

Municipal Discharge Discharge of effluent from waste water treatment plants which receive waste water from households, commercial establishments, and industries in the coastal drainage basin. Combined sewer/separate storm overflows are included in this category.

Municipal Sewage Wastes (mostly liquid) originating from a community; may be composed of domestic wastewaters and/or industrial discharges.

Municipal Sludge Semi-liquid residue remaining from the treatment of municipal water and wastewater.

Municipal Solid Waste Common garbage or trash generated by industries, businesses, institutions, and homes.

Mutagen/Mutagenicity An agent that causes a permanent genetic change in a cell other than that which occurs during normal growth. Mutagenicity is the capacity of a chemical or physical agent to cause such permanent changes.

National Ambient Air Quality Standards (NAAQS) Standards established by the EPA that apply for outdoor air throughout the country. See also *Criteria Pollutants, State Implementation Plans, Emissions Trading*.

National Emissions Standards for Hazardous Air Pollutants (NESHAPS) Emissions standards set by the EPA for an air pollutant not covered by NAAQS that may cause an increase in fatalities or in serious, irreversible, or incapacitating illnesses. Primary standards are designed to protect human health; secondary standards are designed to protect public welfare (e.g., building facades, visibility, crops, and domestic animals).

National Estuary Program A program established under the Clean Water Act Amendments of 1987 to develop and implement conservation and management plans for protecting estuaries and restoring and maintaining their chemical, physical, and biological integrity, as well as controlling point and nonpoint pollution sources.

National Institute of Occupational Safety and Health (NIOSH) An agency of the Centers for Disease Control of the Department of Health and Human Services. NIOSH is the research arm of OSHA, the Occupational Safety and Health Administration.

National Municipal Plan A policy created in 1984 by EPA and the states in 1984 to bring all publicly owned treatment works into compliance with Clean Water Act requirements.

National Pollutant Discharge Elimination System (NPDES) A provision of the Clean Water Act that prohibits discharge of pollutants into waters of the United States unless a special permit is issued by the EPA, a state, or where delegated, a tribal government on a Native American reservation.

National Priorities List (NPL) The EPA's list of the most serious uncontrolled or abandoned hazardous waste sites identified for possible long-term remedial action under Superfund. The list is based primarily on the score a site receives from the Hazard Ranking System. The EPA is required to update the NPL at least once a year. A site must be on the NPL to receive money from the Trust Fund for remedial action.

National Response Center The federal operations center that receives notifications of all releases of oil and hazardous substances into the environment. Open 24 hours a day, it is operated by the U.S. Coast Guard, which evaluates all reports and notifies the appropriate agency.

National Response Team (NRT) Representatives of 13 U.S. federal agencies that, as a team, coordinate federal responses to nationally significant incidents of pollution—an oil spill, a major chemical release, or a—superfund response action—and provide advice and technical assistance to the responding agency(ies) before and during a response action.

Native Used in reference to plants, a plant whose presence and survival in a specific region is not the result of human intervention. Certain experts argue that plants imported to a region by prehistoric peoples should be considered native. The term for plants that are imported and then adapt to survive without human cultivation is "naturalized."

Native Species (1) A species that is indigenous in a specified area for all or part of its life span. (2) A plant whose presence and survival in a specific region is not the result of human intervention.

New Source Performance Standards (NSPS) Uniform national EPA air emission and water effluent standards which limit the amount of pollution allowed from new sources or from modified existing sources.

New Source Review (NSR) A Clean Air Act requirement that State Implementation Plans must include a permit review that applies to the construction and operation of new and modified stationary sources in nonattainment areas to ensure attainment of national ambient air quality standards.

Nitrate A compound containing nitrogen that can exist in the atmosphere or as a dissolved gas in water and which can have harmful effects on humans and animals. Nitrates in water can cause severe illness in infants and domestic animals. A plant nutrient and inorganic fertilizer, nitrate is found in septic systems, animal feed lots, agricultural fertilizers, manure, industrial waste waters, sanitary landfills, and garbage dumps.

Nitric Oxide (NO) A gas formed by combustion under high temperature and high pressure in an internal combustion engine; it is converted by sunlight and photochemical processes in ambient air to nitrogen oxide. NO is a precursor of ground-level ozone pollution, or smog.

Nitrification The process whereby ammonia in wastewater is oxidized to nitrite and then to nitrate by bacterial or chemical reactions.

Nitrilotriacetic Acid (NTA) A compound now replacing phosphates in detergents.

Nitrite (1) An intermediate in the process of nitrification. (2) Nitrous oxide salts used in food preservation.

Nitrogen Dioxide (NO_2) The result of nitric oxide combining with oxygen in the atmosphere; major component of photochemical smog.

Nitrogen Oxide (NOx) The result of photochemical reactions of nitric oxide in ambient air; major component of photochemical smog. Product of combustion from transportation and stationary sources and a major contributor to the formation of ozone in the troposphere and to acid deposition.

Nitrogenous Wastes Animal or vegetable residues that contain significant amounts of nitrogen.

Nitrophenols Synthetic organopesticides containing carbon, hydrogen, nitrogen, and oxygen.

No-Observable-Adverse-Effect Level (NOAEL) An exposure level at which there are no statistically or biologically significant increases in the frequency or severity of adverse effects between the exposed population and its appropriate control; some effects may be produced at this level, but they are not considered as adverse, or as precursors to adverse effects. In an experiment with several NOAELs, the regulatory focus is primarily on the highest one, leading to the common usage of the term NOAEL as the highest exposure without adverse effects.

No-Observed-Effect Level (NOEL) Exposure level at which there are no statistically or biological significant differences in the frequency or severity of any effect in the exposed or control populations.

Noble Metal Chemically inactive metal such as gold; does not corrode easily.

Non-aqueous Phase Liquid (NAIL) Contaminants that remain undiluted as the original bulk liquid in the subsurface—for example, spilled oil.

Nonpoint Sources Diffuse pollution sources (i.e., without a single point of origin or not introduced into a receiving stream from a specific outlet). The pollutants are generally carried off the land by storm water. Common nonpoint sources are agriculture, forestry, urban, mining, construction, dams, channels, land disposal, saltwater intrusion, and city streets.

Nonpotable Water Water that has not been treated for human consumption in conformance with applicable drinking water quality regulations.

Nuclear Winter Prediction by some scientists that smoke and debris rising from massive fires of a nuclear war could block sunlight for weeks or months, cooling the earth's surface and producing climate changes that could, for example, negatively affect world agricultural and weather patterns.

Nutrient A substance assimilated by living things that promotes growth. The term is generally applied to nitrogen and phosphorus in wastewater but is also applied to other essential and trace elements.

Nutrient Pollution Contamination of water resources by excessive inputs of nutrients. In surface waters, excess algal production is a major concern.

Occupational Safety and Health Administration (OSHA) OSHA resides under the U.S. Department of Labor. OSHA implements the provisions of the 1970 Occupational Safety and Health Act. It establishes and enforces protective standards for employees in the workplace.

OECD Guidelines Testing guidelines prepared by the Organization of Economic and Cooperative Development of the United Nations. They assist in preparation of protocols for studies of toxicology, environmental fate, and so on.

Offgas/Outgas A process of evaporation or chemical decomposition through which vapors are released from materials.

Organic (1) Referring to or derived from living organisms. (2) In chemistry, any compound containing carbon.

Organic Chemicals/Compounds Naturally occurring (animal or plant-produced or synthetic) substances containing mainly carbon, hydrogen, nitrogen, and oxygen.

Organic Matter Carbonaceous waste contained in plant or animal matter and originating from domestic or industrial sources.

Organism Any form of animal or plant life.

Organophosphates Pesticides that contain phosphorus; short-lived, but some can be toxic when first applied.

Organophyllic A substance that easily combines with organic compounds.

Osmosis The passage of a liquid from a weak solution to a more concentrated solution across a semi-permeable membrane that allows passage of the solvent (water) but not the dissolved solids.

Outfall The place where effluent is discharged; often refers to discharge into receiving waters.

Overdraft The pumping of water from a groundwater basin or aquifer in excess of the supply flowing into the basin; results in a depletion or "mining" of the groundwater in the basin.

Overland Flow A land application technique that cleanses waste water by allowing it to flow over a sloped surface. As the water flows over the surface, contaminants are absorbed and the water is collected at the bottom of the slope for reuse.

Oxidant A collective term for some of the primary constituents of photochemical smog.

Oxidation The chemical addition of oxygen to break down pollutants or organic waste; for example, destruction of chemicals such as cyanides, phenols, and organic sulfur compounds in sewage by bacterial and chemical means.

Oxidation Pond A man-made body of water in which waste is consumed by bacteria, used most frequently with other waste treatment processes; a sewage lagoon.

Oxidation-Reduction Potential The electric potential required to transfer electrons from one compound or element (the oxidant) to another compound (the reductant); used as a qualitative measure of the state of oxidation in water treatment systems.

Oxidizer Any agent or process that receives electrons during a chemical reaction.

Oxygenated Solvent An organic solvent containing oxygen as part of the molecular structure. Alcohols and ketones are oxygenated compounds often used as paint solvents.

Ozonation/Ozonator Application of ozone to water for disinfection or for taste and odor control. The ozonator is the device that does this.

Ozone (O3) Found in two layers of the atmosphere, the stratosphere and the troposphere. In the stratosphere (the atmospheric layer 7 to 10 miles or more above the Earth's surface) ozone is a natural form of oxygen that provides a protective layer shielding the Earth from ultraviolet radiation. In the troposphere (the layer extending up 7 to 10 miles from the Earth's surface), ozone is a chemical oxidant and major component of photochemical smog. It can seriously impair the respiratory system and is one of the most widespread of all the criteria pollutants

for which the Clean Air Act required the EPA to set standards. Ozone in the troposphere is produced through complex chemical reactions of nitrogen oxides, which are among the primary pollutants emitted by combustion sources; hydrocarbons, released into the atmosphere through the combustion, handling, and processing of petroleum products; and sunlight.

Ozone Depletion Destruction of the stratospheric ozone layer, which shields the Earth from ultraviolet radiation harmful to life. This destruction of ozone is caused by the breakdown of certain chlorine and/or bromine-containing compounds (chlorofluorocarbons or halons), which break down when they reach the stratosphere and then catalytically destroy ozone molecules.

Ozone Hole A thinning break in the stratospheric ozone layer. Designation of amount of such depletion as an "ozone hole" is made when the detected amount of depletion exceeds 50 percent. Seasonal ozone holes have been observed over both the Antarctic and Arctic regions, part of Canada, and the extreme northeastern United States.

Ozone Layer The protective layer in the atmosphere, about 15 miles above the ground, that absorbs some of the sun's ultraviolet rays, thereby reducing the amount of potentially harmful radiation that reaches the Earth's surface.

Packaging The assembly of one or more containers and other components necessary to ensure minimum compliance with a program's storage and shipment packaging requirements. Also, the containers, etc. involved.

Pandemic A widespread epidemic throughout an area, nation or the world.

Parameter A variable, measurable property whose value is a determinant of the characteristics of a system; for example, temperature, pressure, and density are parameters of the atmosphere.

Particulates (1) Fine liquid or solid particles such as dust, smoke, mist, fumes, or smog, found in air or emissions. (2) Very small solids suspended in water; they can vary in size, shape, density and electrical charge and can be gathered together by coagulation and flocculation.

Parts per Billion (ppb)/Parts per Million (ppm) Units commonly used to express contamination ratios, as in establishing the maximum permissible amount of a contaminant in water, land, or air.

Pathogens Microorganisms (e.g., bacteria, viruses, or parasites) that can cause disease in human beings, animals, and plants.

Pay-as-You-Throw Systems under which residents pay for municipal waste management and disposal services by weight or volume collected, not a fixed fee.

Peak Electricity Demand The maximum electricity used to meet the cooling load of a building or buildings in a given area.

Peak Levels Levels of airborne pollutant contaminants much higher than average or occurring for short periods of time in response to sudden releases.

Permissible Dose The dose of a chemical that may be received by an individual without the expectation of a significantly harmful result.

Permissible Exposure Limit (PEL) Regulatory limits for workplace exposure to contaminants as established by OSHA.

Persistence Refers to the length of time a compound stays in the environment, once introduced. A compound may persist for less than a second or indefinitely.

Persistent Organic Pollutant (POP) A chemical substance that persists in the environment, bioaccumulates through the food web, and poses a risk of causing adverse effects to human health and the environment.

Pesticide Substances or mixture there of intended for preventing, destroying, repelling, or mitigating any pest. Also, a substance or mixture intended for use as a plant regulator, defoliant, or desiccant.

PETE (Polyethylene Terepthalate) Thermoplastic material used in plastic soft drink and rigid containers.

pH An expression of the intensity of the basic or acid condition of a liquid; may range from 0 to 14, where 0 is the most acid and 7 is neutral. Natural waters usually have a pH between 6.5 and 8.5.

Phenols Organic compounds that are byproducts of petroleum refining, tanning, and textile, dye, and resin manufacturing. Low concentrations cause taste and odor problems in water; higher concentrations can kill aquatic life and humans.

Phosphates Certain chemical compounds containing phosphorus.

Phosphorus An essential chemical food element that can contribute to the eutrophication of lakes and other water bodies. Increased phosphorus levels result from discharge of phosphorus-containing materials into surface waters.

Photochemical Oxidants Air pollutants formed by the action of sunlight on oxides of nitrogen and hydrocarbons.

Photochemical Smog Air pollution caused by chemical reactions of various pollutants emitted from different sources.

Photosynthesis The manufacture by plants of carbohydrates and oxygen from carbon dioxide mediated by chlorophyll in the presence of sunlight.

Photovoltaic Having the capacity to generate electricity from the energy of sunlight, using photocells.

Phytoplankton That portion of the plankton community composed of tiny plants; for example, algae, diatoms.

Phytoremediation Low-cost remediation option for sites with widely dispersed contamination at low concentrations.

Phytotoxic Harmful to plants.

Phytotreatment (Phytoremediation) The cultivation of specialized plants that absorb specific contaminants from the soil through their roots or foliage. This reduces the concentration of contaminants in the soil, but incorporates them into biomasses that may be released back into the environment when the plant dies or is harvested.

Plasticizers Chemicals added to soft plastics to preserve their flexibility. These agents offgas slowly, eventually rendering the plastic brittle.

PM-10/PM-2.5 PM 10 is measure of particles in the atmosphere with a diameter of less than ten or equal to a nominal 10 micrometers. PM-2.5 is a measure of smaller particles in the air. PM-10 has been the pollutant particulate level standard against which the EPA has been measuring Clean Air Act compliance. On the basis of newer scientific findings, the agency is considering regulations that will make PM-2.5 the new "standard."

Point Source A single, stationary location or fixed facility from which pollutants are discharged; any single identifiable source of pollution.

Pollutant Any substance that directly or indirectly creates an adverse human health or environmental effect when introduced into any environmental media.

Pollutant Pathways Avenues for distribution of pollutants. In most buildings, for example, HVAC systems are the primary pathways although all building components can interact to affect how air movement distributes pollutants.

Pollutant Standard Index (PSI) Indicator of one or more pollutants that may be used to inform the public about the potential for adverse health effects from air pollution in major cities.

Pollution The introduction of a pollutant into the environment.

Pollution Prevention The act of reducing or eliminating the use, release, or generation of a pollutant or potential pollutant through source reduction, recycling, reuse, reclamation, or modification of operating practices.

Pollution Prevention Program A comprehensive management, planning, capital budgeting, and monitoring program to promote and support the development and implementation of pollution prevention throughout an organization or at a specific facility. Such a program should have a statement of policy and goals; plan for measuring performance; and specified time frames for implementation, measurement of progress, and reevaluation.

Polychlorinated Biphenyls (PCB) A group of toxic, persistent chemicals used in electrical transformers and capacitors for insulating purposes, and in gas pipeline systems as lubricant. The sale and new use of these chemicals, also known as PCBs, were banned by law in 1979.

Poly Ethylene Terephthalate (PET) A polyester plastic used widely in soft drink bottles.

Polymer A natural or synthetic chemical structure where two or more like molecules are joined to form a more complex molecular structure (e.g., polyethylene in plastic).

Polyvinyl Chloride (PVC) (1) A polymer derived from oil or liquid natural gas and salt (sodium chloride). The liquid natural gas or petroleum is refined and reacted with chlorine from the salt to form vinyl chloride monomer. Vinyl chloride monomer, a known carcinogen, is polymerized to form PVC resin. (2) A tough, environmentally indestructible plastic that releases hydrochloric acid when burned.

Postconsumer Refers to materials that are reclaimed from products that have already served their intended end use as consumer item.

Potable Water Water that does not endanger the lives or health of human beings and that conforms to applicable regulations for drinking water quality.

Postconsumer Materials Materials or finished products that have served their intended use and have been diverted or recovered from waste destined for disposal, having completed their lives as consumer items. Postconsumer materials are part of the broader category of recovered materials.

Postconsumer Recycling Use of materials generated from residential and consumer waste for new or similar purposes; for example, converting wastepaper from offices into corrugated boxes or newsprint.

Potentiation The ability of one chemical to increase the effect of another chemical.

Preconsumer Refers to materials that are reclaimed from manufacturing and other industrial processes, and products which have not served their intended end use as a consumer item.

Preconsumer Materials/Waste Materials generated in manufacturing and converting processes, such as manufacturing scrap and trimmings and cuttings. Includes print overruns, over-issue publications, and obsolete inventories.

Precursor In photochemistry, a compound antecedent to a pollutant. For example, volatile organic compounds (VOCs) and nitric oxides of nitrogen react in sunlight to form ozone or other photochemical oxidants. As such, VOCs and oxides of nitrogen are precursors.

Product-Service System (PSS) A combination of product(s) and related service(s) marketed as a single business offer.

Project XL An EPA initiative to give states and the regulated community the flexibility to develop comprehensive strategies as alternatives to multiple current regulatory requirements in order to exceed compliance and increase overall environmental benefits.

Putrefaction Biological decomposition of organic matter; associated with anaerobic conditions.

Putrescible Able to rot quickly enough to cause odors and attract flies.

Pyrethrum and Pyrethrins Pyrethrum is made from powdered flowers of the chrysanthemum family. The active insecticidal ingredient is pyrethrin. Some people are acutely sensitive to pyrethrum. Adverse reactions range from contact dermatitis and asthmalike attacks to anaphylactic reactions with peripheral vascular collapse. As early as 1934, a cross-reaction between ragweed allergies and pyrethrum sensitivities was noted in the medical literature. Some pyrethrum formulations include petrochemicals as solvents and propellants, as well as synergists to make them more toxic. Pyrethrum and pyrethrins are used for pest control.

Pyrolysis Decomposition of a chemical by extreme heat.

Radioactive Decay Spontaneous change in an atom by emission of charged particles and/or gamma rays; also known as radioactive disintegration and radioactivity.

Radioactive Substances Substances that emit ionizing radiation.

Radioactive Waste Waste that emits energy as rays, waves, streams or energetic particles. Radioactive materials are often mixed with hazardous waste, from nuclear reactors, research institutions, or hospitals.

Radioisotopes Chemical variants of radioactive elements with potentially oncogenic, teratogenic, and mutagenic effects on the human body.

Radionuclide Radioactive particle, man-made (anthropogenic) or natural, with a distinct atomic weight number. Can have a long life as soil or water pollutant.

Radon A colorless naturally occurring, radioactive, inert gas formed by radioactive decay of radium atoms in soil or rocks. Trace radon emissions may be detected after excavating into subsoil for building foundations.

Radon Daughters/Radon Progeny Short-lived radioactive decay products of radon that decay into longer-lived lead isotopes that can attach themselves to airborne dust and other particles and, if inhaled, damage the linings of the lungs.

Radon Decay Products A term used to refer collectively to the immediate products of the radon decay chain. These include Po-218, Pb-214, Bi-214, and Po-214, which have an average combined half-life of about 30 minutes.

Rainwater Harvesting Collecting rainwater from a catchment area and storing it for future use.

Reasonable Maximum Exposure The maximum exposure reasonably expected to occur in a population.

Reasonable Worst Case An estimate of the individual dose, exposure, or risk level received by an individual in a defined population that is greater than the 90th percentile but less than that received by anyone in the 98th percentile in the same population.

Recharge The process by which water is added to a zone of saturation, usually by percolation from the soil surface (e.g., the recharge of an aquifer).

Recharge Rate The quantity of water per unit of time that replenishes or refills an aquifer.

Reclaim A procedure of either regenerating or processing a material, either used or unused, to recover or make a usable product.

Reclaimed Water Nonpotable water that is highly treated and used for approved purposes other than drinking water.

Recognized Environmental Condition The presence or likely presence of any hazardous substances or petroleum products that may affect the catchment area.

Recombinant Bacteria A microorganism whose genetic make-up has been altered by deliberate introduction of new genetic elements. The offspring of these altered bacteria also contain these new genetic elements; that is, they "breed true."

Recombinant DNA The new DNA that is formed by combining pieces of DNA from different organisms or cells.

Recommended Maximum Contaminant Level (RMCL) The maximum level of a contaminant in drinking water at which no known or anticipated adverse effect on human health would occur, and that includes an adequate margin of safety. Recommended levels are nonenforceable health goals.

Recycle Recovering or reprocessing materials for use in the form of raw materials in the manufacture of new products other than fuel for producing heat or power by combustion.

Recycled Material Material that has been reprocessed from recovered (reclaimed) material by means of a manufacturing process and made into a final product or into a component for incorporation into a product.

Recycled Content Proportion, by mass, of recycled material in either a product *or* packaging.

Red Tide A proliferation of marine plankton that is toxic and often fatal to fish, perhaps stimulated by the addition of nutrients. A tide can be red, green, or brown, depending on the coloration of the plankton.

Release Any spilling, leaking, pumping, pouring, emitting, discharging, injecting, escaping, leaching, dumping, or disposing any material or pollutant into the environment.

Remanufactured Product A product composed of both new and restored components. Remanufacturing is the process of the disassembly of products known to be worn, defective, or discarded that can be reused or restored to original equipment manufacturer specification by cleaning, repairing or replacing in a manufacturing environment, and then reassembled to sound working condition, and tested. The remanufactured product is ready for a second life, performing as if it were new.

Remediation (1) Cleanup or other methods used to remove or contain a toxic spill or hazardous materials from a Superfund site. (2) For the Asbestos Hazard Emergency Response program, abatement methods, including evaluation, repair, enclosure, encapsulation, or removal of greater than 3 linear feet or square feet of asbestos-containing materials from a building.

Renewable A renewable product can be grown or naturally replenished or cleansed at a rate that exceeds human depletion of the resource.

Renewable Energy Energy obtained from renewable or perpetual resources, including wind, solar, ocean (including tidal, wave, current, and thermal), geothermal, biomass, and hydroelectric energy resources.

Renewable Energy Certificates (RECs) Tradable environmental commodities in which represent that electricity was generated from a renewable resource.

Renewable Resource A resource that is grown, naturally replenished or replaced at a rate that exceeds depletion of the useable supply of that resource.

Residual Amount of a pollutant remaining in the environment after a natural or technological process has taken place; for example, the sludge remaining after initial wastewater treatment, or particulates remaining in air after it passes through a scrubbing or other process.

Resource A material that has a recoverable value.

Reuse Using a material, product, or component of the waste stream in its original form more than once.

Reverse Osmosis A treatment process used in water systems by adding pressure to force water through a semi-permeable membrane. Reverse osmosis removes most drinking water contaminants. Also used in wastewater treatment. Large-scale reverse osmosis plants are being developed.

Ribonucleic Acid (RNA) A molecule that carries the genetic message from DNA to a cellular protein-producing mechanism.

Riparian Habitat Areas adjacent to rivers and streams with a differing density, diversity, and productivity of plant and animal species relative to nearby uplands.

Riparian Rights Entitlement of a land owner to certain uses of water on or bordering the property, including the right to prevent diversion or misuse of upstream waters. Generally a matter of state law.

Risk A measure of the probability that damage to life, health, property, and/or the environment will occur as a result of a given hazard.

Risk (Adverse) for Endangered Species Risk to aquatic species if anticipated pesticide residue levels equal one-fifth of LD10 or one-tenth of LC50; risk to terrestrial species if anticipated pesticide residue levels equal one-fifth of LC10 or one-tenth of LC50.

Risk Assessment Qualitative and quantitative evaluation of the risk posed to human health and/or the environment by the actual or potential presence and/or use of specific pollutants.

Risk Characterization The last phase of the risk assessment process that estimates the potential for adverse health or ecological effects to occur from exposure to a stressor and evaluates the uncertainty involved.

Risk Factor Characteristics (e.g., race, sex, age, obesity) or variables (e.g., smoking, occupational exposure level) associated with increased probability of a toxic effect.

Risk Management The process of evaluating and selecting alternative regulatory and nonregulatory responses to risk. The selection process necessarily requires the consideration of legal, economic, and behavioral factors.

Rodenticide A chemical or agent used to destroy rats or other rodent pests, or to prevent them from damaging food, crops, etc.

Runoff That part of precipitation, snow melt, or irrigation water that runs off the land into streams or other surface water. It can carry pollutants from the air and land into receiving waters.

Sand Filters Devices that remove some suspended solids from sewage. Air and bacteria decompose additional wastes that filter through the sand so that cleaner water drains from the bed.

Scrubber An air pollution device that uses a spray of water or reactant or a dry process to trap pollutants in emissions.

Secondary Effect Action of a stressor on supporting components of the ecosystem, which in turn impacts the ecological component of concern.

Secondary Treatment The second step in most publicly owned waste treatment systems during which bacteria consume the organic parts of the waste. It is accomplished by bringing together waste, bacteria, and oxygen in trickling filters or in the activated sludge process. This treatment removes floating and settleable solids and about 90 percent of the oxygen-demanding substances and suspended solids. Disinfection is the final stage of secondary treatment.

Semivolatile Organic Compounds Organic compounds that volatilize slowly at standard temperature (20°C and 1 atm pressure).

Septic System An on-site system designed to treat and dispose of domestic sewage. A typical septic system consists of tank that receives waste from a residence or business and a system of tile lines or a pit for disposal of the liquid effluent (sludge) that remains after decomposition of the solids by bacteria in the tank and must be pumped out periodically.

Septic Tank An underground storage tank for wastes from homes not connected to a sewer line. Waste goes directly from the home to the tank.

Shading Coefficient The amount of the sun's heat transmitted through a given window compared with that of a standard 1/8-inch-thick single pane of glass under the same conditions.

Sick Building Syndrome (SBS) Condition in which a building's occupants experience health or comfort effects, or both, that appear to be linked to time spent therein, but where no specific illness or cause can be identified. Condition may be localized in a particular room or zone, or may spread throughout the building.

Sink As used in reference to indoor air quality, refers to a surface or material which absorbs, stores, and releases energy or matter.

Sinking In buildings, generally refers to the absorption of VOCs by sinks ("soft" building materials). See also *Adsorption and Sinks*. According to the EPA, "sinking" is defined as: controlling oil spills by using an agent to trap the oil and sink it to the bottom of the body of water where the agent and the oil are biodegraded.

Smog Air pollution typically associated with oxidants.

Solvents Found in adhesives, coal tar pitch and coal tar roofing, metal cleaners, putty, impermeable paints and coatings, pipe cements (polyurethane resins), wire coverings, transformers. Aliphatic hydrocarbons, aromatic hydrocarbons, petroleum naphtha, tetrachloroethylene, toluene are found in solvents.

Sorption The action of soaking up or attracting substances; process used in many pollution control systems.

Source Reduction An activity that eliminates or decreases wastes by avoiding their creation, typically by materials substitution, process design, or product redesign.

Source Separation Segregating various wastes at the point of generation (e.g., separation of paper, metal and glass from other wastes to make recycling simpler and more efficient).

Species (1) A reproductively isolated aggregate of interbreeding organisms having common attributes and usually designated by a common name. (2) An organism belonging to such a category.

Sprawl Physical pattern of expansion of urban areas into rural or agricultural areas.

Stakeholder Organization, governmental entity, or individual that has a stake in or may be impacted by a given approach to environmental regulation, pollution prevention, energy conservation, etc.

State Emergency Response Commission (SERC) Commission appointed by each state governor according to the requirements of SARA Title III. The SERCs designate emergency planning districts, appoint local emergency planning committees, and supervise and coordinate their activities.

State Management Plan Under FIFRA, a state management plan required by EPA to allow states, tribes, and U.S. territories the flexibility to design and implement ways to protect groundwater from the use of certain pesticides.

Stratosphere The portion of the atmosphere 10-to-25 miles above the earth's surface.

Stressors Physical, chemical, or biological entities that can induce adverse effects on ecosystems or human health.

Sulfur Dioxide (SO_2) A pungent, colorless, gas-formed primarily by the combustion of fossil fuels; becomes a pollutant when present in large amounts.

Superfund The program operated under the legislative authority of CERCLA and SARA that funds and carries out EPA solid waste emergency and long-term removal and remedial activities. These activities include establishing the National Priorities List, investigating sites for inclusion on the list, determining their priority, and conducting and/or supervising cleanup and other remedial actions.

Superfund Innovative Technology Evaluation (SITE) Program EPA program to promote development and use of innovative treatment and site characterization technologies in Superfund site cleanups.

Surface Runoff Precipitation, snow melt, or irrigation water in excess of what can infiltrate the soil surface and be stored in small surface depressions; a major transporter of non-point-source pollutants in rivers, streams, and lakes.

Suspended Loads Specific sediment particles maintained in the water column by turbulence and carried with the flow of water.

Suspended Solids Small particles of solid pollutants that float on the surface of, or are suspended in, sewage or other liquids. They resist removal by conventional means.

Sustainable Sustainable practices and sustainable communities meet the needs of present generations without compromising those needs for future generations. To be truly sustainable, a human community must not decrease biodiversity, must not consume resources faster than these are renewed, must recycle and reuse virtually all materials, and must rely primarily on resources of its own region. Ecological/environmental sustainability is defined by the EPA as the maintenance of ecosystem components and functions for future generations.

Sustainable Communities Communities that are founded in sustainable development practices.

Sustainable Development Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

Sustainability The maintenance of ecosystem components and functions for future generations.

Synthetic Organic Chemicals (SOCs) Man-made (anthropogenic) organic chemicals. Some SOCs are volatile; others tend to stay dissolved in water instead of evaporating.

Systemic Pesticide A chemical absorbed by an organism that interacts with the organism and makes the organism toxic to pests.

Teratogen A substance capable of causing birth defects.

Tertiary Treatment Advanced cleaning of wastewater that goes beyond the secondary or biological stage, removing nutrients such as phosphorus, nitrogen, and most BOD and suspended solids.

Theoretical Maximum Residue Contribution The theoretical maximum amount of a pesticide in the daily diet of an average person. It assumes that the diet is composed of all food items for which there are tolerance-level residues of the pesticide. The TMRC is expressed as milligrams of pesticide/kilograms of body weight/day.

Therapeutic Index The ratio of the dose required to produce toxic or lethal effects to the dose required to produce nonadverse or therapeutic response.

Threshold Planning Quantity A quantity designated for each chemical on the list of extremely hazardous substances that triggers notification by facilities to the State Emergency Response Commission that such facilities are subject to emergency planning requirements under SARA Title III.

Thermal Pollution Discharge of heated water from industrial processes that can kill or injure aquatic organisms.

Thermal Stratification The formation of layers of different temperatures in a lake or reservoir.

Threshold (1) The dose or exposure level below which a significant adverse effect is not expected. (2) The lowest dose of a chemical at which a specified measurable effect is observed and below which it is not observed.

Threshold Level Time-weighted average pollutant concentration values, exposure beyond which is likely to adversely affect human health.

Threshold Limit Value (TLV) The concentration of an airborne substance to which an average person can be repeatedly exposed without adverse effects. TLVs may be expressed in three ways: (a) TLV-TWA, time-weighted average, based on an allowable exposure averaged over a normal 8-hour workday or 40-hour workweek; (b) TLV-STEL, short-term exposure limit or maximum concentration for a brief specified period of time, depending on a specific chemical (TWA must still be met); and (c) TLV-C, ceiling exposure limit or maximum exposure concentration not to be exceeded under any circumstances (TWA must still be met).

Tight Buildings Buildings that are designed to let in minimal infiltration air in order to reduce heating and cooling energy costs. In actuality, buildings typically exhibit leakage that is on the same order as required ventilation; however, this leakage is not well distributed and cannot serve as a substitute for proper ventilation.

Time-weighted Average (TWA) In air sampling, the average air concentration of contaminants during a given period.

Total Dissolved Phosphorous The total phosphorous content of all material that will pass through a filter, which is determined as orthophosphate without prior digestion or hydrolysis. Also called soluble P. or ortho P.

Total Dissolved Solids (TDS) All material that passes the standard glass river filter; now called total filtrable residue. Term is used to reflect salinity.

Total Maximum Daily Load (TMDL) A calculation of the highest amount of a pollutant that a water body can receive and safely meet water quality standards set by the state, territory, or authorized tribe.

Total Petroleum Hydrocarbons (TPH) Measure of the concentration or mass of petroleum hydrocarbon constituents present in a given amount of soil or water. The word "total" is a misnomer; few, if any, of the procedures for quantifying hydrocarbons can measure all of them in a given sample. Volatile ones are usually lost in the process and not quantified, and nonpetroleum hydrocarbons sometimes appear in the analysis.

Total Suspended Particles (TSP) A method of monitoring airborne particulate matter by total weight.

Total Suspended Solids (TSS) A measure of the suspended solids in wastewater, effluent, or water bodies, determined by tests for "total suspended nonfilterable solids."

Total Volatile Organic Compound (TVOC) Compound measured in $\mu g/m^3$ (micrograms per cubic meter).

Toxaphene Chemical that causes adverse health effects in domestic water supplies and is toxic to freshwater and marine aquatic life.

Toxic Chemical Any chemical listed in the EPA rules as "Toxic Chemicals Subject to Section 313 of the Emergency Planning and Community Right-to-Know Act of 1986."

Toxic Chemical Release Form Information form required of facilities that manufacture, process, or use (in quantities above a specific amount) chemicals listed under SARA, Title III.

Toxic Concentration The concentration at which a substance produces a toxic effect.

Toxic Dose The dose level at which a substance produces a toxic effect.

Toxic Pollutants Materials that cause death, disease, or birth defects in organisms that ingest or absorb them. The quantities and exposures necessary to cause these effects can vary widely.

Toxic Release Inventory Database of toxic releases in the United States compiled from SARA Title III Section 313 reports.

Toxic Substance A chemical or mixture that may present an unreasonable risk of injury to health or the environment.

Toxic Waste A waste that can produce injury if inhaled, swallowed, or absorbed through the skin.

Toxicant A harmful substance or agent that may injure an exposed organism.

Toxicity The property of a material, or combination of materials, to adversely affect organisms, tissues, or cells.

Toxicity Assessment Characterization of the toxicological properties and effects of a chemical, with special emphasis on establishment of dose-response characteristics.

Toxicity Testing Biological testing (usually with an invertebrate, fish, or small mammal) to determine the adverse effects of a compound or effluent.

Toxicological Profile An examination, summary, and interpretation of a hazardous substance to determine levels of exposure and associated health effects.

Transpiration The process by which water vapor is lost to the atmosphere from living plants. The term can also be applied to the quantity of water thus dissipated.

Treatment Mechanism used for reducing the quantity or toxicity of a waste after its generation in a process.

Trichloroethylene (TCE) A stable, low boiling-point colorless liquid, toxic if inhaled. Used as a solvent or metal degreasing agent, and in other industrial applications.

Trihalomethane (THM) One of a family of organic compounds named as derivative of methane. THMs are generally byproducts of chlorination of drinking water that contains organic material.

Troposphere The layer of the atmosphere closest to the Earth's surface.

Uncertainty Factor One of several factors used in calculating the reference dose from experimental data. UFs are intended to account for (1) the variation in sensitivity among human beings, (2) the uncertainty in extrapolating animal data to human beings, (3) the uncertainty in extrapolating data obtained in a study that covers less than the full life of the exposed animal or human being, and (4) the uncertainty in using LOAEL data rather than NOAEL data.

Urban Heat Island An urban area that, because of denuded landscape, impermeable surfaces, surfaces with low albedo, massive buildings, heat-generating cars and machines, and pollutants, is measurably hotter than surrounding rural areas.

Urban Runoff Storm water from city streets and adjacent domestic or commercial properties that carries pollutants of various kinds into the sewer systems and receiving waters.

Urban Sprawl Physical pattern of expansion of urban areas into rural or agricultural areas. See also *Sprawl*.

Unreasonable Risk Under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), "unreasonable adverse effects" means any unreasonable risk to man or the environment, taking into account the medical, economic, social, and environmental costs and benefits of any pesticide.

Urethanes A family of plastics (polyurethanes) used for varnish coatings, foamed insulations, highly durable paints, and rubber goods.

Vadose Zone The zone between land surface and the water table within which the moisture content is less than saturation (except in the capillary fringe) and pressure is less than atmospheric. Soil pore space also typically contains air or other gases. The capillary fringe is included in the vadose zone.

Variable Air Volume (VAV) A method of modulating the amount of heating or cooling effect that is delivered to a building by the HVAC system. The flow of air is modulated, rather than the temperature. VAV systems typically consist of VAV boxes that throttle supply airflow to individual zones, some mechanism to control supply fanflow to matchbox demand, and the interconnecting ductwork and components.

Ventilation Rate The rate at which indoor air enters and leaves a building. Expressed as the number of changes of outdoor air per unit of time (air changes per hour (ACH), or the rate at which a volume of outdoor air enters in cubic feet per minute (CFM).

Vinyl Chloride A chemical compound used in producing some plastics, that is believed to be oncogenic.

Virgin Materials Resources extracted from nature in their raw form, such as timber or metal ore.

Volatile In chemistry, refers to a substance that evaporates readily.

Volatile Organic Compound (VOC) An organic compound that participates in atmospheric photochemical reactions, except those designated by EPA as having negligible photochemical reactivity. Volatile organic compounds are chemical compounds based on carbon and hydrogen structures and are vaporized at room temperatures.

Volatile Solids Those solids in water or other liquids that are lost on ignition of the dry solids at 550°C.

Waste Output from a process or facility operation that is not used, reused, reclaimed, or recycled productively, and that is placed directly into the environment or treated through pollution control.

Waste Characterization Identification of chemical and microbiological constituents of a waste material.

Waste Exchange Arrangement by which companies exchange their wastes for the benefit of both parties.

Waste Minimization To eliminate or decrease, to the maximum extent practicable, the generation of waste by any method of source reduction, reuse, reclamation, or recycling.

Waste Reduction To decrease or eliminate the generation of waste by any method of source reduction, reuse, reclamation, or recycle.

Waste Stream The total flow of solid waste from homes, businesses, institutions, and manufacturing plants that is recycled, burned, or disposed of in landfills or segments thereof, such as the "residential waste stream" or the "recyclable waste stream."

Water Reuse Cycling water one or more times for beneficial use as reclaimed water.

Watershed The land area that drains into a stream; the watershed for a major river may encompass a number of smaller watersheds that ultimately combine at a common point.

Watershed Approach A coordinated framework for environmental management that focuses public and private efforts on the highest priority problems within hydrologically defined geographic areas, taking into consideration both ground- and surface water flow.

Watershed Area A topographic area within a line drawn to connect the highest points uphill of a drinking water-intake into which overland flow drains.

Wetlands An area that is saturated by surface or groundwater, with vegetation adapted for life under those soil conditions such as swamps, bogs, fens, marshes, and estuaries.

Xenobiota Biotum displaced from its normal habitat; a chemical foreign to a biological system.

Xeriscape™ A trademarked term referring to water-efficient choices in planting and irrigation design. It refers to seven basic principles to conserve water and protect the environment. These include: planning and design, use of well-adapted plants, soil analysis, practical turf areas, use of mulches, appropriate maintenance, and efficient irrigation.

Xylene Found in paints, varnishes, lacquers, solvents, xylenes are included in the formulations of paints, adhesives, and some furniture products, and are observed offgassing. Xylenes are considered to be a chronic toxin capable of potentially causing fertility problems and developmental defects. Xylenes will also have potential health impacts on wildlife.

Zero Air Atmospheric air purified to contain less than 0.1 ppm total hydrocarbons.

Zooplankton Small (often microscopic) free-floating aquatic plants or animals.

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