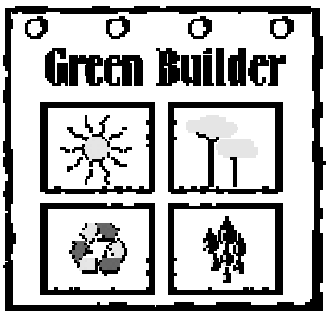
A GUIDE TO DEVELOPING

City of Austin Green Builder Program

HBA of Metropolitan Denver



HBA of Central New Mexico

HBA of Kitsap County, WA

Suburban Maryland BIA

Clark County HBA, WA

GREEN BUILDER PROGRAMS

by

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for

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OVERVIEW

Green building is the design, construction, and operation of homes according to resource-efficiency standards for energy, water, building design and materials, and indoor air quality. In 1991, there was one local program in the United States giving market recognition to green builders and their homes—the city of Austin's Green Builder program. In 1998, there were at least seven new programs up and running with many more under development. There is strong growing interest among builders, environmental organizations, and local governments in tapping existing and developing new market demand for more resource-efficient homes. In addition, there is a growing awareness that the key for tapping or developing this demand is linking resource efficiency to:

- **lower operating costs** – homes that use less heating/cooling and use less water have lower monthly utility bills. Also more durable building components reduce upkeep and replacement costs.
- **increased comfort** – homes that are resource-efficient have more even temperatures throughout the home, with less drafts and better humidity control.
- **lower maintenance** – in most families today, free time is a precious commodity—lawns that require less weeding/watering and decks that require no sealing/staining are more than welcomed.
- **increased resale value** – more and more homeowners are reporting better selling value with documented lower monthly utility bills.
- **improved environmental quality**—in and out of doors – builder attention to moisture control construction details, low VOC paints, and air exchange/filtration can contribute to a more comfortable and healthy indoor environment. Builder attention to overall resource-efficiency can contribute to a better local environment.

With this interest and demand comes the need for accurate and complete information on the numerous ways that the design, construction and operation of homes can protect or enhance environmental quality. Local organizations need to know how to develop successful programs. Home builders need to know building options to consider as well as the feasibility, benefits, and relative costs of these various options. Home buyers need to be made aware of the advantages of resource-efficient homes.

This green builder program guide is designed to address these needs. There is enormous opportunity in these programs to protect both national and local natural resources and use the marketplace to demonstrate real value to both builders and buyers. The guide has been developed primarily for home builder associations (HBAs), but also for builders and other parties (e.g. local governments who want to work with HBAs on a program).

Developing a local program that distinguishes and promotes resource-efficient development, design, and construction is a big undertaking. With funding from the U.S. Environmental Protection Agency, the NAHB Research Center has developed this guide for builders, HBAs, and other interested parties to aid in the development of a local program.

This guide was developed through:

1. An extensive review of the existing local green builder programs, primarily HBA programs, but including several municipal programs. All but one of the programs are voluntary and market-driven (Appendix A is a summary profile of six programs endorsed or developed by a local HBA).

2. The development of the Greater Atlanta HBA's green builder program. A draft of the guide was used by the HBA program development committee.

The guide has two primary sections:

1. **Steps** - The basic eleven steps required to develop a program; a how-to manual for the structure of a program.

2. **Template** - A guide on what to put into a green builder program; a how-to manual for the contents of a program. This section of the guide will be converted into a software package. The software package will add features such as the following:

    a. Program development committees can "build" (cut and paste) their program content areas and checklists from an electronic template.

    b. Once developed, the local checklist can be distributed to participating builders electronically. Builders can learn the program from the electronic checklist and track their individual project's compliance.

    c. The checklist can be organized according to content areas—energy, water, indoor air quality—or job sequencing—foundation, framing, finish. The electronic version will allow the user to "toggle" back and forth between organizations. This flexibility meets the needs of both builders and buyers in working with specific green building features. The organization according to job sequencing is particularly important in encouraging builders to take a more systematic approach to green building.

    d. The electronic format also permits the layering of information. This makes the total amount of information more manageable and accessible.

Here are a few quick points to consider before working with the guide:

1. Terminology - People can have trouble with the term "green" building—it has a lot of different meanings and associations. It is used here as the quickest and easiest term to describe resource-efficient or environmentally-sensible construction practices, systems, materials, and building operation.

2. Scope - The focus of this guide is currently new residential construction. It touches on the larger issue of land development and recognizes the potential and importance represented by remodeling but mainly deals with issues relating to construction of a new home on an individual plot of land.

3. Context - This guide should be used taking into consideration the structure of your local home building industry and with the appropriate level of recognition for local as well as national environmental issues.

STEPS IN DEVELOPING A GREEN BUILDER PROGRAM

Introduction

When a home builder association or other local organization decides to investigate the development of a green builder program, the first steps are the most important. If the right information is collected and if the implications of early choices are considered, the chances of achieving a well-designed and meaningful program are enhanced.

The steps suggested below are generally sequential but some items may require simultaneous action. At the beginning of any project, there can be a "chicken-and-egg" phenomenon in which it seems as though it's hard to know where to start on one issue without implications for another. As you follow the steps below, notice is given for actions or issues that may be tied to other elements or features of your program and its development.

Although this guide has been developed primarily for use by home builder associations, other organizations interested in developing programs that promote resource-efficient construction will find it useful as well. The important point to remember is that the most effective programs are those in which both the target industry and local government have significant buy-in from the beginning of the project. If you are using this guide and your organization is not an HBA, be sure that members of the building industry are involved from start to finish. As the steps below suggest, HBAs using this guide should consider, seriously and early in the process, the role that local government can play in program development.

Program development is broken down into eleven steps. Details for each step follow the summary list presented below.

STEP ONE: ***Determine member and home buyer interest in/basic knowledge of green building.***
STEP TWO: ***Establish a developmental committee.***
STEP THREE: ***Set objectives of the program***.
STEP FOUR: ***Determine program partners.***
STEP FIVE: ***Determine program coverage.***
STEP SIX: ***Discuss structure of the program budget.***
STEP SEVEN: ***Consider the role of existing programs.***
STEP EIGHT: ***Determine the certification or approval process.***
STEP NINE: ***Discuss and establish program resources and activities.***
STEP TEN: ***Establish key elements of program structure***.
STEP ELEVEN: ***Create program content items.***

NOTE: These steps are the result of a review of existing local green builders programs. Six of the programs are summarized in Appendix A, contact information for eight programs is listed in Appendix B, and sample program checklists are included in Appendix C.

STEP ONE: ***Determine member and home buyer interest in/basic knowledge of green building.***

You are probably investigating a green builder program in response to interest from members and/or a local government agency. The HBA will want to know how important this issue is to builder and associate members and the builder members will want to know how important the issue is to their clients. The feedback you will be looking for is a combination of the level of interest in, awareness of, and subject knowledge on green building or resource-efficient construction.

NOTE: It's important to recognize the differences among interest, awareness, and subject knowledge. Quite often consumers demonstrate interest and some awareness of environmental issues, but make little connection between these and the home building and buying process. If this is true, then a marketing campaign becomes an educational campaign. Educational campaigns can be the shared responsibility of any number of entities including industry groups, government agencies, foundations, and environmental organizations.

There are two basic mechanisms for getting feedback from builders and home buyers— focus groups and surveys. Each have been used by home builders associations in testing the waters for a green builder program.

Focus groups - A focus group is a qualitative market research tool used to gain information and insight on the attitudes, motivations, perceptions, and decision-making processes of a select group. The group normally consists of eight to ten people selected for certain attributes: occupation, expressed interest, level of education, etc.

The keys to a successful focus group are a clearly defined agenda and a professional moderator. Sessions can be audio and video-recorded for later review. The cost to set up, conduct, and analyze one 2-3 hour focus group can run from $4,000 to $10,000. See Appendix D for the guide to and results of focus groups conducted by the Research Center and the HBA of Greater Atlanta. While some of the issues covered were particular to the Atlanta market and environment, much of the information is relevant to any HBA interested in designing their program to meet or create market demand.

Builder surveys - HBAs have used general membership meetings, fax, mail, and telephone interviews as methods of obtaining completed surveys. General membership meeting surveys are by far the least expensive but limit the range of responses to a group generally much smaller than total membership. Fax and mail surveys cast a much wider net. Care must be taken to keep the survey short enough to enable builders to complete it quickly but substantive enough to enable the organization to get back useful information. Phone interviews can be the most useful because they encourage feedback that doesn't fit the confines of the survey questions. Phone interviews are, however, time-consuming for both the builders and the interviewers and confining because they often require prior scheduling of the interview. See Appendix E for a copy of and results from the Greater Atlanta HBA's builder survey.

Home buyer surveys - The key to a home buyer survey is to identify a forum or vehicle that targets this particular consumer group. Two successful approaches include in-person interviews at a home show event and a written survey run in the home section of a local newspaper.

The HBA of Central New Mexico used a Home Showcase event to conduct in-person interviews with 250 potential home buyers. Conducting an exit survey at a home show event effectively targeted the survey to potential home buyers. The survey was developed, conducted, and analyzed by a professional business information group, for approximately $1,100.

The HBAs of Kitsap County and Clark County also administered surveys at home show events. The surveys were developed by the program consultant and conducted by HBA and local government volunteers at the HBA show booths.

The Greater Atlanta HBA made arrangements to run a full page survey in the home section of the Sunday edition of the *Atlanta Constitution*. The completed one page survey was mailed or faxed back to the HBA. See Appendix F for a copy of the survey and a summary of the results.

Surveys of builders and home buyers can accomplish two things. They give valuable information from the direct results and they get the word out to individuals, firms, or agencies that might contribute to the development of your program.

STEP TWO: ***Establish a development committee.***

The development of a green builder program involves plenty of decision-making regarding the objectives, scope, financing, and structure of the program. The make-up of the committee (builders, remodelers, developers, associate members, outside organizations) needs to be broad enough to include any and all directions the program might take. On the other hand, it's important that the program development maintain a focus that is reasonable given the program objectives and resources available. It's easy to see how this step is closely linked to several other steps, particularly Steps 3 and 4.

Consider the following entities in committee membership:

1. **Builders.** It's important that your committee include a range of builders—small custom, medium production, and large volume builders. Differences in methods of construction, management, financing, product selection, and marketing can all have a significant impact on program structure and content.
2. **Remodelers.** Even if you are unsure if your program will initially cover remodeling, it is important to have this perspective during early planning stages.
3. **HBA Leadership.** It is essential that HBA leadership be directly involved through membership on the development committee or be indirectly involved through regular briefings. HBA leadership commitment to the program will in this way be cultivated or maintained.
4. **Local government.** HBAs have worked with local departments of energy conservation, public works, solid waste, and pollution prevention taking advantage of both their financial and technical resources. As discussed below and in Step 4, the timing and level of local government involvement can be important to program development.
5. **Lender(s).** Financial incentives for both home buyer and builder participation in the program are a key part of the program—at least one lender should be involved in program development.
6. **Realtor(s).** The realty community can play an important role in the marketing of any program.
7. **Associate members.** Distributors, trade contractors, and local product manufacturers can be important sources of technical information and funding support.

8. **Environmental building professional.** Even with the assistance this guide provides, nothing can replace local experience in resource-efficient design and construction. Seeking out a consultant to provide technical support to the committee is particularly important if the committee lacks builder members with field experience in this arena. Depending on the availability and expertise of HBA staff, a consultant can also supply project management.

There are two basic approaches to establishing a development committee.

1. One is to start with a core group of approximately six HBA members (primarily builders) and staff who will be needed to review subsequent steps before decisions are made to expand the development committee to outside organizations. This early work by the builder development committee will help to ensure that the eventual make-up of the committee includes the right mix of perspectives and resources. This start-up committee will probably limit its role to establishing initial program objectives and scope before moving on to expand the committee.
2. The second approach is to include at least one outside organization from the very beginning because of resources and a level of common interest which the group or groups bring to the table. This raises the issue of partners in program development as discussed in Step 4.

STEP THREE: ***Set objectives of the program***.

There are lots of reasons for establishing a green builder program:

1. ***To Acknowledge*** and promote existing builder practices that represent resource-efficient or environmentally-friendly construction.
2. ***To Encourage*** and reward the use of new or additional builder practices that represent resource-efficient or environmentally-friendly construction.
3. ***To Satisfy*** existing and/or ***create*** new market demand for resource-efficient or environmentally-friendly construction.
4. ***To Improve*** existing or establish productive new relationships with select local and state government agencies.
5. ***To Educate*** builders and home buyers with meaningful, comprehensive, and practical information about the impact home building can and does have on the environment.
6. ***To Shape*** the public debate and regulatory agenda on local environmental issues.

Several of the HBAs with green builder programs have stated that one of the most important program benefits has been the good will generated with the public in general and some local government offices specifically. A green builder program represents the opportunity for both private industry and government to demonstrate cooperation and consensus, building public support for both.

It's important for the HBA and the development committee to discuss and establish the program objectives in the early stages of program development because the objectives have a significant impact on everything that follows. It can also be important to prioritize the objectives because this can significantly affect the structure of the program. It's not uncommon for groups excited about a new program to want to dive into the nuts and bolts of how the program will look and work and give only passing recognition to setting objectives, a generally much less interesting task. Time spent early on establishing program objectives can save time and avoid problems when the program hits the streets.

STEP FOUR: ***Determine program partners.***

The decision to include outside organizations in the development of the program is often based on one or more of the following three factors: credibility, control, and financial resources.

1. Credibility - A stand-alone program, regardless of whether it is developed by an HBA, an environmental organization, or a government agency, takes on the added challenge of convincing the public and outside parties with a vested interest that the program is substantive and objective. Generally, programs that contain an element of public/private partnership have greater credibility and receive more supportive media coverage than stand-alone programs.
2. Control - The trade-off often made when a program involves two or more organizations is one of control. It is likely that the enhanced credibility of a partnership brings with it some compromise or accommodation in the objectives or how they are prioritized. This is why initial discussions regarding objectives can be important when seeking the right partners in program development.
3. Financial Resources - Although the costs of starting and running a program are discussed later, they usually include HBA staff time, production of educational and marketing materials, and consulting services (marketing, surveying, environmental building consulting). The resources of each HBA and the goals of the program will determine how important partners with financial resources are to program development. Program development costs are discussed in detail in Step 6.

Listed below are entities to consider when seeking partners.

1. Government agencies - A variety of local or state government agencies or departments may be interested in contributing to the development of a local green builder program including those in the following areas: energy conservation, environmental quality, planning, solid waste, and building inspection. Consider that the contributing entity may want to create a focus on the particular environmental issue in which the office or agency is engaged. Another important consideration when working with government agencies is the substantial time and effort required if you are seeking grants or other forms of financial support.
2. Building product manufacturers - While local distributors and suppliers are quite often participants in local HBA programs as associate members, there may be major product manufacturers willing to be major financial sponsors of a local green builder program. It is important to discuss with product manufacturers any expectations they may have for featuring particular products as a part of their sponsorship.
3. Public utilities - Many public utilities have existing programs that may gain greater prominence or acceptance by builders if incorporated into a comprehensive HBA program such as a green builder program. Rather than the utility interpreting the development of an HBA program as a potential competitor to an existing utility program, the utility is invited to enhance its existing program within the umbrella of the new program. This is particularly important as imminent deregulation of the industry increases pressure to support only the most cost-effective programs. It is important to establish with the utility any desire the HBA has to keep the program fuel-neutral for their builder members.
4. Non-profit organizations/foundations - Non-profit organizations with an investment in local environmental issues and or the local home building industry can make good partners in the development of a green builder program. These organizations often have strong positive relationships with both the media and environmentally-related government agencies.

With the development committee and program objectives established, information on member and home buyer interest and attitudes collected, and initial financial resources identified, details of the program's structure can be addressed.

STEP FIVE: ***Determine program coverage.***

There are four types of HBA members that a green builder program can cover: residential builders, remodelers, light commercial builders, and land developers. Which groups are covered depends on the ease of program design and implementation as well as member interest and demand.

1. Residential builders - The easiest portion of the program to develop is for residential builders and generally, this is the largest segment of non-associate membership. The programs we reviewed were all designed to cover or certify builder's individual projects, not the builders or their businesses.
2. Remodelers - Because remodeling projects vary so widely in scope and type, certifying remodeling projects is difficult. It is possible to tailor requirements for standard major remodeling projects (kitchens, baths, whole house renovation, additions) but handling smaller projects (re-roofing, window replacement, add-on decks) may not be feasible. Some programs are investigating certification of *remodelers* rather than their *projects* based on required training and a code of principles, enabling a remodeler to claim and demonstrate aspects of green building in all or most projects. Other entities to consider under remodeling include specialty contractors—siding, windows, insulation retrofit, roofing, painting. While their incorporation into a program presents additional challenges, in almost all markets they represent a substantial portion of total remodeling activity.
3. Light commercial builders - Since many HBA members are engaged in commercial light-frame construction, programs can be designed to include these projects as well. Adjustments to the program criteria for light commercial projects can reflect the differences in code for commercial buildings such as HVAC requirements and fire safety. While commercial green building standards have been developed by the U.S. Green Building Council (a rating system entitled LEEDS - Leadership in Energy and Environmental Design Sustainability), the LEEDS program is more suited to larger commercial buildings.
4. Land developers - Developing a program for land development involves issues such as local planning, zoning, storm water management, infrastructure standards, and transportation systems. Addressing these issues may require significant changes in regulations, ordinances, and master plans, as well as long-term political and educational efforts. Several of the existing green builder programs initially did not include elements or an entire section on land development for the above reasons, but do plan to use the green builder program over the long term to address growth issues.

STEP SIX: ***Discuss first year budget and structure of program fees.***

The first year budget of a green builder program involves the costs of development and implementation. Most of the development costs are labor related—staff, HBA members, and possibly consultant(s). Implementation costs can be largely the hard costs of printing materials, planning events, and promotion. The table below, in broad categories, describes the costs of several of the existing green builder programs.

Table 1 - First Year Budget for Green Builder Programs

Features	**Range of approximate cost in dollars or hours**			
Hard costs	**Kitsap**	**Central New Mexico**	**Denver**	**Atlanta (projected)**
Advertising	$ 4,000	$30,000	$0[1]	$30,000
Builder/consumer surveys/focus groups	$ 500	$ 1, 100	N/A	$ 2,000
Marketing materials (logo, ad slicks, yard signs, certificates, plaques, etc.)	$ 7,000	$ 7,500	$ 8,000 - $10,000	25,000
Builder handbooks	$ 3,400	$ 750	$ 500	$ 500
Hard Cost Subtotal	$14,900	$39,350	$ 8,500 - $10,500	$57,000
Labor				
Program development (HBA staff)	$ 6,200	(320 hrs)	(200 hrs)	(300 hrs)
Program development (consultant)	$24,500	480 hrs	100 hrs	$25,000
Event planning (staff)	$0	160 hrs	100 hrs?	$250 per
Total	**$45,600**	**≅$57,000**	**≅$50,000**	**≅$98,000**
Field checks (independent inspector)	N/A	N/A	$350 per	$250 per

Here are some general rules of thumb taken from the existing green builder programs:

1. At least initially, the programs are not set up as revenue generators—the goal is to make the program revenue-neutral after the first or second year.
2. Staff time to develop and administer the program is often not specifically allocated to the program budget. Staff are under direction as to the portion of their time to invest in development, implementation, and then ongoing administration of the program. The total staff investment during the first year of program development averages around ¼- to ½-time for one person.
3. Program membership fees are often set up to cover only the hard costs of the program—printing materials, signs and, conducting spot checks. Not including advertising and staff time, program hard costs average around $10,000.
4. Advertising costs often are set up to be covered by project sponsorships. This is reflected in the wide range of advertising costs in the first year of the programs.
5. It takes a substantial amount of time to gather and present background information on the content areas of the program into an HBA library and/or a builder's handbook. Before investing time and money in either, check with builder members likely to enroll in the program on which vehicle they think will be most useful.

Even before specific features of the program have been established, however, answers to the following questions can help in determining program structure:

1. Are enrollment fees to builders annual and/or per project?
2. Are builder member fees tied in any way to builder volume?
3. Can a builder pay more to be a founding member and receive a sponsor-level of recognition?
4. Can associate members (architects, subcontractors, building material suppliers, lenders) join and how do their fees compare to builders?

[1] The Denver program included no advertising in its first year but with its partner, the Governor's Energy Office, spent $75,000 in the second year.

5. What is the cost of being a program sponsor or partner, and is there a limit to the number of sponsors or partners?

Existing programs report the following range of fee structures:

Annual fee for builders[2]:	$50 - $295 (HBA members)	$250 - $750 (non-HBA)
Per project fee for builders[3]:	$50 - $75 (HBA members)	$50 - $150 (non-HBA)
Annual fee for associates:	$250 - $295	
Program partners or sponsors:	$10,000 - $50,000	

STEP SEVEN: ***Consider the role of existing programs.***

The development committee should compile a list of existing local, regional or national programs which may relate to the green builder program. These programs may be HBA, NAHB, federal/state/local government, local environmental, or utility programs. Some examples include:

- EPA Energy Star (energy program)
- Edison Electric Institute E Seal (energy program)
- Home Energy Rating System (HERS) (energy program)
- American Lung Association's Health House (indoor air quality program)
- NAHB/KAB Build America Beautiful (waste management program)
- Good Cents EarthChoice or Environmental Home (energy & resource-efficiency program)

It is important that builders who already have an investment in an existing program be given credit within the new program. This guide comes with a fairly strong recommendation to include or even feature a voluntary energy-efficiency marketing program such as Energy Star because of the significant and distinct advantages to builders and home buyers that the programs can bring. See the Energy-Efficiency Overview section of this guide for a more complete discussion of this issue.

NOTE: In 1998, the U.S. Department of the Treasury began working on a proposed residential energy tax credit. The tax credit would apply to homes that meet energy-efficiency criteria–the criteria have yet to be determined. In 1998 as well, the State of New York drafted an act to create an income tax credit for the construction of environmentally–sound buildings. The act only applies to commercial buildings and multi-family residential greater than 20,000 square feet. It's important for local green builder programs to keep abreast of initiatives such as these and to determine if advocacy for or participation in the development of such initiatives is in the building community's best interest.

STEP EIGHT: ***Determine the certification or approval process.***

There can be two elements to the process of certifying participants in the program: an initial agreement and project-by-project certification. Some programs have a fairly formal contractual agreement for members of the program that states the rights and responsibilities of both the member and the administrator of the program. Typical elements of these agreements include:

[2] The municipally-run program in the city of Austin, TX has no annual or per project fees.
[3] The Denver program discounts per project fees for large projects within a single-builder community.

Builder Member

- Pay dues (annual and project)
- Enroll minimum # of projects
- Permit use of builder name in program
- Be responsible for compliance
- Provide random access to projects for spot verification
- Limit use of program materials to enrolled projects
- Fairly represent & document compliance to home buyer

Program or Administrator

- Provide technical support/training
- Promote program to general public
- Promote program to realtors/suppliers/builders
- Provide stated materials (e.g. yard signs)
- Establish grievance process
- Maintain records/process applications
- Provide financial oversight

Most programs have started out with a self-certification process for builders and their projects with an agreement that the program has the right to randomly check any project's compliance to program criteria.

NOTE: The incentive for builders to comply with self-certification comes from the explicit contract they have made with the program and the implied commitment the builder has made in the representation of the home to the home buyer. This latter commitment can be made more powerful or better defined by requiring that the builder provide a copy of the check list or record of compliance on the project to the home buyer.

In areas with strong existing voluntary energy-efficiency programs, investigate their certification or compliance process and see if it is compatible with objectives of your program's certification process. Certifications or inspections for the energy program may be expanded to include inspections for the remaining green building compliance.

Over time, several programs have developed or are developing a system to at least spot check compliance. The issue of validation is an important one in developing a program because of the costs—third-party ratings or certifications alone can range from $250 to $500—and the liability—the program administrators and/or sponsors are potentially exposed for the responsibility of homes which do not meet the criteria claimed in the representation or certification.

Consider the following in the establishment of a verification system:

1. Check to see if a third-party verification firm—building consultants, non-profit building organization, local university housing program—is available in your area.
2. Determine whether certification inspections can be accomplished in one or more site visits.
3. Determine whether inspections will include testing such as a blower door or duct blast (see Energy section of template for further discussion).
4. Determine who will pay for initial inspections and re-inspections for homes that do not comply.

5. Decide whether failure of one randomly selected home will trigger additional inspections.
6. Determine who will review the merit of write-in items submitted on individual projects.

STEP NINE: ***Discuss and establish program resources and activities.***

There is a wide range of resources and activities to be considered in the development of a green builder program. The following list highlights the most significant resources that can be offered to builders.

Resources

1. Builder Handbook - Most existing green builder programs have a handbook which builders receive when they enter the program. Most are in the form of a 3-ring binder, making changes and updates easier. Some handbooks are designed to be an introduction of the program to the builder, some are set up as a marketing tool for the builder to use with clients, and some are meant to be an extensive, detailed reference and educational tool for the builder. The most common elements of the handbooks are the following:

    - **Summary checklist** - This is a checklist all of the items described in one-line phrases on one or two pages. This summary sheet is often the same as the record of compliance that a builder will complete for each qualifying home or project.
    - **Detailed item descriptions section** - Although some or many of the items may require little elaboration for builders, others may require detailed examples or instructions. This can be accomplished by including lots of details in the handbook or by including specific references that are part of the program resource library as discussed below.
    - **Resource section** - The implementation of many program items requires contact or outlet information. Because this is the portion of the program that is the most subject to change (e.g. add new companies, change contact personnel, update range of services), this information is often kept in a separate section of the handbook.

NOTE: The elements listed above can be provided in a software package as presented in the second part of this guide.

2. HBA Resource Library - There is a balance to be struck between the amount and level of information given to builders in the handbook and materials kept for builder use in the HBA library. Some programs report that builders use little of the detailed information in the handbook and prefer to seek out information and guidance on specific items in which they are interested. Others report that builders like a reference that is thorough enough to be used as an independent tool. The design and intent of the library and handbook may also be affected by the type, frequency, and level of education/training that the program provides.
3. Newsletter - Several programs have a one-page newsletter that goes to all members on a regular basis. The newsletter is used to announce upcoming events, to make members aware of updates on the program, and to provide tips to builders on green building techniques.
4. Website - More and more builder and associate members are on-line and the HBA web site can be used in place of or in conjunction with the newsletter to communicate with program members.
5. Promotional Materials - The specific materials that programs provide to their builders include yard signs, ad slicks, logo stickers, brochures, certificates, plaques, and homeowner manual starter kits.

The yard signs tend to be the corrugated plastic type that run as little as about $3 apiece and are durable. The brochures are generally 4- to 8-panel fold-out pamphlets for builders to give to prospective clients. Certificates and plaques can be either for the builder to use in a home office or for the builder to give to homeowners. Starter manuals for builders to give to home owners at move-in generally include recommended operation and maintenance that is environmentally sound, as well as suggestions for more benign cleaning and lawn and garden care.

Activities

1. Training - Training can be in the form of initial orientation and/or as an ongoing educational series. Several programs have or are developing a builder training series to expose builders to the full range of options available within the program. While some of the techniques or actions suggested within the program may be straightforward or current practice for many builders, others may require both classroom and hands-on education. Builder training is generally a part of the program that is not well-developed during the first year but evolves in subsequent years as builder needs are established.
2. Parade of Homes - Several HBAs have featured a green builder as part of a Parade of Homes or even created a Parade of Homes devoted exclusively to green builder projects. Because of the intensity of preparation which already exists for a typical Parade of Homes event, HBA staff planning to incorporate a green building element should count on a substantial commitment of time to the event, particularly in the first year. On the other hand, the general exposure and home buyer education opportunities for a Parade of Homes event are enormous.
3. Community events - Any existing community event which focuses either on housing or the environment provides an opportunity for the HBA to get the word out to potential home buyers about the advantages of buying a resource-efficient home. The Denver HBA created a mobile exhibit featuring many elements of their program for such events. The Central New Mexico HBA is working on a green construction project with a local middle school to demonstrate to the children just what is involved with resource-efficient construction. The Build a Better Kitsap program has a booth that features resource-efficient techniques and materials in its construction. The booth is used at home shows and other local events. Any event that involves the creation of an exhibit will involve the costs of its construction as well as the costs involved in the set-up, breakdown, and storage of the unit.

STEP TEN: ***Establish key elements of program structure***

This step and step eleven are often considered together because of the impact they can have on each other. The approach taken by the Atlanta HBA development committee is described at the end of this step.

There are five basic decisions to make in setting up the structure of the content areas and individual items of a green builder program: performance-based vs. prescriptive standards, number of levels, types of requirements, weighting of items by points, and organization of content areas.

1. Standards - Individual items in the program can be expressed as performance-based, prescriptive, or a combination of both.

Performance-based standards are expressed in terms of the end product—the emphasis is on where you end up, not how you get there. An example would be: "Increase efficient use of framing lumber by 10%". The standard does not dictate how the improvement in framing efficiency is achieved but rather sets an end to be achieved.

Characteristics of performance-based standards include:

1. The method and details of how a level of performance is achieved are left to the practitioners--the builders--giving them more flexibility and encouraging ingenuity.
2. A baseline or conventional performance must be established for comparative purposes.
3. Comparing individual performance with the baseline usually requires a calculation system or software program.
4. If the current local building code is used as the baseline, then areas of the green builder program which are not addressed in the code may require establishing baseline for these areas.

Prescriptive standards are expressed in terms of the means used to achieve an end--the emphasis is on how you achieve a desired outcome. An example would be: "Use at least three of the following efficient framing techniques....". The standard does not specifically address what is achieved but focuses on specific ways in which the general objective of more efficient framing can be achieved.

Characteristics of prescriptive standards include:

1. The method and details of compliance are explicitly stated.
2. The system is generally simple and easy to use.
3. There is no need for an explicitly stated baseline or conventional practice.
4. There is no need for a system of calculation or software program.

In general, a performance-based approach can require more time and/or investment in the compliance process than a prescriptive approach. A prescriptive approach requires carefully considered options and language so that the simplicity of the system does not come at the price of relevance, feasibility, or flexibility.

Some of the existing programs use a combination of both types of standards and most provide a range of options that are prescriptive in nature but broad enough to provide builders with significant flexibility. In general, prescriptive standards that are well thought out, expressed clearly, and generated by a builder committee, have a good chance of being acceptable and useful to participating builders.

2. Levels - Programs can be either "all-or-nothing" single-level or multiple-level programs.

With single-level programs, builders meet one point or item total to qualify projects in the program. Single-level programs are generally set up for simplicity, both for the builder and the buyer. The key with a single-level program is to set the bar high enough to make the certification meaningful but not so high as to discourage builder participation. As an example of a single-level program, see the Denver HBA Built Green[SM] checklist in Appendix C.

Multiple-level programs generally have three or four levels under which builder projects can qualify their homes. Multiple-level programs are designed to accommodate and distinguish among

a wider range of builder projects. They are often set up to draw both builders and home buyers into the concept of environmentally-sensible practices at the basic level and provide opportunities for progression and education at the higher levels. For examples of multi-level programs, see the Central New Mexico and Kitsap County HBA programs in Appendix C.

3. Requirements – Programs vary widely in both the extent and nature of requirements. All of the programs have sought a balance between flexibility—with the attraction this has to participating builders—and prescription—with the sense of standardization, substance, and credibility that this establishes. The best way to describe the various ways that requirements can be handled is by examples from existing programs. Program checklists for each of the programs discussed below are presented in Appendix C.

City of Austin Green Builder Program – This program has a specific list of features that every building project must exhibit to qualify. These are essentially minimum program requirements and are called Basic requirements. The requirements ensure that every home in the program will have at least a minimal number of material selection, energy-efficiency, indoor air quality, and water efficiency items.

Build a Better Kitsap Program – This program has a "green codes" section. It "requires" that builders meet the tough energy, ventilation, and water conservation regulations in the state of Washington's residential building code. Builders, of course, gain no points or advantage for these code items but their inclusion in the program is a way of acknowledging that significant environmental building features are already a part of the way homes are built in Kitsap County.

Denver HBA Built Green℠ Program – The Denver program gives builders the greatest flexibility in qualifying homes with a requirement in only one program category, energy. Builders must include a minimum of 38 other items from the checklist, but they need not be from any particular category or in any particular distribution.

HBA of Central New Mexico Program – The New Mexico program is the most directive of the programs reviewed. In addition to having basic requirements like the Austin program, the list of specific required items in each program category increases with each level (the Austin program simply requires more points in total for higher levels). Flexibility is achieved by permitting some selection within category requirements and encouraging builder "write-in" items.

4. Straight item count vs. point-weighting - Programs can either treat every listed item with equal weight or assign points to each item. The simplest approach is clearly to treat each item equally, in essence giving each program item a value of one (See the Denver HBA Built Green™ program checklist).

Points can be assigned to each item based on the relative difficulty or cost of an item, the relative significance of the environmental impact of an item, or a combination of the two. In almost all cases, the determination of points for items is accomplished by way of consensus among the members of the developmental committee. This is primarily a qualitative process and some acknowledgment of the decision-making process should be clearly stated in the program.

5. Organization of content areas - The number, listing order, and selection of content areas are all a part of how the program items are organized. Content areas can be organized by environmental issue, by

building system, or by CSI code/approximate chronology as the issues arise at the job site. With each approach, a certain number of items can be difficult to place. Builders tend to be most comfortable with an organization that follows the order in which the items need to be addressed on the job. To a greater or lesser degree, all of the programs reviewed followed an organization based on environmental issues.

The software approach suggested in the Overview provides the advantage of keeping two types of organizations. Builders get the job sequence list that they find most useful in the actual construction of projects and non-builders—home buyers, environmentalists, government officials—get the topics with which they are familiar—energy conservation, water conservation, etc.

In any case, the content areas should be numerous enough to create distinct topic areas but not split to a level that overwhelms the builder with the sheer mass of the program. The real art to developing a program on a topic as potentially complex and far-ranging as resource-efficient construction is to keep the program comprehensive and focused.

The Atlanta HBA program development committee took the following approach in determining the key elements of their program.

1. *Reviewed, discussed, and selected items from each content area.* The committee used this review to familiarize themselves with the overall meaning of each content area and the details of each checklist item.
2. *Reviewed, discussed, and selected existing programs around which their program would be built.* The HBA has a water conservation program, the Water Smart Home—an 18-item checklist requiring 100 points out of a total 240—which they wanted to feature. They also selected the EPA Energy Star Homes program as one way to meet energy-efficiency requirements of their program.
3. *Selected program structure*. The builders of the committee selected a single-level program with checklist items of variable point value. They chose to establish no requirements for each content area.
4. *Established relative weight of content areas.* The committee assigned relative weights to content areas—e.g energy efficiency weighted by a factor of 1.00, water conservation and indoor air quality weighted .50, site planning and waste management weighted by a factor of .25, etc. The weights were based on factors such as importance of issue with consumers, local environmental significance, availability of options/techniques, etc.
5. *Established basis for assigning points.* The committee chose to build point values for the entire program roughly around an EPA Energy Star Home rating equaling 100 points.
6. *Assigned individual item point values.* Each committee member is assigned an "environmental value" (1-4) and a "building value" (1-4) for each item. In this way the environmental importance or impact of an item and the builders' assessments of cost or difficulty of an item were built into the final point value for the item.
7. *Assigned content area point total requirements and overall program point total requirement.* The builders on the committee applied the draft points system to their own businesses and came up with point requirements based on how they would "make the grade". Custom and production builders came to consensus on requirements.
8. *Conducted "trial runs" outside the committee*. The draft program structure and point requirements were tested on a small group of active HBA builders and selected local government agencies from which the HBA was seeking support for their program.

STEP ELEVEN: ***Create program content items.***

The next section of this guide--the template--is dedicated to a review of the full spectrum of potential program items. As individual topic areas and items are reviewed, here are some basic issues to consider:

1. Avoid vague language—be as quantitative as possible so that meeting an item is clear cut for the builder.
   Example: "Use compact fluorescent light bulbs" can be improved to
   "Install at least 2 fluorescent permanent light fixtures or provide homeowner with 4 compact fluorescent light bulbs."
2. Avoid putting more than one action, technique, or material in one item.
   Example: "Recycle wood, metals, and cardboard on the job site" can be improved to "Recycle all untreated, solid sawn lumber and plywood/OSB cut-off waste"
   "Recycle all waste metals"
   "Recycle all corrugated cardboard" (three separate items)
3. If your program uses points, avoid ranges for a single item whenever possible.
   Example: "____ (1-5 points) Recycle construction waste" can be improved to
   "___ (1-5 points) Take one point for each of the following construction materials that you recycle: wood, cardboard, metals, plastics, drywall"
4. Link items to resources—this is particularly important for items which may be new to builders.
   Example: "Use OVE techniques" can be improved to
   "Use in-line framing (see efficient framing in reference section for details)"
5. Leave room for items not considered—even the most thorough of program development efforts will not anticipate every builder's approach. Acknowledge this by including a write-in item in each content area.
   Example: "Use this space to include a water conservation technique that you employ that is not included in this section—see program administrator for approval and credit" (Builder writes in "Provide homeowner with 'soaker' garden hose at move-in").
6. Try to keep the same level of detail across topic areas and on individual items.

Finally, take full advantage of the electronic version of the template. The objective of providing the template in this form is to allow customization to meet local program needs.

GREEN BUILDER PROGRAM TEMPLATE

Introduction

The second half of this guide is the template of content items to consider. This template was developed by extensive review of the existing local green builder programs, a test of the content item selection with the green builder program development committee for the Greater Atlanta HBA, and by review of resources and references on each content area. The items have been grouped by the following content areas:

1. Site Development
2. Energy Efficiency (Site)
3. Energy Efficiency (Envelope)
4. Energy Efficiency (HVAC)
5. Energy Efficiency (Appliances/Lighting)
6. Resource Efficiency (Design)
7. Resource Efficiency (Material Selection)
8. Indoor Air Quality
9. Waste Management
10. Water Efficiency (Indoor Use)
11. Water Efficiency (Outdoor Use)
12. Homeowner Opportunities
13. Business Operations
14. Land Development

This template will also be made available in a software form which permits reorganization of the program content items by job sequence and job code. This reorganization allows users to switch from the content area organization—which probably makes the most sense to non-builders like home buyers—to job sequence which makes the most sense to builders (starting with design issues and moving on to site, foundation, framing and so on).

The material within each content area follows the organization below:

Overview/Discussion - This is a general discussion of the nature and scope of the content area and any issues which may surface on the topic.

Review of Local Programs - This section includes the following:

1. a checklist summary table presenting all content items, local program inclusion of the items, and a Recommendation on each item (an **R** stands for Requirement, an **E** for elective or optional item), and,
2. a general description of each content item, including a brief evaluation of the Cost, Availability, and overall Practicality of the item (labeled **C/A/P**).

Guide Recommendations - An explanation or elaboration on how the recommended or required items from the table should be specifically treated.

Resources - A list of selected resources and a brief description of the resource. Resources include publications, trade journal articles, and web sites. Each has been screened as useful and relevant to mainstream residential builders.

Four important notes:

1. Very few individual items are recommended as program requirements. In a voluntary market program, the builder and the buyer's preferences should dictate selection.

2. Some items listed in the tables under individual program columns are not "recommended" in the last column-Guide Recommendation. If not discussed in the Recommendations section of each content area, assume that the item was not strong enough to warrant specific inclusion.

3. Although all of the local programs listed in the early Appendices were used in the development of this guide, only four are listed in most of the content area tables.
   This is for the following reasons:

   a. The Clark County HBA and City of Scottsdale, AZ programs were still under development as this guide was being developed.
   b. The Suburban Maryland Building Industry association (SMBIA) program has such a strong focus on land development that this program was only included in this one content area.

4. Energy efficiency is too important and too broad a topic to cover in one content area. In addition to being divided into four categories, an Energy Overview section is included to cover general energy issues.

5. General Green Building Resources: Although each content area has a topic–specific resource section, there are some resources that appear repeatedly because they are good general resources on green building. These publications, periodicals, and web resources are compiled in Appendix G as an overall resource.

6. Three builder profiles showing how their projects qualified in three different local programs are included in Appendix H for your reference.

1. Site Planning

Overview/Discussion

Planning and development issues can be approached from two vantage points:

- Site Planning which pertains to the builder whose projects typically consist of one or two buildings on a single lot and

- Land Development which pertains to the developer whose projects typically involve large tracts of land, multiple buildings, and multiple uses.

Individual site planning is discussed here and land development issues are discussed in the final section of the guide. This split reflects two related points:

1. While all of the green builder programs reviewed address individual site planning issues, only two address in detail the much broader topic of land development.
2. Land development involves bigger and harder issues to tackle often involving significant regulatory and even statutory changes. Most local programs take on green development only after setting the groundwork with a green builder program.

Detailed site assessment and preplanning can be as important to the single family home on a relatively small lot as they are to multiple buildings and uses on a larger property. Building location and orientation, existing site features, erosion control, and disturbance can all be part of a thorough site analysis. In addition, any features of adjacent properties that might affect solar access, prevailing winds, or drainage patterns can be taken into account.

With the site and building design complete, the builder also has opportunities to demonstrate environmentally-sensible construction practices. Even before the foundation is poured, careful planning prior to grading and excavation can protect vegetation and soil-assets which have significant value to both the home owner and the community.

Table 2 - Review of Local Programs: Site Planning Checklist Summary

Program Items	Green Builder Programs				
	Austin	**Denver**	**Kitsap**	**Central New Mexico**	**Guide Recommendations**
Existing tree protection	E	E	E		E
Minimize site disruption	E		E	E	E
Erosion control measures	E		E		E
Set aside & reuse top soil		E	E		E

Identifying locations to store reserved topsoil, clearly marking and/or fencing trees to be saved, and planning drainage patterns can protect the site's natural resources. In addition, such forethought can prevent rework later in construction, thus saving time and money.

Existing tree protection - Most programs offer fencing to a tree's drip line as the best protection mechanism. Consideration should also be given to selection criteria for tree preservation, required grade changes, watering needs during construction, and mulch protection. See Appendix I for details on tree protection and the NAHB "Building with Trees" workshops under Resources.

Cost/Availability/Practicality (C/A/P): The presence, condition, and value of existing site vegetation can vary greatly. Studies by NAHB and others have clearly demonstrated the value that mature, healthy site vegetation has to home buyers. Builders may either develop or retain the expertise to evaluate the value and feasibility of protecting existing vegetation. Such expertise can vary widely in cost. While private consultants might be fairly expensive, Soil and Water Conservation departments, Cooperative Extension offices, and universities may offer resources at little or no cost. Protecting existing site vegetation may also require redefining standard practices of the builder's excavating and other trade contractors.

Minimize site disruption - A building design that "fits" existing contours will require less earth to be moved. The programs set a minimum percentage of the total lot area that must be left undisturbed.

C/A/P: Using a straight lot percentage makes it disproportionally more difficult for builders with small lots to meet this item. It may be more practical to set a reasonable boundary margin—15 to 20 feet—around the structural footprint as a requirement for minimizing site disruption. The overall feasibility of this item will depend on the ability of the builder and his site super to "make it stick" with all subs, most importantly starting with the land clearing and excavation crews. Builders may want to consider contract language driving home the value of existing site resources to both the builder and the home owner.

Erosion control measures - Erosion control requirements vary widely from jurisdiction to jurisdiction. Control measures include site perimeter silt fencing, mulching of disturbed soil areas, and limits on grade slope ratios. Erosion control measures are most effective when they protect both soil and soil structure.

C/A/P: The most obvious benefit of erosion control goes to the community or surrounding environment and this can make it harder to justify added expense. Site soil resources can, however, be presented as a valuable asset to the homeowner.

Top soil reuse - This item can be an erosion control item but one program treats this as a separate item.

C/A/P: Saving the top soil for reuse can pay back twice—once in eliminating the need for hauling it away and again when new material does not need to be brought in. The feasibility of stockpiling top soil depends on lot size and an understanding with and commitment from the grading contractor.

Building location and orientation - Most programs address this issue within the Energy Efficiency section and further discussion can be found there.

C/A/P: Locating the building with respect for existing wildlife and habitat, and responsiveness to natural features, can greatly enhance intangible benefits at no additional cost. In orienting the building

so as to maximize solar gain/shading and natural light and ventilation, energy costs to heat and/or cool the home can be reduced.

Guide Recommendations

- Include all four-program items as options. Consider requiring one item of choice from this content area.
- Consider giving builders program credit for participation in NAHB & The National Arbor Day Foundations "Building with Trees" training and/or recognition program (see reference below).

Resources:

Building Greener Neighborhoods: Trees as Part of the Plan, American Forests and Home Builder Press of NAHB, 1995, $12. This is a powerful, concise text that clearly outlines what to do, how to do it, and what good lot development saves or adds to the property. Although the focus is on tree preservation, there is a natural extension to other related site development topics: storm water management, placement of infrastructure, passive solar design.

Storm Water Management: Environmentally Sound Approaches, *Environmental Building News*, Vol. 3, No. 5. Sept./Oct., '94. Concise treatment of alternatives to conventional techniques.

Preservation Specifications for New Construction Sites, May, 1996 by Isabelle Green and Associates. This contract document is a good example of exacting contract language by a landscape architect setting the key points for protecting site resources during construction. It may be best suited to commercial construction but the overall concepts presented are relevant for residential construction as well (reprinted as Appendix I with permission).

Tree Protection During Construction, by Owen E. Dell. This two page document is a handy bullet list of specific items to consider in tree protection (reprinted as Appendix I with permission).

Building with Trees – NAHB Workshops: Full-day training sessions offered around the country. Workshops are currently conducted by Charles A. Stewart, a leading consultant on the techniques of saving trees during construction. For more information, contact NAHB or The National Arbor Day Foundation at (402) 474-5655.

Websites:

http://www.ai.org/dnr/soilcons/erosion/index.htm – This site of the Indiana Department of Natural Resources offers information specifically for the home builder regarding causes of erosion and control measures.

http://www.fabriscape.com – This site describes and is a supplier for landscape fabrics for a variety of purposes – slope containment, patio/pavement underliners, groundcovers, and weed control. The products offered by this firm are good examples of erosion control materials available to builders.

Energy Efficiency - General Overview

Because energy use is both the single most important resource-efficiency issue in home building and the broadest in its scope, the topic is broken down into the following four content areas:

1. **Site** - This refers to the way that the building and site features are designed and relate to environmental factors—primarily the sun and wind.

2. **Building Envelope** - Walls, ceilings, windows and doors foundations play a major role in heat loss and gain.

3. **Mechanical systems** - HVAC systems, water heating systems, and related delivery systems (ducting and plumbing) determine home energy consumption.

4. **Appliances and Lighting** - Appliance and lighting options in today's homes are almost limitless but choices have a large impact on home energy consumption.

But before these individual content areas are addressed, it's important that some key aspects of the overall topic be considered. Energy efficiency in homes is a complex topic. The complexity results from a number of key factors, including: variety of end uses, variations in local climate, occupant behavior, fuel sources.

This complexity can make cost-effectiveness determinations of various energy efficiency strategies challenging. On the other hand, in comparison to other elements of green builder programs, energy use is both relatively quantifiable and predictable. Many energy codes, standards, and voluntary programs have established quantitative requirements or measurements of energy efficiency in residential construction. The big question is: What approach or approaches should a local program take toward the topic of energy efficiency as a whole?

To begin answering this question, a brief discussion of both prescriptive and performance based approaches is required as well as an overview of specific existing voluntary energy programs.

Prescriptive and Performance Approaches

Program requirements concerning energy efficiency can be expressed as prescriptive requirements, in which specific technologies are required or credited, or as performance requirements, in which the overall performance of the home is evaluated.

Prescriptive requirements are mandates to use a specific technology or technique. Examples could include requirements to use gas furnaces with AFUE efficiency ratings greater than 80%, or R-40 or greater attic insulation, or to install windows incorporating low-e coatings and argon gas fill.

Performance requirements are expressed in terms of a maximum energy use for space heating, space cooling and or underlying loads, often on a unit area basis, such as 15,000 Btu/sq. ft. per year as a space heating requirement. Performance requirements generally require some form of performance prediction calculation to be performed as part of the program compliance process. Such predictive calculations are generally implemented as computer programs which accept information on the design,

climate, and assumed occupancy patterns of the home, and provide an estimate of energy use in one or more of the basic end use categories. These methods vary greatly in complexity and sophistication.

Performance requirements may also be expressed in terms of an overall energy rating. Home energy rating systems (HERS) have been in use by utilities, state agencies, and others for some years. Home energy rating systems have the potential to provide consistent information on the energy efficiency of homes in all parts of the country. However a national effort to achieve consensus among the major interest groups on a standardized rating system is still in the process.

Existing Voluntary Energy Programs

It is likely that existing voluntary energy-efficiency programs are being used, have been considered by builder members, or are locally available regardless of your location. Programs to consider, which NAHB has officially recognized and approved, include (See the Resources at the end of this energy overview for information on each of these programs):

1. EPA/DoE Energy Star - The Energy Star Home program is a voluntary marketing program in which a builder, through a memorandum of understanding (MOU), commits to building to an energy standard of 30% better than the 1993 Model Energy Code (MEC-93). The program is developing more prescriptive compliance avenues called builder option packages (BOPs) either developed for a specific region (ReBOP) or in a builder/Energy Star ally—utility, or insulation or window manufacturer—partnership (ABOP). Energy Star Allies include utilities and building product manufactures.
2. Edison Electric Institute's E-Seal - E-Seal is a marketing program sponsored by the EEI which certifies that an electric utility home construction program is 10 to 30% better than MEC-92. The program is performance based and includes environmental attributes beyond energy including water, waste, and indoor air quality. The program is fuel neutral.
3. Comfort Home Program – Comfort Home is a program used by a number of utilities to feature cost-effective energy strategies that link savings, energy-efficiency, and comfort. Comfort Home is the longest running energy program that meets NAHB criteria for endorsement. The Comfort Home Program is backed by a comfort and energy consumption warranty.
4. Johns Manville Performance Home - This is a manufacturer's marketing program which features particular insulation products and systems and is built around a user-friendly software package which can be used to meet various energy code standards and the EPA Energy Star standard. The program is entirely energy focused.

NOTE: All of these programs restrict their coverage of energy to the guide content areas 3 and 4—building envelope and HVAC systems. The guide content areas 1 and 5—site and appliances/lighting are not addressed (EPA's Energy Star Program has separate components for appliances and lighting—they are not part of the Energy Star Homes components and the lighting program targets the commercial sector).

There are some clear advantages to the programs described above:

1. **Analysis of various strategies or packages of energy-efficiency features** - Many programs will work with builders to develop packages of energy-efficient features which meet the performance level required by the program.
2. **Recognition and credibility** - Some of the existing energy efficiency programs have significant name recognition with the buying public.
3. **Marketing materials** - If existing marketing materials can be melded to the green builder program, significant economies can be realized.
4. **Field testing cost defrayal** - One of the major expenses involved with any program of this nature is the cost of independent confirmation of compliance. A large part of this cost—between $150 and $300—can be a blower door test and duct blasting test which the energy program recommends or requires. It is possible to work with the existing programs in picking up at least some of the costs of third-party assessment.
5. **Preferential loan rates** - Most of the programs have relationships with major lending institutions for preferential loan rates or other conditions.

Guide Recommendations for Establishing Program Energy Requirements:

1. Require one of two paths for compliance with the energy portion of your green builder program:
    a. Include the energy component of one of the NAHB-endorsed programs described above.
    b. Use the list of recommended items from the energy content areas 3 and 4—building envelope and HVAC systems—to develop a prescriptive path for program energy compliance.
2. Add as optional or requirement some number of additional energy items from content areas 2 and 5—site and appliances/lighting.

<u>Resources:</u>

EPA Energy Star Home Program - Phone: 1-888-STAR-YES.
website: www.epa.gov/appdstar/homes/

The Johns Manville Performance Home Program - Phone: 800.654.3103.
website: www.jm.com

Edison Electric Institute (EEI) E-Seal Program - Phone: (202) 508-5557.
website: *www.eei.org/CSM/e_seal/*

The Comfort Home Program - Phone: (800) 367-7223.
website: *wwwcomforthome.com*

The Good Cents Environmental Home Program - Phone: 1 800 653-3445.
website: www.GoodCents.com

2. Energy Efficiency - Site

Overview/Discussion

Direct sunlight can strongly influence both heating and cooling loads in homes. This effect is a function of how much solar radiation reaches a home and whether it hits the walls, windows, or roof. Other factors include the size and type of glazing on each wall. The amount of solar radiation getting to the home is often described in terms of solar access, shading, and orientation.

Solar access - This refers to the presence or absence of obstructions between direct sunlight and the building. It is most often applied in heating contexts and therefore defined in terms of the absence of obstructions. An example is a requirement that direct sunlight or beam radiation be able to reach the building between 9AM and 3 PM from October 21 to February 21. Such a requirement can in turn be converted to a set of angles of view from the building that must remain unobstructed.

Solar access may refer to simply designing for future use of the sun. The development of much less expensive photo-voltaic (PV) materials may soon make solar access a valuable feature of many homes. Recent government and utility initiatives for PV systems are driving consumer and builder interest.

Shading – Shading can be thought of as the opposite of solar access, and is usually used to include the obstruction of sunlight by site features, trees, and roof overhangs or other building components. Use of the term "shading" often implies the intentional obstruction to reduce cooling loads.

Orientation – This refers to alignment of the building on the site to increase solar gains during the heating season and to reduce gains during the cooling season. In general, this means turning the primary axis of the building or emphasizing the glazing so there is significant glazing on the south (or south +- 30 deg), and little glazing within +- 30 deg of east and west. South glazing is most efficient for passive solar gains in the winter, while its summer heat gain penalty is less than for east and west glass (south glass can also be shaded so that direct radiation in the summer is eliminated). East and west facing glazing generally gains little useful energy in the winter, and suffers large, unwanted gains in the summer.

Review of Local Programs:

Solar Access–Shading, Orientation - One program [WA] includes an elective element calling for orientation to make the "best use" of passive solar. Guidelines in the program manual suggest this means orienting one face of the home due south, designing for up to 8% glass on this exposure, and avoiding winter shading. A second program [TX] includes elective elements addressing orientation and shading of east and west walls. A third program [CO] includes several overlapping elective elements concerning solar inputs, including a long-axis orientation element, a summer shading element, and an element requiring roof design suitable for future solar use. Two programs include overall passive solar performance elements, discussed later under windows.

Cost/Availability/Practicality (C/A/P): The ease with which a builder can incorporate solar access, shading and orientation into a particular project will vary widely depending on existing lot conditions—slope, lot dimensions, existing regulation, features of adjacent lots—as well as other

considerations such as aesthetics and customer preferences. The energy savings, however, associated with these principles is significant, ranging as high as one-third of the total building load. The key is to acknowledge their impact on energy consumption, incorporate the principles into structure placement and design whenever possible and practical, and accommodate their absence with other building features—overhangs, awnings, glazing coatings, interior shades—when conditions prevent their implementation.

NOTE: Developing an energy-efficient relationship among these three factors can be achieved with building features rather than site features—overhangs, awnings, window glazing types, etc. The use of energy-efficient site features should be considered when the site allows and building features used to augment or replace when site conditions are not conducive to energy considerations.

Table 3 – Energy Efficiency (Site) Checklist Summary

Site	**Austin**	**Denver**	**Kitsap**	**Guide Recommendations**
Solar Access		E		E
Shading	E	E		E
Orientation	E	E	E	E

Guide Recommendations

1. Include passive solar elements as elective. Consider requiring one of the following to address passive solar design beyond just site elements:

    a. One of the energy site electives or
    b. One of the window treatments—overhangs, awnings, tinted glazing (lower SHGC)—under energy-building or
    c. Homeowner education materials on the import/importance of interior shade use to regulate solar gain.

2. Develop specific guidelines according to local climate.
    e.g., Heating Climate:

    Solar Access:
    a. predominant glazing facing within 30 degrees of south
    b. south glazing receives maximum winter solar exposure.

    Shading:
    a. if applicable, provide natural summer shading for south and west windows.

    Orientation:
    a. long axis oriented east/west
    b. natural or manmade buffers in direction of prevailing winds.

Resources:

The Passive Solar House – Using Solar Design to Heat & Cool Your Home, James Kachadorian, Chelsea Green Publishing Co., White River Junction, Vermont, 1997. This book provides a comprehensive overview of passive solar design principles. Building siting and orientation, design strategies, heat loss, and solar gain are clearly explained. Methods and worksheets for calculating a building's energy load are provided in addition to insolation and degree data for major cities in the U.S.

Websites:

http://solstice.crest.org/staff/ceg/sunangle/ - Allows one to find solar angles for all latitudes and longitudes at any time of day through the year. This tool can be very useful to the architect, builder, or home owner in locating and sizing overhangs.

http://www.its-canada.com/reed/index.htm – The Residential Energy Efficient Database (REED) is a Canadian site that provides useful information regarding many aspects of energy efficient home design and construction. Specific topics addressed include: siting, building layout and design of a simplified method for calculating the approximate heat load of the home, and guidelines for HVAC system design and sizing. Since this is a Canadian sponsored site, there is no information regarding design considerations for cooling climates or AC systems.

3. Energy Efficiency - Building Envelope

Overview/Discussion

Improving the energy efficiency of the building envelope can be approached in several inter-related ways:

1. Design of the building itself
2. Choice of materials
3. Care and method of installation

NOTE: While the quality of installation or workmanship can be as important to energy efficiency as design and materials, it is more difficult to address in a program such as a green builder program. While none of the local programs reviewed for this guide directly address the issue of workmanship in their checklists, it is an issue that many address in training programs for green builders. Some suggestions for incorporating the workmanship issue into programs are made in the recommendations for this content area.

Primarily, the programs reviewed address building envelope efficiency from the following perspectives:

- Passive solar design
- Insulation and insulating systems
- Air leakage

All of the above elements are inter-related in that most design details, materials and installation methods can affect more than one aspect of building performance simultaneously. For instance, an insulating material may retard both heat flow and moisture or water vapor penetration. However, in order to clarify the discussion, characteristics affecting the energy efficiency of the building envelope will be covered separately.

Passive Solar Design

Designing a home to optimize solar gain can significantly reduce mechanical heating and cooling requirements in most climates. Even the cloudiest and coldest regions can incorporate many of the items listed below (Passive solar design incorporates features of the building site–see the previous content area for a more in–depth discussion of site issues). Typically, the components of a passive system are an integral part of the building itself. In very general terms, passive solar design relies upon the following components:

1. Glazing – to maximize/minimize solar gain.
2. Masonry or water – for storage of thermal radiation.
3. Fans/pumps/natural convection – for delivery of warm (cool) air.
4. Overhangs/awnings – for shading.

Individual elements of passive solar design can be employed without necessarily moving to a full-blown passive solar design. Green builders can use the principles and techniques as site, design, and customer requirements allow.

Insulation

In general, the higher the total R-value of a floor, wall or roof assembly, the better the heating and cooling performance. Total R-value refers to the insulating value of all the layers of materials, including insulation, masonry, sheathing, siding, etc., and the effects of solid structural members on overall performance. Proper installation is critical to the performance of all insulation systems. A gap between any insulating material and adjacent surfaces will reduce the overall performance of any system. The appropriate type and level of insulation can vary from building system to building system and climate to climate.

Foundation: Typical R-values for foundation insulation range from 4 to 13. Energy savings for foundation wall insulation decrease as the depth below grade increases. For this reason, the added energy savings achieved by placing insulation in full-backfill basements from, say 4 ft below grade down to the footings, may not be financially justified. However, full height insulation of slightly lower R-value on the interior will outperform half-height exterior insulation. Depending upon plans to finish basement space, insulation suitable for interior use is less expensive than extruded rigid foam and can be a sensible choice.

Some codes require crawl spaces to be vented to the outdoors. Building researchers are increasingly taking the position that it makes sense, from a moisture control and thermal performance point of view, to treat crawl spaces as conditioned space. In this case, crawl space walls would be insulated as are basement walls and no insulation would be used in the joists between basement and first floor.

Walls: Wall R-values typically range from R-11 to about R-23. Increasing the R-value by, say 15%, can often be done using some combination of foam sheathing, higher density insulation between studs, and reduced framing. The thermal performance of walls is more important in northern climates, where heating needs are driven by the typically more severe difference between indoor and outdoor temperatures. In hot climates, the temperature difference is a lesser factor, and solar radiation, internal heat production, and moisture production are relatively more important.

Ceilings: As with above grade walls, the energy efficiency of a ceiling is a function of insulating R-value, air leakage, and material characteristics in absorbing, transmitting, and emitting solar radiation. Air leakage and radiant barriers will be discussed later in this section. R-values for ceiling insulation where an attic is present and there is no space limitation typically range from R-19 to R-50. In vaulted ceilings, where space is limited by framing member depth and often by requirements for ventilation, R-values may range from 19 to about 30.

Air Leakage

Air leakage through the exterior envelope and air flows within building cavities can be a significant source of energy loss. As much as 30-40% of a building's energy load can be attributed to infiltration in some climates. Infiltration occurs at gaps and joints between insulation and framing materials,

penetrations within the structural envelope itself such as holes drilled for plumbing and wiring, and at cracks around doors and windows. In addition, infiltration affects indoor humidity levels and thus, comfort.

Typical well-built new housing in the U.S. will have natural air change rates between .3 and .5 air changes per hour (ACH natural).[4] An air change of around .3-.4 natural is approximately the rate at which most codes require mechanical ventilation. This is discussed further in the section on Indoor Air Quality.

Radiant Barriers

Radiation is the direct transfer of heat from an object at a higher temperature to one at a lower temperature. A material's ability to radiate heat (long wave radiation) depends upon its color as well as its temperature. Although all materials will absorb and radiate heat to some degree, in general, a good radiant barrier will reflect more heat energy than it absorbs. Foil-face objects are good examples. Radiant barriers are more effective in cooling situations due to typically higher temperatures and lower convection currents in attic spaces during the summer.

Moisture Penetration

Generally, moisture can enter the building envelope in two ways:

- Condensation of water vapor when air moving through a cavity reaches its dew point.
- Wind-driven rain that enters the cavity in liquid form.

Excessive moisture penetration is relevant to green building issues primarily for two reasons:

- Performance and effectiveness of insulation is compromised.
- Degradation of building materials is a durability issue.

Construction details that can help prevent moisture problems include:

- Flashing details at doors, windows, chimneys, and roof/wall junctures.
- Sealing details at doors, windows, plumbing and electrical penetrations.
- Appropriate use of vapor barriers.
- Attic, cathedral ceiling, and crawl space ventilation.

It should be assumed that moisture intrusion will occur at some point under certain conditions during the life of a building. At some time, the combination of high humidity levels and sufficient temperature difference may result in condensation developing within the wall or roof cavity. Despite careful flashing and sealing details, it is likely that wind-driven rain will find its way behind exterior

[4] Measurements of a building's degree of air tightness are reported in two different ways. In addition to natural air change per hour, measurements are also given at a pressure of 50 Pascals. 50 Pascals is the standard pressure at which blower door test results are reported. Given the variation in outdoor conditions, this standardizes measurements for purposes of comparison of different buildings. The number of air changes at 50 Pascals can be roughly converted to natural air change rates by dividing by 17-20.

siding under certain weather conditions. Therefore, in addition to careful sealing and appropriate use of vapor barriers, attention should also be given to drying potential and drainage pathways.

Review of the Programs

Passive solar:

Glazing Placement – In general, windows oriented toward the south can gather useful energy in the winter, and see only high-angle sunlight that can be effectively shaded out in the summer. East and west facing glass will see some solar gain year round. Due to the sun's lower position in the sky, these gains will not be as substantial as that from glazing on the south. However, in climates with significant cooling loads, windows on east and west walls require shading to prevent unwanted heat gain. In all cases, north facing glass is a net energy loser. It should be noted, however, that large gains made in window performance have reduced the energy penalty for glazed openings vs. solid walls.

Skylights, if not carefully oriented, can add significantly to the cooling loads in homes, and must generally be considered as providing an energy penalty. Light tubes are small skylights in the form of tubes with reflective interior surfaces. They are generally designed to be installed between framing 16 or 24" on center, and to extend from roof to ceiling; hence they require no structural modification and no separately framed well or shaft. Light tubes may reduce unwanted summer heat gain and winter heat loss when compared to conventional skylights of similar lighting performance. There is some evidence supporting the lighting energy saved with light tubes but no research has been conducted that includes heat loss/gain as well as lighting savings.

Cost/Availability/Practicality (C/A/P): Not all sites will allow for ideal placement of glazing with respect to energy efficiency. Daylighting, ventilation, views, and aesthetics are all considerations that must be balanced with concerns for heat loss and gain. Light tubes retail from $200 to $400, depending on the tube diameter and other features.

Glazing sizing – Various rules of thumb have been put forth regarding appropriate amounts of glazing so that a building will maximize solar gains without overheating. Some such figures are:

- South glass: 6-8% of the floor area
- East and north glass: 4% combined of the floor area
- West glass: 2% of the floor area

These figures are a rough starting point. Glazing for a heavily passive solar home can be increased when thermal mass is added. Other considerations such as shading devices are also factors that affect optimal amounts of glass for energy performance.

C/A/P: A number of references listed at the end of this section provide information regarding ratios of glass-to-mass. Calculations regarding amounts of energy transmitted and stored and subsequent release to the living space over time can get complicated. Accurate sizing will usually require the services of a design professional.

Glazing type - A number of high performance or "super" windows have become available in the past few years. The technical approaches to improving window performance include:

- low-e coatings on glass
- argon or other gas used between panes
- tinted glass
- lower conductance edge spacers between panes
- lower conductance frames
- more airtight construction

The relative performance of windows is summarized in the U-value and Solar Heat Gain Coefficient (SHGC) factors provided under National Fenestration Rating Council (NFRC) certification. Both values refer to whole window performance taking the effects of frame and sash into account as well as the glazing itself. The U-value is the reciprocal of R-value and refers to the insulating capacity of the window. Typical whole-window U-values range from about .33 for a wood or vinyl-framed double paned low-e window to about 1 for a single pane window with a thermally broken aluminum frame. The Solar Heat Gain Coefficient is a rating of solar heat transmission through the entire window.[5] SHGC values range from about .3 for a low-e argon-filled vinyl frame window to .66 for a single-paned window with similar frame.

Unless different types of glazing are used according to the particular orientation, glazing choice is a compromise. The desire and opportunity for solar gain during the winter need to be balanced against the need to block some solar radiation to prevent overheating. Although it is relatively common for manufacturers to produce a line of window units offering different glazing options for a given model, one of the main deterrents to such practice is the added effort required to ensure that the different windows are installed in the proper locations.

C/A/P: High performance windows do carry a cost premium as compared to single or double-paned units. However, except in very temperate climates, they reduce energy requirements and help to increase comfort. More energy efficient windows and doors will also permit heating and cooling systems to be down-sized. Payback periods will vary depending on the climate.

Overhangs, shading – Providing correctly sized overhangs, awnings, or shades for south, east, and west glazing will reduce unwanted heat gains during cooling seasons. In regions where air conditioning is installed, shading of west windows is always advisable. In hot climates where cooling is a significant concern for longer periods, shading of east and south glazing may be warranted as well. The higher incident angle of the sun from June to September is not enough to naturally prevent unwanted solar gain through south-facing glass during the spring and fall. The references listed at the end of this section give information about sizing such overhangs.

C/A/P: As with many features of site-sensitive building design, overhangs and shading devices often serve aesthetic as well as practical purposes. In addition to providing protection from the elements, they can be an integral part of the architectural style as well. Designing exterior overhangs that will totally shade east and west windows is difficult. In hotter climates, some sort of interior shading device may be needed as well.

[5] A Shading Coefficient (SC) is the former value used to quantify the solar energy transmission of glazing. It is approximately equal to the SHGC multiplied by 1.15.

Buffer spaces – Unconditioned spaces on the north or west sides of a building reduce the amount of wall area directly exposed to ambient conditions. Examples of such spaces are entryways, garages, storage areas, or closets. While enclosed buffer spaces are most effective in heating climates, open sheltered spaces—carports, outside hallways—are effective shading in cooling climates.

C/A/P: Strategically locating unconditioned areas may not always be possible depending upon other design considerations and site characteristics. However, it should be kept in mind during the design phase since it does not increase costs.

Table 4 – Energy Efficiency (Building Envelope) Checklist Summary

Envelope	Austin	Denver	Kitsap	New Mexico	Guide Recommendations
Passive solar (building elements)					
Glazing on South or E/W	E	E			E
Skylights prohibited	E				
Window min performance standard, (e.g. U-.33 NFRC)	E	E	E	E	E
Windows minimum construction standard (e.g. 2-glass, ½" space, or wood/vinyl frame)	E	E			E
Overhangs/Shading	E		E	E	E
Buffer spaces on west exposure	E				E
Earth sheltered design	E				
Insulation					
Insulate foundation/slab to min. level		E		E	
Walls – improved R-value		E	E	E	E
"Full-fill" insulation or spray foam	E	E			
Integral insulation, e.g. foam core panels	E				E
Ceiling insulation minimum			E	E	E
Blown ceiling insulation	E				
Raised heel trusses	E	E			E
AirSealing					
Prescriptive air sealing		E	E		E
House wrap		E			E
Blower door test minimum	E	E			E
Limitation on recessed lighting in thermal boundary		E			E
Other					
Ceiling radiant barrier	E				E

Earth-sheltered designs – Earth bermed or earth covered buildings take advantage of the more constant annual temperatures below grade. This type of design is particularly well suited to a sloping site. There is, of course, potential for confusion regarding what exactly should count as “earth-bermed”. If offering this element as an elective, a program may want to specify that a minimum amount of the

building envelope be earth-sheltered – for instance, 50% of exterior walls or roof enclosing living space.

C/A/P: Earth sheltered designs are not well suited to areas with high water tables or extensive underground springs.

Insulation:

Insulate foundation to minimum level – Common approaches to insulation include:

- Exterior foam (usually extruded polystyrene) sheathing,
- Interior fiberglass, hung from framing and/or pinned to wall, with vinyl or foil protective facing,
- Interior fiberglass, placed between studs

C/A/P: The cost of foundation wall insulation (rigid used on exterior) is high and it is most cost effective where colder winters prevail and exposed, high-conductance (cast concrete) foundations are used. Typically, existing energy code requirements call for some level of insulation below grade. Perimeter or edge insulation is the most effective energy savings strategy for concrete slab-on-grade foundations. Cases of termites gaining access to buildings by tunneling through or behind exterior foam insulation have been reported and exterior foam insulation should be used with caution in termite-prone areas. Installation of exterior foundation insulation requires special detailing at the sill or bottom plate and may require adjustment of foundation wall dimensions.

Wall sheathing minimum R-value – Insulation placed on the exterior of a building in addition to cavity insulation can provide additional benefits as an air barrier and, with closed-cell foam, a moisture barrier if seams are taped. One should consider the local climate and the characteristics of the entire wall regarding moisture entrapment when deciding to use extruded foam on the exterior.

C/A/P: The optimal level of wall insulation from a combined cost/energy savings perspective is climate-specific and can be calculated with a wide variety of energy-efficiency resources.

"Full-fill" insulation or spray foam – As a strictly stand-alone material**,** spray foam insulation systems afford better thermal performance than more conventional insulation for several reasons:

1. Higher R-value per inch.
2. Complete cavity fill.
3. Better performance as an air barrier.
4. Reduced possibility for degradation caused by rodents.

However, testing has not indicated significant increase in overall building performance attributable to different insulating systems alone.

C/A/P: Typically, the cost of sprayed foam is higher than conventional insulation materials and requires installation by a specialty contractor.

Integral Insulation – A variety of foam core panel systems are available for above and below-grade walls as well as roofs. The combined structural and thermal systems manufactured in a controlled environment can be advantageous in certain applications. However, equivalent performance of conventional site-built systems can be achieved with careful detailing and installation.

C/A/P: Integral systems are available in most areas of the country. Costs will vary depending upon the particular system chosen and proximity to the building site. Some panelized systems require installation by a crane or lull but do reduce overall framing labor needs.

Ceiling insulation minimum – Because warm air rises, the potential for heat loss or gain through a ceiling or roof is greater than that through the foundation, floor, or walls. Depending upon existing energy code requirements and climate, offering credit for increased ceiling insulation may be warranted.

C/A/P: Although installing additional attic insulation is a fairly easy thing to do, there comes a point where simply increasing R-value is no longer cost-effective. This point will vary depending upon climate.

Blown ceiling insulation – Advantages of blown insulation over fiberglass batts have not been supported by research.

C/A/P: Blown cellulose or fiberglass is available in all parts of the country as is the equipment for installation. In attic installations, the cost and ease of installation is about the same as for batts.

Raised heel trusses – Raised heel trusses do allow for more insulation at the eave and therefore, improve thermal performance at a typically difficult spot to properly insulate.

C/A/P: There is no significant cost increase in raised heel trusses themselves. Higher labor costs may be involved in increased siding and boxing out soffits.

Air Leakage:

Prescriptive air sealing – Windows and doors are typically the first areas that come to mind when people consider air tightening. Proper installation, caulking flanges, and sealing spaces between framing and jambs significantly reduces air infiltration as well as the possibility of moisture penetration. However, significant air leakage also occurs at plumbing, electrical, duct penetrations and joints between wall, floor, and roof assemblies. Careful caulking in these areas will reduce unwanted air flows and infiltration. A carefully installed polyethylene air-vapor barrier that is continuous between floors and caulked at seams and penetrations is appropriate in cold climates. In hot, humid climates, plastic air-vapor barriers and attention to sealing details should be performed on the exterior for moisture reasons.

C/A/P: Framing and insulation crews will require some training in air tightness detailing to achieve higher levels of performance. Insulation companies often offer an “air sealing package”. The cost of air sealing to a moderate level of about .3 ACH natural is in the range of $250 to $500.

House Wrap – Tyvek and similar materials installed as air barriers over the exterior sheathing have become almost an industry standard. A building paper lapped shingle style with seams taped will help reduce air penetration at framing junctures whether it be a house wrap or 15# felt paper. Either material correctly installed will reduce infiltration and provide another layer of protection against moisture intrusion.

C/A/P: Both house wrap and felt paper are readily available materials. House wraps cost approximately three times more per square foot than 15# felt. The 9' widths of house wrap can be an advantage in installation.

Blower door testing – To test a building's air tightness, a variable speed calibrated fan unit is temporarily installed into an exterior door and used to pressurize or depressurize the house. Such tests can be useful in providing comparative information about air tightness since it is difficult to know intuitively how well sealing methods have actually worked. Blower door tests do not, however, directly determine natural leakage rates.

C/A/P: Blower door tests can range in cost from $150 to $250. Availability of a contractor or agency with the appropriate equipment and expertise will depend upon locality. Often, county weatherization agencies will perform such testing at a reasonable cost.

Limitation on recessed lighting in thermal boundary – Recessed lighting located in the building envelope can result in large amounts of heat loss. However, IC rated sealed units have no openings in the housing and enable one to install insulation in direct contact with the units. If the insulation installed around and above the housing is equivalent to the rest of the attic, the energy penalty normally associated with recessed lights is avoided. Soffits can also be built so that recessed housings do not penetrate the exterior envelope. It is not advisable to install recessed lights in cathedral ceilings in any climate.

C/A/P: IC rated sealed housings are equivalent to those not rated for insulation contact. Soffits may be objectionable for aesthetic reasons in some cases and will add slightly to framing and drywalling costs.

Radiant barriers:

Ceiling radiant barriers – Testing has shown that radiant barriers are more effective in reducing cooling loads than in reducing heating loads. Used primarily in rooter ceiling assemblies, the radiant barrier should be placed as close as possible to the roof surface. Steel or metal roofing materials act as radiant barriers themselves. Under heating conditions, a radiant barrier should be placed just above the ceiling finish material and below the insulation. Radiant barriers placed on top of the attic insulation can cause condensation and frost to develop when outdoor temperatures fall much below 10 F.

C/A/P: In hot climates with significant cooling loads, ceiling or roof radiant barriers are a cost-effective approach. In cold climates, additional insulation is likely to be more effective than installation of a ceiling radiant barrier. In cold or moderate climates with fairly cold winter temperatures, trying to obtain both heating and cooling benefits by placing radiant barriers on top of attic insulation is not recommended.

Guide Recommendations

Offering a set of prescriptive measures with regard to building envelope efficiency is difficult for several reasons:

1. Effective passive solar strategies are based upon the building working as a system rather than a number of isolated, arbitrary measures.

2. Building design is closely tied to the specific climate and the particular site. It is not advisable to penalize builders for what they do not or cannot do, but rather offer credit for optimizing under existing conditions and constraints.

A Green Building program should allow the builder and home owner sufficient flexibility to choose those aspects of envelope design that best suit their needs and specific situation. A program can approach this in one of two ways:

1. Offer credit for compliance with an energy program such as EPA's Energy Star Program

OR

2. Offer credit for achieving various levels of energy performance over and above what is conventionally required by existing energy or building codes. For example, levels of improvement might be set at 10%, 20%, and 30%.

In any area, there may be certain measures that are considered important enough to pull out as stand alone items. For example, window shading may be one such element for areas with high cooling loads; added thermal protection may be appropriate in predominantly heating climates. Although it is recommended that most such measures be elective items, programs will need to make decisions regarding such issues on an individual basis.

3. Spray foam insulation is not recommended as an individual program element because there is insufficient evidence supporting the environmental or energy superiority of this one insulation system.

4. Give credit for participation in certified installation programs. There are a growing number of certified building product/system installation programs. Industries such as siding, windows, HVAC, and insulation have been developing certification programs as the most effective way to encourage and establish standards of quality workmanship.

5. Give credit for builder training on quality and specific installation methods. Total quality management (TQM) training and quality award programs are a recognized and important part of the residential building industry. Many HBAs, with no connection to green building, hold regular training sessions on all aspects of construction workmanship. Because of the impact that quality workmanship can have on building performance, green builder programs can and should give credit for builder efforts in this area.

As an example, the Greater Atlanta HBA is establishing a relationship between their newly developed green builder program and their existing Certified Professional Home Builder Program (CPHB). Required training for the CPHB will be given credit under the green builder program. In this way,

builder efforts towards workmanship and building performance are formally recognized in their green builder program.

Resources:

The Energy Source Directory, Iris Communications. Lists over 500 products that help improve a home's energy efficiency from insulation and air barriers to heating and cooling equipment.

The Passive Solar House – Using Solar Design to Heat & Cool Your Home, James Kachadorian, Chelsea Green Publishing Co., White River Junction, Vermont, 1997. This book provides a comprehensive overview of passive solar design principles. Building siting and orientation, design strategies, heat loss, and solar gain are clearly explained. Methods and worksheets for calculating a building's energy load are provided in addition to insolation and degree data for major cities in the U. S.

Residential Windows, John Carmody, Stephen Selkowitz, Lisa Heschong, W.W. Norton & Company, New York, 1996. Since windows are the largest source of heat loss or gain in a home, this book completely dedicated to the topic may be of interest to builders and home owners alike. Energy performance of different glazings, the effect of frame materials, design issues, daylighting, ventilation, and shading are covered and will prove helpful to those making decisions about "which window?" and "where?".

The Builders' Field Guides, Energy Efficient Building Association. Four guides for cold, mixed, hot-dry, and mixed-dry climates are available. Sensible design and construction principles for each climate are discussed and methods are illustrated with construction details.

Websites:

http://solstice.crest.org/staff/ceg/sunangle/ - Allows one to find solar angles for all latitudes and longitudes at any time of day. This tool can be very useful to the architect, builder, or home owner in locating and sizing overhangs.

http://www.efficientwindows.org – With an increasing number of choices in glazing and frame type, this site sponsored by the Alliance to Save Energy provides helpful information for selecting windows for different climate conditions and orientation.

http://www.fsec.ucf.edu – The Florida Solar Energy Center has done extensive research and testing regarding a range of issues pertaining to energy efficiency in buildings. Some of the topics covered are: comparisons of different building systems, retrofits to improve energy efficiency, light-colored roofing, and photovoltaics. In addition, the site also offers directories of sources for building products to improve energy efficiency.

http://www.buildingscience.com/ – This site of the Building Science Corporation offers useful information regarding problems frequently found in buildings and how to avoid them. Moisture control in buildings is emphasized.

http://www.its-canada.com/reed/index.htm – The Residential Energy Efficient Database is a Canadian site that provides extremely useful information regarding many aspects of energy efficient home design and construction. Specific topics addressed include: siting the building to take full advantage of natural features to help reduce energy loads, building layout and design with several house plans of varied size and style, a simplified method for calculating the approximate heat load of the home, and guidelines for HVAC system design and sizing. Since this is a Canadian sponsored site, there is no information regarding design considerations for cooling climates or AC systems.

4. Energy Efficiency – HVAC and Plumbing Equipment

Overview/Discussion

In most climates, energy use for space heating and cooling and water heating will comprise over half of a home's energy consumption. In cold climates, heating alone can account for as much as 2/3 of the total energy bills. After careful siting, design, and construction detailing with respect to the building envelope, improvements to the heating/cooling system are the next place to look for energy and cost savings.

There are any number of ways (and combinations) to meet the space conditioning and water heating needs of homes. As with siting and design of the home itself, there is no one system that is best in all situations. In fact, under any given set of conditions, there is often more than one way to solve the HVAC puzzle efficiently.

Best practices regarding a home's mechanical systems will revolve around a number of factors:

- Balance of heating and cooling requirements.
- Availability and cost of fuels/energy.
- Personal preference and lifestyle of the home owner.

For instance, in moderate climates where requirements for cooling dominate and temperatures do not fall much below 40 F during most of the winter, a heat pump may make the most sense. Where heating loads are predominant, a gas or oil fired furnace or boiler may be the best choice. Where natural gas is available and relatively inexpensive, a condensing gas furnace has the highest efficiency available. However, a zoned hydronic system with an efficient oil- or gas-fired boiler may be an equally good choice in that multiple zones allow for adjusting the temperature of different areas of the home to different uses. And, some home owners prefer hot water heat to "draftier" forced air. If heat is called for during significant portions of the year, one system that heats both the living space and the domestic water may be preferred.

The efficiency of all systems depends on regular maintenance. This topic will be discussed in Section 14 – Home Owner Opportunities.

Space Heating/Cooling:

90%+ AFUE – Annual Fuel Utilization Efficiency (AFUE) is a measure of overall furnace or boiler efficiency taking standby losses as well as combustion efficiency into account. Federal standards require a minimum AFUE of 78% for forced-air furnaces. With improved burners and heat exchangers, conventional furnaces have AFUE ratings of 80-85% and boilers are slightly higher – 82-87%. By reclaiming a substantial portion of the heat in the exhaust gases, high efficiency or condensing furnaces operate at efficiencies between 90% and 95%. Water vapor in the combustion products is cooled to the point of condensation and the lower temperature gases can be exhausted via a through-the-wall PVC pipe. Heating energy use and costs can be considered proportional to AFUE, and an upgrade from 80% to 94% AFUE will reduce heating costs by about 14%.

Review of the Programs:

Table 5 – Energy Efficiency (HVAC/Plumbing) Checklist Summary

Heating/Cooling Systems	Austin	Denver	Kitsap	New Mexico	Guide Recommendations
Space Heating/Cooling					
90%+ AFUE furnace	E	E			E
Radiant floor heating				E	
Air conditioner min SEER	R			R	E
Geothermal system	E				E
Evaporative cooler				E	E
Active solar space heating		E			
High efficiency, sealed combustion gas/wood fireplace w/outside air		E		E	E
HVAC sizing method, component matching	R				E
Duct design, insulation, sealing	E	E	E	E	E
Provide air returns in bedrooms		E			E
Duct pressure test	E				E
Programmable thermostat	E	E			E
Whole house fan	E	E			E
Ceiling fans or rough-in	R	E		R	
Domestic Hot Water					
Water heater fuel		E			
Water heater efficiency	E	E		R	E
Sealed combustion DHW	E		E		E
Insulate DHW tank or pipes		E			E
Water heater placement relative to loads		E			E
Install active solar DHW	E	E			E
Hot water demand recirculation		E			E
DHW heat recovery	E				E
Combined DHW/space heating	E				E

Cost/Availability/Practicality (C/A/P): Higher efficiency gas furnaces are available in all parts of the nation, at a cost of several hundred dollars above standard units. Condensing gas furnaces cost approximately $500 more than those that meet minimum federal requirements. There are fewer options for high efficiency boilers, but several are available. Recently, high efficiency oil-fired condensing furnaces are being manufactured again after early problems with controls and clogging of flue passages. The plastic venting systems used with condensing heating appliances can exit the home through the roof or through a side wall increasing savings by eliminating a chimney. However, there are restrictions regarding proximity to door and window openings. In other respects, the installation of high efficiency heating units is similar to that of conventional units.

NOTE: Sealed combustion furnaces and boilers offer the advantages of both higher efficiency and reduced potential for backdrafting. The controlled steady supply of outdoor air to the burner increases performance and eliminates the need for a damper.

Radiant Floor Heating – Radiant floor heating systems (as opposed to electric radiant ceiling panels) can be an efficient as well as comfortable method of space heating. In a radiant system, water-filled plastic tubing is run within a concrete slab or insulated wood floor. Typically, the water is heated with a gas- or oil-fired boiler and can be combined with the domestic water heating system. Electric resistance elements for heating the water would not be economical or energy efficient unless installed within a concrete slab having greater thermal mass and on a night-rate or low demand timer. Radiant floor heating offers the same possibility for zoning as baseboard hydronic heating.

C/A/P: Design information and materials for radiant floor heating systems are readily available. Radiant slab systems pose the obvious problems for repair. However, the major potential for damage to the tubing is during construction. Costs are similar to conventional hydronic systems.

Minimum SEER – Central air conditioning system efficiencies are referred to as SEER ratings or Seasonal Energy Efficiency Ratio. This is the ratio of seasonal energy output to energy input (Room air conditioner efficiencies do not factor in performance over the whole cooling season but rather refer only to the ratio of cooling output to power input). Federal standards establish a minimum air conditioner efficiency or SEER rating of 10. Efficiency upgrades are available up to about 15 -18 SEER. Efficiency upgrades should produce roughly proportional decreases in energy use and cost. The programs that offer credit for increased equipment efficiencies reference SEER values of 12 to 14.

C/A/P: Air conditioners with efficiencies between SEER 11 and 14 are available in most parts of the country. The cost premium is about $500-$600. Units with SEERs of 15-18 have dual compressors and more elaborate controls increasing their costs by several thousand dollars. These models are not in high demand and therefore, are not readily available.

Fireplaces – Fuel burning fireplaces should be chosen with care for installation in new homes that are tightly constructed. Many home buyers desire a wood or gas burning fireplace for the aesthetic appeal and cozy feeling that a fire provides. The problem is that this cozy feeling is not necessarily born out by the actual heat delivered to the living space; and, the aesthetics of a burning fire may compromise indoor as well as outdoor air quality. The latter issue is discussed in Section 8 - Indoor Air Quality.

Traditional open hearth fireplaces are net energy losers and one program prohibits their installation entirely. When not in use, the chimney serves as an easy escape for household air – even with dampers closed. During use, this exit of warm interior air can be as high as 1.4 Air Changes/Hour due to the excess air required to feed the fire and maintain the draw.

Enclosed fireplaces are better performers with rated efficiencies from 60%-80%. However, a test of 50 Canadian homes showed that actual efficiencies ranged widely between 10% and 70%.

Several features contribute to better performance:

1. *Secondary combustion*: Catalytic converters or design for secondary combustion will insure more complete burning of the fuel. Less heat is lost up the chimney and fewer particulates are emitted.

2. *Sealed combustion*: Controlled supply air from the outdoors provides better assurance that the amount of air required for combustion is available without drawing from the interior of the house. However, under some outdoor conditions, eddying and depressurization at the outside wall can cause these inlet ports to become exhaust flues.

3. *Tight-fitting glass doors*: The use of tight fitting doors is critical in reducing undesired excess air flow through fireplaces that in turn will decrease efficiencies and increase potential indoor air quality problems. There are apparently no standards for tight-fitting doors so their quality and effectiveness at controlling air flow must be evaluated on an individual basis. Ceramic glass doors are better at radiating heat to the living space than those tempered glass.

4. *Thermal mass*: many of the fireplaces on the market are installed in chases on the exterior wall. This results in greater heat loss to the outside as well as reduction in the benefits of radiant heat transfer to interior objects. Masonry heaters, Russian fireplaces, Rumsford fireplaces, and some woodstoves offer the advantages of larger amounts of thermal mass for heat storage and/or location within the living space.

C/A/P: There are a wide variety of high-efficiency fireplaces on the market with a fairly broad price range as well. Careful research is warranted given the many options, manufacturers' claims, and lack of third-party efficiency ratings for wood burning units.

Geothermal Heat Pumps – Geothermal heat pumps, (also called ground source heat pumps), are heat pumps that use the thermal mass of the earth as a source of useful heat in the winter and as a sink for waste heat in the summer. Because geothermal units rely on relatively constant ground temperatures of 45-50 F, they provide greater heating and cooling capacity during periods of extreme temperature, and generally should require less supplemental electric resistance heating during cold winter conditions as compared to air-source heat pumps. The performance of geothermal systems can easily exceed that of conventional, air-source heat pumps, with Coefficient of Performance (COP) typically in the range of 3.5 to 4.5. These values translate to equivalent SEER ratings of 12 to 15.

C/A/P: Barriers to the use of geothermal systems are first cost and the land required for ground loops. Geothermal installations may cost several thousand dollars more than conventional HVAC systems, although some builders report lower marginal costs. Geothermal systems require a ground loop, placed in horizontal trenches or vertical bores, or a source of ground water. Careful planning is required to place ground loops, especially for installations where lots are small. Professional design is important for assured performance. A significant number of electric utilities, as members of the Geothermal Heat Pump Consortium, are promoting these systems and using financial incentives to attract builders and home buyers.

Evaporative Cooling – Evaporative cooling refers to the cooling effect produced when water is allowed to evaporate into air. The result is air that is both lower in temperature and higher in humidity than before the evaporative process. The process reduces energy consumption because it eliminates the use of a compressor driven refrigeration cycle.

C/A/P: Evaporative cooling is a viable method only in very dry areas, i.e. the desert southwest, and equipment is generally available in that part of the country. Note that evaporative coolers consume water, which may be a valuable resource in the very areas where they are most suited. Installation practices are similar as compared to conventional air conditioning systems.

Active Solar Space Heating – Active solar space heating refers to the use of solar collectors independent of the structure of the home to gather heat for space heating. Generally, single glazed flat plate collectors with a black selective coating collect heat via an air or water-glycol medium. The heated air or liquid is then transferred directly to the living space or to a storage area via a fan or pump. Usually, distribution to the home consists of a forced air system since hydronic baseboards or radiators require temperatures of approx. 180 F, which are beyond the practical capability of active solar systems.

C/A/P: Active solar space heating is relatively complex and very expensive to install. It is not likely to be implemented in any significant number of homes without large financial incentives. President Clinton's Million Solar Roofs initiative will lend support to the development of affordable solar technologies for space and water heating as well as electrical needs. At this time, incentives developed at the state level primarily target larger commercial and institutional buildings and utility power generation. It may take some time before potential advantages become available to the individual homeowner.

HVAC Equipment Sizing and Matching – HVAC equipment is typically selected based on an estimated maximum heating or cooling load. While undersizing can lead to comfort problems, oversizing can lead to poor energy efficiency as well as comfort problems. Oversized equipment will tend to cycle on and off more frequently, and thus, operating time is greater in lower efficiency conditions early in each cycle. This is true in particular for refrigeration cycle equipment, including heat pumps and conventional air conditioners. In cooling, less dehumidification occurs early in each cycle, so frequent cycling leads to less dehumidification at a given temperature, which can be a source of poor comfort. Oversizing and increased cycling of combustion equipment, while not representing as significant comfort and efficiency implications as is the case for cooling systems, does result in wear and tear on system components.

The standard method for determining the size of heating and air conditioning equipment is the Air Conditioning Contractors Association Manual J. Research indicates that carefully executed Manual J sizing can be considered adequate for determining system sizing.

C/A/P: The primary barrier to proper sizing of HVAC equipment is the resistance of builders and/or HVAC contractors. This resistance may often be based on the desire to reduce the possibility of callbacks due to undersizing and inadequate heating or cooling output. Some HVAC subcontractors claim that they are not informed of design changes made during construction that affect heating and cooling loads, and typically oversize because of this.

Duct Design and Location – Ducts placed in unconditioned areas including attics, crawl spaces, and garages, have been shown to significantly degrade HVAC system performance. The performance loss is due to two factors; air leakage, and conductive losses. Losses of 20 to 25% of space conditioning energy are common for duct systems completely outside the thermal envelope. The best way to address these potential losses, from an energy perspective, is to place all ducting inside the thermal envelope, so air leakage and conductive losses are going primarily to the conditioned space. If this is not practical, conductive losses can be mitigated by insulating and air-sealing ducts. The use of flexible ductwork should be minimized for reasons of performance. Flex duct can have pressure losses five times greater than metal ductwork.

Even when located within the conditioned envelope, leaky ductwork will compromise equipment performance as well as the efficiency of delivery of conditioned air. It can result in the depressurization of basements which can cause backdrafting of the furnace exhaust gases. Air leakage can be reduced by sealing ductwork with water-based mastics designed for this application. The air tightness of duct work can be tested after installation, using calibrated fans and testing procedures similar to blower door methods used for testing whole building air tightness.

Other aspects of ductwork design that help to improve system efficiency include minimizing elbows and sharp turns, installation of turning vanes and scoops, installation of dampers at each take-off, and proper sizing of registers.

C/A/P: The cost of sealing ducts is approximately one man-day and $50 of mastic. The best payback is achieved in the areas of highest air leakage – for instance, at the plenum which has the greatest seam length. It is also one of the easier areas to reach for purposes of sealing. One major barrier to air sealing of ducts is the lack of familiarity on the part of many HVAC contractors with sealing materials and methods. This may be overcome through training. Sealing and insulating ductwork in attics is much more easily accomplished before drywalling, when all sides of the ducting is more readily accessible.

Just as blower door tests assess air leakage in the whole house, duct blasting can assess air leakage in HVAC delivery systems. Building science contractors, local utility programs, or local energy conservation agencies are all sources of this type of testing.

Programmable Thermostats – Programmable thermostats that provide for automatic temperature setback at various times of day do provide for some energy and thus cost savings. Although the savings will vary depending upon climate and type of systems, reductions of 6%-10% can be realized. Adaptive recovery thermostats should be used with heat pumps during the heating cycle. Otherwise, the electric resistance element will come on every time the house calls for heat, rather than waiting for the heat pump to do its job.

C/A/P: Programmable thermostats range in cost from $40-$60 (heat pump programmable set-back thermostats are twice as costly). They allow options for more time and temperature settings and the convenience of automatic setback vs. manual.

Whole House Ventilation – Whole house fans can reduce air conditioning loads if used properly. Ventilating with cool outside air when possible can reduce operating time and therefore, the energy consumption associated with the use of refrigerant systems. This reduction offsets the electrical energy to run the fan. Opening windows on cool evenings can, of course, provide some cooling effect even without fans. However, the larger air flow available with fan assist can be much more effective in cooling down the structure. Saving energy with whole house ventilation requires adherence to specific operating strategies, based on a daily evaluation of outdoor temperature. Simply put, ventilation can save energy when outdoor air is cooler than the indoor temperature. But, if ventilation fans are left on as outdoor temperatures rise, they may increase air conditioner operation. The installation of an indoor-outdoor thermometer may encourage proper operation. In mixed climates, fans should be sealed during the heating season to prevent excessive heat loss.

C/A/P: Whole house fans are readily available in all parts of the U.S. The installed cost is approximately $200-$450. Proper use is a significant issue, and home owners should be instructed in

proper operation. Whole house fans are notoriously difficult to air seal during seasons of non-operation.

Ceiling Fans – Ceiling fans do not inherently reduce energy consumption. Like whole house fans, they require proper operation. By increasing air velocity, ceiling fans make air feel cooler. If this cooling effect is combined with a higher summer thermostat setting, comfort can be maintained while the energy consumption of the air conditioner reduced. Because comfort is also determined by relative humidity, something a ceiling fan can not affect but air conditioning can, the effectiveness of a ceiling fan is highly variable. If the thermostat is not reset, no energy will be saved. Limited research indicates little or no savings in practice.

C/A/P: Ceiling fans range in price from $50 to $1,000. The real cost differences are in the quality of the motor and the efficiency of the blade design.

Water Heating:

Water Heater Fuel – The construction of a new home offers the best opportunity for making choices regarding the water heating system and fuel type with maximum operational efficiency in mind. Of course, fuel costs and availability in the particular region play an important role.

The history of competition between fuels, and desire to satisfy the major gas and electric suppliers has resulted in attempts to promulgate “fuel neutral” energy codes and program requirements. Very few energy codes or programs explicitly provide recognition to a specific fuel, or account for fuel cost. Program requirements for a specific water heating fuel are likely to create conflicts with utilities.

C/A/P: Gas fired water heaters generally cost $150 to $250 more than electric water heaters of similar construction and warranty, at minimum required efficiency levels. Yet, in locations with relatively low natural gas prices and high electric rates, the use of gas may reduce the cost by 50% to 70% as compared to the use of electricity.

Fuel choices are available virtually everywhere in the United States, with electricity almost universally available, natural gas widely available in urban and developed suburban areas, and both LP gas and fuel oil available, with some regional variation, on a delivery basis.

Water Heater Efficiency – Water heater efficiency is described by the “Energy Factor” rating. National appliance standards (NAECA) establish minimum Energy Factors for water heaters as a function of fuel type and size of storage tank with larger tanks having lower efficiencies due to greater standby losses. The Energy Factor takes into account the overall efficiency at which the "fuel" (gas, electricity, or oil) is converted to useful water heating energy, as well as the standby losses, the loss of energy from the warm tank to the surrounding space.

For gas water heaters, Energy Factors range from .42 to .86. For electric resistance water heaters, EF’s range from .81 to .96. Higher efficiencies are achieved through increased tank insulation and, for gas and oil fired heaters, through improved heat transfer from the flame to the water. The highest efficiency gas water heaters are condensing units. They are most often used with combined units designed to provide space heating as well. As a generalization, operating costs for water heaters within a specific fuel type can be assumed directly proportional to Energy Factor.

C/A/P: In general, higher efficiency of water heaters is associated with other construction improvements (such as additional corrosion protection) and/or longer warranties, which also increase the sales price. Electric water heaters with improved insulation and somewhat improved Energy Factors are available at low to moderate cost compared to standard units.

Gas fired water heaters, excluding the premium fully condensing designs, are also available across a fairly narrow range of efficiencies, with higher efficiency associated with higher price. Some of the higher efficiency gas fired water heaters offer venting options including direct venting through a sidewall, and powered venting. Power venting adds considerably to the price of the equipment, but also eliminates chimney costs and provides greater flexibility in venting. The use of power venting with gas fired water heaters also eliminates the potential hazard of appliance backdrafting in tight, efficient homes. Due to the high cost and the relatively low demand for condensing water heaters, there are very few models on the market. Those that are available cost approximately $1500 more than standard models.

Much of the marketing literature used by water heater manufacturers fails to include Energy Factor information. The Consumers' Directory of Certified Efficiency Ratings, published by the Gas Appliance Manufacturers Association (GAMA) provides a consolidated listing of Energy Factors for water heaters of all fuel types. Programs promulgating water heater efficiency standards should provide copies of this directory to local plumbing supply houses and participating builders.

Sealed Combustion – As with other fuel burning appliances, sealed combustion gas- or oil-fired water heaters offer improved performance and reduce potential for backdrafting and associated indoor air quality problems.

C/A/P: The cost of sealed combustion water heaters is approximately 3-4 times higher than those that meet minimum federal standards.

Storage Tank/Pipe Insulation – Insulating jackets for water heater tanks and pipe insulation will reduce standby heat losses. Given that water temperatures are 140 F, heat will be lost even to 70 F conditioned living space.

C/A/P: Water heater jackets and pipe insulation are readily available, easy to install, and a relatively inexpensive way to lower energy use and costs. Water heater jackets start at $10.

Water Heater Location – Locating the water heater in close proximity to the loads makes sense for economic and financial reasons as well as energy efficiency. Construction costs are somewhat reduced because piping distances are shorter. The shorter distances also reduce the time spent waiting for hot water to arrive at the tap.

C/A/P: In order to place the water heater close to areas of use, bathrooms and kitchens must be in the same vicinity. Although this makes sense from constructability and energy efficiency standpoints, it may conflict with the home owner’s preference for room layout and design.

Solar Water Heaters – In direct systems, domestic water is routed through solar collectors and sent to a thermal storage tank. Systems in which dedicated water, an antifreeze solution, or air is used to transfer heat to a thermal storage tank are indirect. The typical solar water heater can meet 40% to

60% of hot water demand in a home. Solar water heating systems have improved dramatically since the '70s energy crisis with lower capital costs, better materials for tanks and piping, better controls, and better aesthetics.

C/A/P: The Department of Energy reports a payback period of 5 – 8 years on modern solar water heating systems given reasonably sunny climates and electricity rates of $0.08/kWh. The improvements in systems, financial incentives, and training/licensing of installers has brought the industry a long way from the image problems of the '70s and '80s.

Drainwater Heat Recovery – Drainwater heat recovery systems reclaim heat from waste hot water to preheat incoming cold water before it enters the water heater or is called for at another appliance. The simplest system consists of a section of copper drain pipe coming from a tub, shower, or washing machine wrapped with a copper coil that supplies cold water to the water heater. The potential reduction in water heater energy use may be 20-30% or more in some cases.

C/A/P: Several drainwater heat recovery units are available commercially, and one, a very simple device which provides a high rate of heat recovery when there is simultaneous supply and drain line flow, is the subject of current field testing by NAHB Research Center. The equipment cost of this system is approximately $180.

Hot Water Recirculation – Recirculation systems are first and foremost a water savings device. They provide hot water more quickly to fixtures distant from the water heater, and are commonly used in large residential buildings such as hotels. By beginning to circulate hot water before the tap is turned on, the amount of water lost down the drain while waiting for hot water temperatures to develop is reduced. However, conventional recirculation systems keep the water in lines hot at all times and actually add to energy consumption because heat loss is increased. Demand-controlled recirculation are those in which the person wanting to use hot water first presses a button in proximity to the fixture. A pump begins circulating water so that hot water is available immediately when the tap is turned on. Demand-controlled systems appear capable of offering the water savings and hot water service benefits of recirculation without the energy penalty.

C/A/P: Recirculation is a program element driven by potential water savings rather than energy savings, but where used, should be limited to demand-controlled or other systems that will not increase energy consumption.

Combined Systems:

Combined/Integral Systems - The term "combined system" in the HVAC context means the use of a single gas fired water heater to provide both domestic hot water and, by delivering heat through a coil to an air stream, space heating.

Two types of combined systems exist:

1. Hot water coils from the boiler circulate through the insulated tank supplying domestic hot water. During the heating season, one system provides both space heating and hot water needs. Because hot water is stored in an insulated tank, the boiler does not cycle on and off as often, thereby reducing fuel use.

2. The second type of system uses a powerful water heater and space heating is delivered at the "recovery efficiency" of the water heater. This is typically around 75% for gas water heaters. Since this is lower than the required minimum efficiency for a gas furnace, combined systems using standard water heaters will not save heating energy.

Systems using condensing water heaters, on the other hand, will deliver space heating energy at efficiencies of over 90%, providing space heating energy performance similar to that of the highest efficiency furnaces.

C/A/P: Some building or plumbing codes limit or prohibit the installation of combined systems, based on requirements or concerns about mixing of potable water piping with space heating piping. Combined system suppliers often claim installation cost savings and floor space savings. Since most HVAC contractors are less familiar with combined systems than conventional heating equipment, the installation learning curve may eliminate potential cost savings. Floor space savings are probably available if installations are planned so that the air handler is suspended from the ceiling of the mechanical area.

Guide Recommendations

- Establish AFUE appropriate for climate. Two levels of credit, >80-85% AFUE and >90% AFUE may be appropriate depending upon type of system.
- Air Conditioning: SEER's 11-14 depending upon climate and existing code requirements. Several levels of credit may be appropriate.
- Evaporative coolers will be appropriate only in hot, dry climates.
- Require sizing of heating and air conditioning systems according to Manual J or manufacturer's equivalent procedure.
- Give credit for locating all ducts within conditioned space; or sealing with mastic and insulating all ductwork in unconditioned areas.
- Offer credit for whole house fans but not individual ceiling fans.
- Offer credit for electric water heaters with EF > .94; for gas water heaters > .60.
- Offer credit for demand-controlled recirculating systems.
- Provide credit for combined systems if condensing water heater is used or if space heating is required a substantial portion of the year.
- Radiant floor heating systems are not recommended for inclusion as a program element because while these systems are noted for their comfort, there is no evidence to suggest that radiant floor heating systems are inherently more energy-efficient than other delivery systems.
- Give credit for active solar systems for water heating depending upon suitability of particular climate.

Resources:

The Energy Source Directory, Iris Communications. Lists over 500 products that help improve a home's energy efficiency from insulation and air barriers to heating and cooling equipment.

Consumers' Directory of Certified Efficiency Ratings for Residential Heating and Water Heating Equipment, Gas Appliance Manufacturers Association, Arlington, VA. This directory lists the efficiency ratings of all models of gas furnaces, boilers, and water heaters according to manufacturer.

HVAC Systems Evaluations, Harold R. Cohen, R.S. Means Co., Inc., 1990. Possibly a more thorough discussion of HVAC equipment, components, and design than some might want but lots of good information. Most importantly, explanations are clearly given so that you don't need to be a mechanical engineer to understand the system design and equipment operation principles that are discussed. Again, good illustrations help a lot. The sections on problem-solving and troubleshooting can be particularly helpful.

A Builder's Guide to Residential HVAC Systems, NAHB Research Center, Home Builder Press, 1997. This guide provides extensive information about HVAC sizing, design, and equipment selection including focus upon considerations for energy efficiency.

Websites:

http://www.ebuild.com – Site of Environmental Building News, a monthly journal covering a wide range of topics pertaining to energy and resource efficiency. Articles range from more practical hands-on issues such as comparisons of framing systems and product review to more politically inclined updates regarding environmental issues on a national and international scale. Articles regarding high efficiency HVAC systems and water heating appliances are often featured.

http://www.plumbingworld.com – This company offers a wide range of plumbing materials and supplies – primarily fixtures and fittings, however, rather than appliances.

http://www.fsec.ucf.edu – The Florida Solar Energy Center has done extensive research and testing regarding a range of issues pertaining to energy efficiency in buildings. This site makes information available about current research as well as results of previous work. Among the topics are comparisons of different building systems, windows, HVAC systems, and photovoltaics.

http://www.its-canada.com/reed/index.htm – The Residential Energy Efficient Database is a Canadian site that provides extremely useful information regarding many aspects of energy efficient home design and construction. Specific topics addressed include: siting the building to take full advantage of natural features to help reduce energy loads, building layout and design with several house plans of varied size and style, a simplified method for calculating the approximate heat load of the home, and guidelines for HVAC system design and sizing. Since this is a Canadian sponsored site, there is no information regarding design considerations for cooling climates or AC systems.

http://www.energyoutlet.com/res/appliances/index.html – A builder or home owner can search this site for a list of the most energy efficient appliances on the market. Suggestions for important questions to ask when shopping for a major appliance are also offered.

http://www.eren.doe.gov/buildings/consumer_information/ – The Department of Energy site not only provides information about appliance standards and EnergyGuide labels but also about energy saving features of all major appliances.

http://www.southface.org/home/sfpubs/sfjv298/breathe.html – The Southface Journal, a publication of the Southface Energy Institute, contains articles on numerous sustainable building topics – including an excellent discussion of methods and materials for sealing HVAC ducts.

http://www.eren.doe.gov/millionroofs – This site provides information about President Clinton's Million Solar Roofs initiative. A state-by-state listing of incentives for renewable energies may be of particular interest. In addition, information about recent developments in photovoltaic technologies is available.

5. Energy Efficiency – Appliances and Lighting

Overview/Discussion

Unlike heating, cooling, and water heating, there is no range of choices for the type of fuel used to meet our appliance and lighting needs. Most require electrical energy–for which 2/3 of the generating energy is lost as waste heat before it even reaches our homes. However, electricity does provide a safe, convenient way to perform many tasks that would otherwise be impossible or cumbersome. Depending upon climate and the severity of space heating and cooling requirements, 20%-30% of a home's energy consumption goes into food preparation and storage, washing and drying clothes, and illumination. Therefore, it is an important place to look for energy savings.

There can be a wide range in the energy performance of different electric models and types (and for some appliances—stoves and clothes dryers—performance differences based on fuel type). Federal standards regarding energy consumption and increased public interest in greater energy efficiency have resulted in many improvements. With this have come increased options so that it makes sense to shop around before choosing a particular refrigerator, dishwasher, or lighting scheme.

Appliances:

In most cases, the builder is likely to have reduced involvement in the choices that his customer makes regarding appliance purchases. However, as mentioned with respect to resource efficient materials, builders can provide home owners with information regarding more energy efficient appliances.

Refrigerators – As one of the largest energy users in the typical home, it pays to choose a refrigerator carefully. There is a fairly wide variation in the energy efficiency of different makes and models of refrigerators; so, it may require some time to research the various options. Usually, the larger the refrigerator, the greater the energy use. However, this is not always the case since some 18 cu. ft. models are better performers than their 16 cu. ft. counterparts. A side-by-side model generally is a bigger energy-eater than one with a top compartment freezer and features such as icemakers and through-the door dispensers also come with higher operating costs and higher price tags.

Cost/Availability/Practicality (C/A/P): Energy efficient models are widely available and most brands offer a variety of options. Because, many of those that are better performers also come with upgrade features such as glass shelves and more flexible storage space, it is difficult to characterize the cost increase associated with greater energy efficiency.

Dishwashers – The energy efficiency of a dishwasher pertains to three different aspects: water temperature, wash cycle, and dry cycle. Heating the water comprises 80 % of the energy consumed by an automatic dishwasher. A booster-heater increases the water temperature to 140-145 F. However, this feature also allows you to turn down the thermostat on your water heater to 120 F, thereby reducing overall water heating costs. For every 10 F reduction in temperature setting, 3-5% energy savings for water heating can be achieved. Most dishwashers have a choice of wash cycles as well as an option for no-heat drying. A "light-wash" setting can reduce the amount of water used by almost 50% in some models and selecting the no-heat dry option eliminates the use of an electric heating element to dry the dishes.

Although all dishwashers must display EnergyGuide labels, the usefulness of the labels can be limited because the energy efficiency ratings do not include any measure of cleaning effectiveness. For instance, the energy ratings are based on normal settings while claims regarding performance may pertain to the heavy-duty pot-scrubbing mode. Furthermore, if you typically run the dishwasher on a setting other than "normal", the energy use will vary from the indicated performance (Also see Section 11 – Water Efficiency – Indoor Use).

C/A/P: Dishwashers range in cost from $300 to almost $1,000. Energy-efficient ones generally start at $450.

Horizontal Axis Washers – Horizontal axis washing machines also achieve their energy savings by using less water as compared to conventional, vertical axis machines. Some models use 40% less water and since water heating accounts for about 90% of a washer's energy use, this yields significant savings. The EnergyGuide ratings for h-axis washers can be misleading because the ratings do not include any comparisons to vertical-axis washers.

C/A/P: H-axis washers are now produced by three major domestic companies and cost about $200 to $300 more than a comparable v-axis machine. Some utilities and public-interest groups offer rebates on h-axis machines.

Gas Dryers/Ranges – From a "primary energy" standpoint, gas appliances are a better match to meeting the end-use energy needs required for drying clothes or cooking food. As mentioned earlier, electricity is a high-grade energy used to meet relatively low-grade end-use requirements for heat.

C/A/P: The option of gas appliances depends primarily upon the availability of fuel. LP gas is available across the country, but the availability of natural gas will depend upon the extent to which it is cost effective for gas suppliers to develop the infrastructure. Typically, gas appliances are less expensive to operate than electric with LP gas slightly more expensive than natural gas. First cost for gas appliances is somewhat higher than for electric; LP gas appliances may cost slightly more than those designed for natural gas. In areas with low municipal rates, co-ops, or night-rates, the balance may differ for cost of operation.

Lighting:

Fluorescent Lighting – Both tube and compact fluorescent lighting reduce energy use by 50%-70% as compared to incandescent lighting. Electronic ballasts and changes in lamp design have brought improvements to the quality of light provided and suitability for use in most standard fixtures. Light quality is very close to that of incandescent bulbs and there is no longer the flickering hum typically associated with fluorescent lighting.

C/A/P: Although more expensive than incandescent bulbs, (approximately $12-$20 vs. $.75), a compact fluorescent bulb will last about ten times as long as an incandescent. Over its 10,000 hour life, savings of approximately 60% can be realized. Compact fluorescents are widely available and offer a range of wattages as well as bulb sizes.

Table 6 – Energy Efficiency (Appliances/Lighting) Checklist Summary

Appliances & Lighting	Austin	Denver	Kitsap	New Mexico	Guide Recommendations
Refrig max energy use		E			E
Dishwasher no-heat dry cycle		E			
Horizontal axis washer		E			E
Gas dryer		E			
Gas range		E			
Provide gas appliance rough-in		E			
Appliances in lower 25 to 50% of operating cost range	E			E	E
Provide info on appliance energy efficiency		E			R
Light colored interior surfaces		E			
Provide fluorescent lighting	E	E	E		E
Provide halogen lighting		E			
Daylighting	E		E		
Outdoor lighting energy savings	E				E
Sealed ICF recessed lighting	E				E
Photovoltaic System	E	E			E

Sealed IC Recessed Lighting – "IC" means that the housings for recessed lights are rated for contact with insulation. Some of these still have "holes" in the housings; so, sealed means that there are no holes or penetrations. Space between these housings and adjacent drywall should also be caulked to prevent additional air flow. If there is room for insulation above and around the housing, there should be no compromise to insulating value. Installation in cathedral ceilings or joist cavities can present problems due to inadequate room for insulation.

C/A/P: The cost of housings rated for installation in an insulated ceiling is equivalent to unrated housings (about $15) and these are readily available from electrical lighting suppliers. Sealed housings may be less available and come with about a $5 premium.

Halogen Lighting – Halogen lighting is 30-50% more efficient in producing useful light output than incandescent lighting when used in appropriate situations. It is advantageous when a high quality, focused light is desired and is often used to illuminate artwork or in retail display. Recently, halogen bulbs have become popular in homes for use in torchieres or free-standing floor lamps which direct light upwards towards the ceiling. In such situations, the amount of light output per watt of electricity used drops drastically. Furthermore, such lamps are often placed too close to walls or ceilings and pose increased risk of fire due to the intense heat generated by the bulbs. Halogen lamps are common in "designer" light fixtures and are generally considered a design upgrade, purchased for reasons other than energy efficiency.

C/A/P: Halogen lights do not offer the array of options that is found in the selection of incandescent or fluorescent bulbs. Their cost is about 2-3 times higher than incandescent lamps but they last much longer.

Daylighting – The most common examples include skylights, light tubes, clerestory windows, light shelves, light-colored walls and particularly ceilings, and sidelights in doors. The thermal gains and losses with various daylighting options must considered.

C/A/P: The energy penalty associated with most conventional skylights is the reason some programs prohibit much less give credit for them. The newer light tubes have demonstrated electric lighting savings. However, while the heat gain and loss associated with light tubes is dramatically less than conventional skylights, no studies are available on the net energy savings with associated heat loss and gain. The orientation of clerestory windows is critical to their performance. The color of interior walls and particularly ceilings is difficult to give credit for since light colors are such common practice.

Outdoor Lighting – Outdoor lighting is desirable from a security and safety standpoint. However, the time these lights are on can extend well beyond their actual use or need. Motion detectors can save energy by turning lights on only when they are needed. Solar powered-lights that charge during the day are also an option for satisfying outdoor lighting needs in an energy efficient manner.

C/A/P: Motion detectors can be installed on any outdoor fixture and cost approximately $30. Photovoltaic lamps cost about $50.

Photovoltaics – Vast improvements have been made in photovoltaic (PV) cell technology over the past twenty years. However, despite engineering improvements and subsequent cost reductions, it still is not a commonplace technology in most homes. The amount of power produced by a PV array and delivered to the load depends on a number of factors:

- The intensity of sunlight striking the cells
- The operating temperature of the cells
- Matching power output of the array to the load
- Internal matching between cells and modules

Peak power output is very sensitive to the amount of light received and the temperature of the cells. Because these conditions constantly vary, power output is variable as well. Current efficiencies of PV cells are in the range of 20-25% with tracking systems improving performance but also increasing costs. In addition to panels that can be installed on a roof or on the ground, the thin film technology has also been applied directly to roofing materials. The system typically requires an inverter and deep cycle batteries for storage unless “excess” power can be fed back into the utility grid.

C/A/P: Although the cost of a PV system is still high (about $0.25/kWh), the costs continue to decline with technology breakthroughs in cell manufacturing and with economies of scale in production. Some utilities are offering automatic buyback of surplus electricity, eliminating the need for costly storage systems, and GMAC financing recently announced a financial incentive package in cooperation with the National Solar Electric Association (NSEA). Systems must be designed and engineered by professionals. Newer products called building integrated photovoltaics (BIPV) show a lot of promise in terms of functionality and aesthetics. President Clinton’s Million Solar Roofs initiative, may make photovoltaic technology more widely available either directly or indirectly through investment by local utilities.

Guide Recommendations

In addition to the one required item, consider requiring one additional element from this content area.

- Offer elective credit for refrigerators and other major appliances that perform in the top 25% of the range for the size and model per Association of Home Appliance Manufacturers Guide.
- Offer elective credit for use of fluorescent lamps in at least 50% of built-in fixtures.
- Offer elective credit for use of fluorescent bulbs in all recessed lighting.
- Require sealed ICF housings for all recessed lights located in thermal boundary.
- Outdoor lights – offer credit for fluorescent, halogen, pv-powered, and/or motion detector.
- It is not recommended to give credit for halogen lights installed indoors. Usually, these are considered an upgrade and used for decorator purposes.
- Give credit for the following under daylighting: light tubes and clerestory windows.

Resources:

Consumer Guide to Home Energy Savings, 4th Edition, 1995, Alex Wilson and John Morrill, American Council for an Energy-Efficient Economy. This book is an excellent resource providing lots of useful information about selecting energy efficient HVAC systems and household appliances. Very practical information about reducing energy needs, making energy-wise and cost-effective decisions regarding purchases, and operating equipment efficiently.

Directory of Certified Refrigerators and Freezers, Association of Home Appliance Manufacturers, 1998. Annually published guide that lists the estimated yearly operating costs for all makes and models of refrigerators and freezers.

Websites:

http://www.light-link.com – A good site for architects, specifiers, or homeowners who want to look for the perfect light fixture from home. This site offers a comprehensive database of fixtures, controls, and bulbs. It can be searched by product type or by company.

http://www.qualitylight.com/techniques/home.html – This site offers many useful tips regarding lighting design considerations specifically for the home.

http://www.energyoutlet.com/res/appliances/index.html – A builder or home owner can search this site for a list of the most energy efficient appliances on the market. Suggestions for important questions to ask when shopping for a major appliance are also offered.

http://www.eren.doe.gov/buildings/consumer_information/ – The Department of Energy site not only provides information about appliance standards and EnergyGuide labels but also about energy saving features of all major appliances.

http://www.eren.doe.gov/millionroofs – This site provides information about President Clinton's Million Solar Roofs initiative. A state-by-state listing of incentives for renewable energies may be of

particular interest. In addition, information about recent developments in photovoltaic technologies is available.

http://www.pge.com/pec/inftoc/siteindx.html – The Pacific Energy Center in San Francisco, CA offers excellent information and hands-on displays to illustrate many principles of energy efficiency. Their website offers informative factsheets on lighting as well as HVAC systems and windows.

6. Resource Efficiency - Design

Overview/Discussion

The 3 R's hierarchy (reduce, reuse, recycle) gives the highest priority to waste reduction. Resource-efficient house design can involve the following waste reduction opportunities:

Efficient Framing Techniques – Using framing components appropriate to structural function (Examples include: eliminating headers in non-load bearing wall openings, increasing framing member spacing, eliminating non-structural use of two-by stock for drywall backing)

Size – Larger homes have to work harder to be resource-efficient than smaller homes. This is in part based on the number of intended occupants but also can be affected by efficiency of design.

Design For Disassembly – Setting up or fastening various building components for easy disassembly and reuse as the use of the home or a component changes or the home is retired.

Review of the programs

1. Efficient Framing Techniques – Treatment of this topic ranges from a single item that treats all techniques collectively to a four or five item list with varying point totals for each. By definition, these techniques involve less material and waste for a given building function or component. Items such as central cutting areas, honing down the take-off list and holding the framers to it, and drywall clips can significantly reduce wood waste.

   Cost/Availability/Practicality (C/A/P): Some builders have documented material purchase savings of $100 to $1400 per house. This does not include any associated disposal savings or associated changes in labor costs (See Appendix I, the Woodside Custom Homes profile and the Reduce/Reuse/Recycle section). Other builders express concerns relating to the quality of materials and performance that must be addressed when optimizing framing: greater spacing for walls ("waviness"), greater spacing for floor members ("bounciness"), load-specific headers (requires a more sophisticated framing crew). Builders who use a system of efficient framing report that the time investment in training and enforcement works best if you have your own framing crew(s) or have a longstanding, productive, business relationship with your framing subcontractor(s).

2. Size – The Austin program applies different multipliers to the point total– <1500 sq. ft. - 1.00, 1500-1800 - .98, 1800-2000 - .96, etc. – essentially making larger homes work a bit harder to achieve the same rating as a smaller home.

   C/A/P: Savings on the size of a house are difficult to quantify because house size is so dependent on function, aesthetics, and marketability. Smaller or more compactly designed home elements such as combined-function rooms, clustered bedrooms to reduce or eliminate hallways, or limited storage and closet space must be balanced against other market demands.

1. Design For Disassembly – This consideration is a rather new concept, perhaps more relevant for commercial buildings in which uses of buildings, internal building elements (office partitions, for example), and room dimensions change with ownership or lease. For most residential builders, the application of this is limited to installed items such as cabinetry. None of the existing programs include or discuss this item.

Table 7 – Resource Efficiency (Design) Checklist Summary

Criterion	Green Builder Programs				
	Austin	**Denver**	**Kitsap**	**Central New Mexico**	**Guide Recommendations**
Efficient Framing	E	E	E		E
Size	E		E		E
Design for Disassembly					

Guide Recommendations

- Treat efficient framing techniques as individual optional items. The impact of waste reduction is significant enough to warrant this (see Appendix J).

  -Frame on greater than 16" centers
  -Single top plate
  -Optimized header sizes
  -Window/door layout
  -2-foot modules
  -Centralized cutting areas
  -Detailed job-site framing plans
  -Two-stud corners
  -Ladder-backing/drywall clips
  -Header hangers
  -Reduced cripples/jacks
  -Optimized roof sheathing
  -Reduced waste factor

- Incorporate overall total point multipliers based on project size. The greater "pressure" this places on larger homes can be completely determined by the choice of multipliers.

Resources:

Cost-Effective Home Building: A Design and Construction Handbook. NAHB Research Center, 1994. This publication is a comprehensive reference for efficient framing and design. Engineering tables are included as appendices.

Affordable by Design. Alice Horrigan. E Magazine, July/August, 1997. A concise discussion and interesting examples of efficient design.

Residential Construction Waste Management: A Builders Field Guide, NAHB Research Center, 1997. This publication includes builder case studies of efficient framing and related cost savings.

Websites:

http://www.crest.org/sustainable/greenbuilding-list-archive/index.html – Center for Renewable Energy and Sustainable Technology – This site contains a database of a wide variety of topics related to green building issues. The online discussion group is an informal exchange of ideas and subject matter runs the gamut. Become a participating member or just browse the archive. Since there is no set format for discussion, the archive is organized by date only so, you may need to hunt for topics of special interest to you.

http://www.ebuild.com – Site of Environmental Building News, a monthly journal covering a wide range of topics pertaining to energy and resource efficiency. Articles range from more practical hands-on issues such as comparisons of framing systems and product review to more political updates regarding environmental issues on a national and international scale.

http://www.co.san-diego.ca.us/cnty/cntydepts/general/cob/policy/F-50.html – This site contains a copy of the policy adopted by San Diego County to encourage resource-efficient construction and renovation practices. Although the voluntary guidelines are fairly general in nature, they are an example of important steps that must be taken by local jurisdictions to facilitate the implementation of sustainable building practices.

7. Resource Efficiency – Materials Selection

Overview/Discussion

There are seven attributes of building materials that builders can use to assess building a product's resource-efficiency:

- ***Recycled Content*** - A distinction is often made between recycled-content levels that are "post-industrial"—manufacturing waste that is recycled back into product within a plant—and "post-consumer"—consumer waste that is taken back to the plant and recycled. In general, most programs recognize post-consumer recycled content; post-industrial recycling is simply considered an additional efficiency of the production process.

- ***Recyclability/Reusability*** - Building products differ in how readily they can be recycled or reused at the end of their first or only use.

- ***Renewability*** - Products made from organic—carbon-based—resources like wood and paper are considered renewable because nature recycles the materials.

- ***Durability*** - The service life of a building material is a reflection of its environmental performance—the longer a material or system stays in use, the better the use of the resources tied up in its production.

- ***Local Production*** - The energy consumption and associated pollution of transporting a building material from its production site to its installation can be a significant part of its environmental performance.

- ***Embodied Energy*** - This is the energy associated with obtaining the raw materials and manufacturing the raw materials into a building product. It generally also includes the transportation energy discussed above as well as the energy associated with any product packaging.

- ***Pollution Production*** - Some building products produce substances during manufacture, installation, or use that are difficult for the environment to assimilate or substances particularly difficult for people or other life forms to handle. The substances can be generated during the production process, be given off from the building product over its use, or be a result of chemical reactions like fire.

Product manufacturers and building scientists can conduct a Life Cycle Assessment or LCA[6] to measure the environmental "footprint" of a building material or system, but LCAs are complex, expensive, and ultimately involve value judgments to compare products. So builders should simply take the local environmental context and the attributes above into consideration as they make material selections. There is rarely one "best" material, particularly since product selection involves considerations other than environmental performance. Green builders should use some basic rules such as the following:

[6] An LCA is an analysis of all of the resources that go into and waste or byproducts which come out of the production, distribution, use, and disposal of a product.

1. All other things being equal, select building products that:

    a. have recycled-content rather than virgin content,
    b. are easily recycled or reused products, particularly if disposal of the product is difficult or the product is single-use,
    c. are made from renewable resources such as trees, particularly if it is a renewable resource that is easily or quickly renewed,
    d. have longer service lives, particularly when they can match the building's service life or have high embodied energy,
    e. are produced locally, particularly for building materials or systems that are massive,
    f. have lower embodied energy, particularly for products or systems with shorter service lives or products where high embodied energy can't be offset by strong non-environmental product characteristics,
    g. are made of materials and who's production and ultimate disposition do not involve environmental difficulties such as ozone-depleting chloro-fluoro carbons (CFCs).

2. Consider local environmental issues in product selection; for example, cement-based products in areas with water shortages, more durable products and systems in high-wind and moisture areas, etc.
3. Consider the building product's function and performance. For some building materials, such as insulation, the material's function and performance are the most significant environmental considerations.
4. Make a habit of asking product manufacturers and distributors for information on the seven attributes listed above; some of the information is more readily available than others and the more inquiries the more likely the producer is to taking these considerations into manufacturing and marketing decisions.
5. Use the resources and references listed at the end of this section in your product selections.

The table below presents general criteria that the five programs have used to identify or recognize resource-efficient building materials or systems.

Recycled-Content – Giving credit for recycled-content building materials is common to all of the green builder programs. Recycled-content is by far the most significant form of resource-efficiency across the programs. The most common recycled-content building materials include:

1. Insulation – Cellulose insulation is made from recycled newspaper and typically has a recycled content of 75%-85%. Most fiberglass insulation has a recycled content of 25% from consumer glass products.

Cost/Availability/Practicality (C/A/P): Brands of each are readily available, have a proven track record, and are either equal to or 5%-10% more costly than substitutes.

2. Exterior Cladding (Roofing and Siding) – Aluminum (nearly 100%), steel (20%-80%), and some composite wood materials have recycled-content.

Table 8 – Resources Efficiency (Materials Selection) Checklist Summary

Criterion	Green Builder Programs				
	Austin	**Denver**	**Kitsap**	**Central New Mexico**	**Guide Recommendations**
Recycled-Content	R&E	E	E	R&E	R
Recyclability/ reusability		E 1 specific material	E 1 specific material		
Renewability	R&E engineered & certified wood	E engineered & certified wood	E engineered wood products	R&E engineered wood products	E
Durability	E	E 1 specific material	E 1 unspecified item	mentioned only, no items	E
Locally-produced	E	E 2 specific items	mentioned only, no items		
Alternative Wall Systems	E ICF, SIP, straw bale, earthen	E ICF, SIP	E SIP	E earthen, straw bale	E
Embodied Energy			mentioned only, no items	mentioned only, no items	
Pollution production	R (one item)		E (one item)	E (one item)	

C/A/P: Steel and aluminum siding come at a price premium but are considered maintenance-free and very durable. Composite wood products for exterior uses vary widely in their perceived reliability, maintenance requirements, and cost.

3. Plastic Decking/Fencing – Recycled plastic and recycled plastic-wood composite decking and fencing are most commonly substituted for pressure-treated wood products.

C/A/P: Significant progress has been made in the appearance and the durability of these materials. While more expensive than common substitutes, these materials are often more durable and lower maintenance. Due to limited structural characteristics, there are no plastic or plastic-wood composite materials that can be used as load-bearing beams or joists.

4. Carpet and Carpet Pad – Most recycled-content carpet is made from post-consumer PET plastic (soda bottles). Recycled-content carpet pad can be made from a variety of post-consumer plastics but most commonly is polyurethane-based.

C/A/P: Recycled-content carpet is becoming more widely available and is inherently stain-resistant. Although the cost of carpet has a wide range, recycled-content carpet is generally cost-competitive. Recycled-content carpet pad is widely available and cost-competitive with substitutes.

5. Flyash Concrete – A byproduct of burning coal which can replace between 15% and 30% of the cement in ready-mix concrete. Concrete with flyash content sets up somewhat more slowly but is easy to work and has a slightly smoother finish.

C/A/P: Many concrete suppliers can obtain flyash to add to their concrete. Local suppliers should be contacted. Flyash suppliers are also listed in a number of the references found at the end of this section. Concrete with flyash may be the same or slightly less expensive than regular concrete due to the reduced amount of portland cement required.

Recyclability/Reusability – With two small exceptions (one program gives credit for reusable concrete forms, the other mentions the recyclability of certain siding materials as part of a larger discussion), the programs do not recognize this aspect of resource-efficiency. This is despite the fact that recycling and reuse play a major role in the waste management section of all of the programs.

C/A/P: It is not practical for builders to select materials based solely on the environmental impact of the cut-off waste or the impact at the end of the material's intended use. It is important, however, for green builders to make the link between purchase and disposal of building products.

Ready Renewability – The term "renewability" is reserved for biological resources such as trees. "Ready renewability" is used here to refer to engineered and certified wood products because engineered wood products are made from fast-growing, often farmed, trees and certified wood products come from forests which are independently certified for their forest management practices. Engineered wood products are the second most common item across the programs.

C/A/P: Engineered Wood – The substitution of innovative engineered wood products for solid-sawn wood products is widespread throughout the residential building industry. The materials are generally cost-competitive and comparable in performance with their substitutes. Care must be taken with engineered lumber in following installation procedures different than their solid-sawn counterparts.

C/A/P: Certified Wood – Certified wood products are generally not widely available. When sources of supply can be found, continuous availability within a reasonable time frame may pose a problem for builders. Usually, certified wood products come with a slight cost premium, depending on whether the distributor passes his cost premium on to the purchaser.

Durability – Building materials that last longer or that require little to no maintenance over their lifetimes represent an important form of resource-efficiency. No programs require items on durability—most programs give limited significance to this form of resource-efficiency. Only one program mentions low-maintenance as a form of resource-efficiency.

C/A/P: Quite often more durable products have higher first costs than their conventional substitutes. Although the green builder programs provide a good context for builders to emphasize the long-term advantages and savings of more durable, lower-maintenance products, there is currently no standardized method to assess the durability of building materials or systems. The only approach at this point in time is to give credit for extended warranties on materials and workmanship.

Locally-Produced – Transporting raw materials and finished goods as part of building product delivery represents resource-efficiency because of the energy consumed and pollution produced. Buying locally-produced goods can be particularly important for bulky and/or massive building materials. In general, this form of resource-efficiency plays a limited role in building material selection.

C/A/P: The availability of information on a product's origin or path to market is the largest hurdle for builders looking for locally-produced building materials. For some materials, the local supplier may be able to provide this information; for other materials, the information may not be available without significant investigation.

Alternative Wall Systems – This is a broad category, encompassing commercially-marketed—structural insulated panels (SIP) and insulated concrete forming systems (ICF)—and "grass roots"—systems straw bale and rammed earth construction. ICFs are included for their durability and energy performance, SIPs for their use of engineered wood products and energy performance, and straw bale and rammed earth for their use of local materials and low embodied energy (see the next section).

C/A/P: SIP – SIP suppliers and manufacturers are located in most parts of the country. Although there is a definite learning curve in terms of design and installation, growing builder interest is in part due to the reduced dependence on a skilled framing crew and quick erection time. It's difficult to establish a cost comparison with equivalent stick framing that has equal energy performance (see the Resources for this section). Some builders report significantly higher material costs for SIPs that offset savings in framing and energy-detailing labor.

C/A/P: ICF – ICF systems are being distributed nationally. Although they are most widely used for below grade applications, some builders use ICFs as a complete wall system based on energy performance, security, comfort, and noise-reduction. Once again, a functionally-equivalent comparison with conventional wall systems is difficult but ICF systems in general do come with an installed cost premium.

C/A/P: Straw bale/rammed earth – The difficulties with less conventional systems such as straw bale construction are often building code-related and lack of expertise/familiarity with the material. Except in a handful of localities, both straw bale and rammed earth construction face regulatory challenges, often based on local building authorities' reluctance to accept such systems.

Embodied Energy – This is the energy footprint or profile over a material's "lifetime", including raw material extraction, production, distribution and, maintenance. This calculation is a major component of a material's LCA. Building materials high in embodied energy relative to their substitutes have no given or set price advantage or disadvantage.

C/A/P: The most significant hurdle in the consideration of low embodied energy materials may be the lack of availability of comparative or quantitative information on this attribute. Information resources are available for a limited number of common building materials. Additionally, many building materials high in embodied energy have significantly greater durability, making the relative importance of this environmental attribute variable.

Pollution Production – Two programs—the Kitsap County and Central New Mexico programs—single out rigid insulation products that contain ozone-depleting CFCs or HCFCs as materials to avoid because of air pollution associated with the material's production. CFCs have recently been banned as

a blowing agent for rigid insulations and have been replaced by less ozone-depleting HCFCs. Expanded Polystyrene (EPS) rigid foam is not made with HCFCs.

The Austin program requires that chemical termite treatments be of a specified type considered to be "non-toxic". They give several alternatives to chemical treatments in the builder's Resource Guide.

C/A/P: Information on the pollution generation of building products is not always readily available. There is no single relationship in terms of cost between substitute products. Builders may obtain useful information from product MSDS but further inquiry will almost always be required to determine the pollution production or toxicity associated with various building products.

Guide Recommendations

1. Require at least two items from this content area. The availability, cost-competiveness, and proven track record of a wide range of recycled-content building materials makes this requirement reasonable for builders.
2. Offer credit on an equal per item basis according to the number of materials with recycled content used. Permit builder write-ins.
3. Include as option engineered or certified wood.
4. Offer credit on an equal per item basis according to the number of durable materials used.
   Examples: -30+ year roofing shingles
   -Brick, stone, or naturally weather-resistant siding
   -Install drainage plane behind siding
   -Install waterproofing system (10 year warranty) on foundation walls
   -Termite shield (region specific)
   -Exterior paint/stain: 10 year warranty
   -Lifetime finishes on hardware
5. Include as options warrantied home systems that are more than 25% above standard.
6. Include material selections based on pollution production as a builder write-in.

Alternative systems are not included as a recommended program item. The reasons for this are twofold:

- There are fairly good reasons to defend the superiority of ICF's and SIP's over conventional framing with respect to energy efficiency. However, the advantage they might hold with respect to resource efficiency is less clear.
- Straw bale and earthen construction certainly qualify as "green" or resource efficient materials depending upon the geographic region. However, these are not systems that are in widespread use. Local programs should offer credit for such systems on a case-by-case basis.

Resources:

The following references are particularly useful to builders and designers in that they most directly answer the questions that builders will have when considering a new product.

- What are the physical characteristics and expected performance of the material?
- Why should I use it?
- Where can I get it?
- How much does it cost?

Environmental Building News Product Catalog, joint publication of E Build, Inc. and What's Working, 1997/98, $59. This catalog provides environmental, cost, and availability information for over 70 building materials. The catalog is set up in a 3-ring binder format for easy expansion of the catalog. As with the well-known Sweet's catalog, product literature from the manufacturer is provided but added is the editors' environmental profile of the product based on their resource-efficiency material selection criteria. An environmental overview for each major building material category (following CSI classification) starts each section of the catalog.

Resources for Environmental Design Index (REDI), Bruce Sullivan (ed.), Iris Communications, Inc., 1997, $25 (hard copy published annually)/free (internet [*oikos.com*]updated bi-monthly). REDI is a database of recycled-content and resource-efficient building materials. This is one of two commercially-available databases that is national in scope and kept current. Basic information on everything except product cost is contained in the product descriptions of over 1,800 companies. Search capabilities, links to company web sites, and frequent updates make the internet version of REDI more useful than the printed one.

Green Building Resource Guide, John Hermannsson AIA Architect, Taunton Press, 1997, $37.95. The *Green Building Resource Guide* lists over 600 building materials. Names and addresses of suppliers are given as well as a brief description of the product. Cost information is provided on a relative basis as compared to a similar conventional product. The *Guide* is also available on CD-ROM.

Alternative Framing Materials in Residential Construction: Three Case Studies, NAHB Research Center, $25. Labor and material cost analysis for structural insulated panels, light-gauge steel, and welded-wire panels (shotcrete). Illustrated.

Guide to Resource Efficient Building Elements, 6th Edition, Center for Resourceful Building Technology. This book provides a listing of resource efficient building materials and systems according to product category. Names of suppliers are given with addresses and phone numbers. Applications of the material are described and pertinent information such as fire rating, R-value, color, and size is given. Information on cost is not provided.

***The Sourcebook for Sustainable Design*, Andrew St. John, Boston Society of Architects, Boston, MA. Lists over 100 recycled products used in construction applications.

Information regarding resource efficient building materials may also be available through a number of local or state agencies. Waste management boards, departments of environmental conservation, trade schools or schools of forestry, and local material suppliers can be good sources of information. This last resource, although not very practical for builders, does

represent an early effort to assess the total environmental foot print of a limited number of building materials.

Environmental Resource Guide(ERG), Joseph Demkin (ed.), American Institute of Architects, John Wiley & Sons, 1996 (published annually), $150. The American Institute of Architects has produced very detailed environmental evaluations of several common building materials in the ERG. The 3-ring binder format is designed for updates and additional evaluations. The reports on individual building materials are long and involved—in general, the ERG is not very builder-friendly and the number of building materials covered is very limited.

Websites:

http://www.oikos.com – The site of Iris Publications, offers the REDI Guide online. Builders can search for sustainable products and materials by building component. Names and addresses of suppliers are also provided. Articles pertaining to a variety of green building topics – construction waste management, HVAC systems, and IAQ–can be found as well.

http://www.fscs.org – The Forest Stewardship Council U.S. maintains a database of lumber suppliers and product manufacturers using certified wood products that meet the council's forest management criteria.

http://www.montana.com/CRBT – The Center for Resourceful Building Technology. The site primarily gives information about CRBT but the long list of practical research they have done may give builders and home owners reason to search them out further.

http://www.sustainable.doe.gov/buildings/gbintro.htm – Sponsored by the Department of Energy this site provides information, resources, and links regarding a number of green building topics including: resource-efficient materials, indoor air quality, waste management, water efficiency, codes and ordinances. Case studies of successful projects around the country offer examples of how communities have implemented various strategies.

http://www.umass.edu/bmatwt – This site provides information on numerous topics related to resource efficient construction. See the "feature articles" by Paul Fisette which are particularly informative and helpful.

http://www.hok.com/sustainabledesign – HOK, a leading commercial architecture firm, has completed numerous projects incorporating sustainable or green building principles. While their database is more oriented to commercial construction, it does contain information on building materials including concrete, wood, insulation, roofing, flooring, and paints.

8. Indoor Air Quality

Overview/Discussion

Indoor air quality (IAQ) is the only content area of green builder programs that does not relate to resource-efficiency or the quality of our outdoor environment. It focuses on the quality of a particular environment—homes—and the well being of one particular species—people. Its inclusion in green builder programs is based on two factors:

1. IAQ can be significantly affected by steps taken to achieve energy-efficiency—that is, tighter, more energy-efficient construction methods and materials.

2. Consumer awareness overall of IAQ issues is increasing and many home buyers have indicated in recent NAHB consumer preference surveys that indoor air quality is important to them. Also home buyers interested in resource-efficient homes are very likely to be interested in indoor air quality issues.

The development of indoor air quality as an issue independent of outdoor pollution has occurred for the following reasons:

- respirating ailments – data from recent years show a marked increase in reported common allergy symptoms and respiratory ailments such as asthma.
- air tightness of homes – energy-efficiency features have reduced the natural air change rate of new and remodeled homes.
- new building products – modern construction materials and home furnishings contain a wide range of chemical compounds; some of these materials outgas volatile organic compounds (VOCs). VOCs may affect the health and comfort of the general population and are increasingly identified as affecting the health and comfort of special populations.

The various agents that can contribute to poor indoor air quality include:

- moisture—the relative humidity inside a home when too high can foster mold and mildew growth and when too low can aggravate eye and throat irritations.
- combustion by-products—from automobiles (in garages), from combustion appliances (malfunctioning gas water heaters, furnaces, stoves and unvented space heaters) and from occupant activities such as candle or oil lamp burning and cigarette, cigar and pipe smoking.
- allergens—from pet dander (dogs and cats), dust mites, cockroaches, spores, and pollen.
- volatile organic compounds—from adhesives, solvents, cleaning agents, and off-gassing from a variety of building materials.
- hobbies – dust from sanding, fumes from photographic darkrooms, etc.
- radon—from underlying soil.
- poor outdoor air quality, especially in urban or industrial areas.

Although there is a great deal of knowledge regarding the types and sources of indoor air pollution, there is a great deal of uncertainty about the relationship between many specific pollutants and human health. This guide recommends that HBAs and builders interested in green building programs make

indoor air quality recommendations to home buyers in the following context (These recommendations are based in large part on *American Journal of Respiratory and Critical Care Medicine Volume 156, No. 3,* [September, 1997] *Part 2 Supplement: American Thoracic Society Workshop Report - Achieving Healthy Indoor Air*):

1. There is no single nor authoritative definition of "healthy air"—the concept and condition is based on many parameters and involves both health and comfort.
2. Public awareness and concerns regarding indoor air quality have led to consumer interest in achieving cleaner indoor air.
3. Reasonable strategies and products exist for persons seeking relief to existing conditions or to attempt to minimize risk for developing problems.
4. Strategies and products should not be marketed as "solutions" to specific health problems—purported health benefits need not necessarily follow.
5. There are large gaps in the understanding of indoor air quality in key areas.
6. A lack of strategies exists for assuring consumer understanding of options and consequences, particularly in the purchase of homes—green builder programs can help address this issue.

There are three basic ways to affect indoor air quality—source control (elimination or isolation), source dilution (ventilation), and source capture (filtration). With source control, agents of poor indoor air quality are identified and kept out of the living area of the home or if they cannot be eliminated, are isolated in place through sealing. Ventilation can reduce the concentration of agents of poor indoor air quality by diluting stale indoor air with fresh outdoor air. Filtration removes materials from the indoor air environment generally as part of the HVAC operation of the home.

NOTE: Moisture problems in homes are by far the most common indoor air quality problem. Although a type of source control difficult to include in an itemized green builder program, careful attention to liquid water movement–foundation drainage systems, house perimeter grading, flashing details–and water vapor movement–air sealing details and vapor barrier systems–can go a long way towards source control for indoor air quality. This issue is more broadly discussed in the energy sections of this template.

The Programs

Items within the green builder programs relating to indoor air quality are categorized in the table on the following page. They are addressed in their usual order of priority: source-control, ventilation, and filtration.

Source Control – The first strategy in efforts to achieve cleaner indoor air is to reduce sources of contaminants. Green builder programs have addressed source control with the following items.

1. Low/no VOC—volatile organic compound—paints, solvents, adhesives: Most programs include several items on low or VOC materials.

Cost/Availability/Practicality (C/A/P): New homes generally have Total Volatile Organic Compound (TVOC) concentrations significantly higher than existing homes—often 2 to 5 times higher. There currently is, however, no widely agreed upon TVOC concentration level indicating poor or unacceptable indoor air quality. There also are no hard and fast rules for the individual contribution of

building materials to VOC concentrations in homes because of the complexity of field evaluations—variable air change rates, variable outgassing rates, VOC interactions, etc.

On the other hand, products from adhesives to paints to wood finishes are readily available on the market that are low VOC—250g/l—and no VOC—less than 100g/l. Performance and price for low and no VOC building materials have become comparable to more traditional products.

2. Formaldehyde-free or sealed building products: Most programs give credit for selecting formaldehyde-free sheathing products/cabinetry/countertops and/or for sealing exposed surfaces of these materials.

C/A/P: All wood products give off or outgas formaldehyde over time. However, the outgassing associated with wood products containing formaldehyde-based adhesives, particularly urea-formaldehyde, is the real source of the indoor air quality concerns associated with this substance. Particleboard building products—cabinetry and countertops, some types of floor underlayment—and to a much lesser extent engineered wood products using phenolic resins—engineered floor joists, plywood, and OSB—are sources of formaldehyde outgassing.

Cabinetry and countertops made of particleboard are price point items—switching to another cabinet or countertop system or sealing all exposed edges can add significantly to cost.

3. Carpet area limitations: Two programs give elective credit for limiting total floor area that is carpeted. Although carpet, carpet pad, and carpet adhesive can contribute to the total VOC load in a home for a short period of time initially, this program limitation is related to the harbor carpet can provide for dander, spores, and dust mites.

C/A/P: The practicality of this limitation depends on a wide variety of factors including climate and inherent customer preferences. This item can incur significant extra cost, depending on the replacement flooring material and whether some double coverage results from throw rugs being desired or even necessary over the installed finish flooring. The Carpet and Rug Institute has established IAQ testing programs and labels for carpet, carpet pad (cushion) and carpet adhesives. Green builders using carpet should look for products bearing the CRI IAQ label.

The following items are building systems, a category encompassing any design item or house system selected for its contribution to indoor air quality.

4. Detached garage: A garage that does not have a common wall with living space can eliminate one of the larger potential sources of indoor air pollution.

C/A/P: The square foot cost of a detached garage will be higher than for an attached garage. In many living situations, there is a strong customer preference for the shelter and security features of a garage that is only a doorway from the inside of the home.

5. Central vacuum system: Traditional, portable vacuum cleaners can contribute to poor indoor air quality by simply stirring up and redistributing smaller particles that make it through the vacuum cleaner's filtration system. Central vacuum systems that exhaust to the outside eliminate these agents.
C/A/P: Central vac systems run around $1,000 installed. Systems are widely available and commonly offered to buyers for features other than indoor air quality.

6. Vented, locked storage areas outside the living space: Providing a chemical storage area outside the home isolates volatile finishing materials, cleaning agents, and petroleum products, thereby eliminating these agents' potential for poor indoor air quality.

C/A/P: The added cost of this type of storage area is likely to be modest. Homeowners with children will likely respond positively to the builder's concern for safety.

7. Radon slab venting: Passive radon venting basically involves a plastic pipe vent which runs from the slab through the roof, a gas-permeable layer of coarse aggregate beneath the slab and a polyethylene barrier between the aggregate and slab. Active venting uses the same system with an in-line fan installed in the attic to keep a negative pressure on the area beneath the slab.

C/A/P: EPA has developed a map of radon zones that predict radon potential on a county-by-county basis. EPA recommends that homes built in areas of the highest radon potential, Zone 1, be built with radon–resistant features. It is not possible, however, to accurately predict which homes will develop unacceptable concentrations of radon gas until after the home is built. On the other hand, the cost of the retro–fitting radon–resistant features is usually three times as much as installation at time of home construction. In new homes, passive systems range from $350 to $500. The cost of installing a fan to convert the passive system to an active one is about $200.

Ventilation – One way to improve indoor air quality is to vent rooms or components that can actively and directly affect indoor air quality:

1. Local exhaust fans: Bathroom exhaust fans vented to the outdoors control moisture accumulation (moisture is a critical element of mold and mildew growth). Kitchen hood fans vented to the outdoors control the accumulation of both moisture and combustion byproducts (particularly important for natural gas appliances). Kitchen design and cabinetry layout affect exhaust fan feasibility and cost.

C/A/P: Local exhaust fans ducted to the outdoors are a common component of today's construction. Installed cost information is readily available to builders. Exhaust fans can be wired to the light switch, set to a timer, or hard wired for 24-hour operation as part of a whole-house ventilation strategy. Use of exhaust fans affected by how noisy they are in operation. While quieter fans are more likely to be used by occupants (and are more durable—have a larger service life), their cost, about $80-$90, is higher than standard units. See the discussion under #4 – HRV systems in this section.

NOTE: Any time that air is pulled out of a home in one area, an equal amount of air inevitably will be pulled into the home from the outside in other areas. Areas of the home from which make-up air should not be drawn are covered in the following two items.

2. Garage exhaust fans: In attached garages, these fans are usually on a timer with the garage door opener to keep auto exhaust fumes from entering the living area of the home. In homes with attached garages, auto exhaust has been identified as one of the more significant potential sources of indoor pollutants.

C/A/P: The installed cost of a timer-controlled garage exhaust fan is generally less than $200. A green builder may justify the added cost in terms of the market distinction for home safety that this item brings.

3. Space and water heating equipment: The exhaust from gas/oil/wood water heaters, furnaces, wood stoves, and fireplaces is by code vented to the outdoors. Any combustion device relying only on natural drafting can potentially backdraft (Backdrafting is the spillage of exhaust gases back into the living space because a negative pressure or pull was created by, for example, an exhaust fan in some other area of the home). This spillage can be minimal and short-lived such as when a standard natural gas appliance fires up. If prolonged, however, such as when an appliance is malfunctioning or a sustained significant negative pressure is created, the backdrafting can represent a serious hazard. To avoid this potential, two programs specify sealed combustion appliances and two specify an outside air source for combustion appliances. Either approach can reduce or eliminate the potential for backdrafting.

C/A/P: All new gas furnaces are power-vented. Most new high-efficiency condensing furnaces are sealed combustion (sometimes also called direct vent). Condensing efficiency, sealed combustion furnaces carry an installed cost premium of $500 or more. The venting strategies for gas water heaters vary significantly. Sealed combustion water heaters carry an installed cost premium of at least $500. While the incidence of backdrafting from properly–maintained vented combustion appliances is unlikely to be significant, it is difficult to assess given all the factors—overall air tightness of the home, other systems such as clothes dryers, exhaust fans, fireplaces, and location of all of the above—that can play a role. The presence and design of fireplaces or wood stoves in a home are the most significant potential sources of backdrafting.

4. Balanced, whole-house ventilation and heat-recovery ventilation (HRV) systems: Whole house ventilation systems actively bring in outside air and exhaust indoor air at a desired exchange rate. These systems are often called balanced ventilation systems because the exhaust and intake are equal and the active ventilation system neither pressurizes nor depressurizes the home. Heat-recovery ventilators are balanced, whole-house ventilation systems that also have a heat exchanger so that stale, warm indoor air can, to a large extent, give off its heat content to incoming fresh, cold air. HVAC systems that also include an integral HRV component are available.

NOTE: Energy recovery ventilators (ERVs) exchange sensible and latent heat; that is they deal with both heat content of the air and the moisture in the air. In general, ERVs serve balanced, whole-house ventilation needs in areas with any significant hot and humid season.

C/A/P: The installed cost of these systems is generally between $1,000 and $2,000 (The majority of the cost is for the air exchange equipment—the heat recovery components have only a modest impact on the total installed cost). An active air exchange system is highly recommended, if not required, in homes with air changes per hour (ACH) of less than .35.

NOTE: There are a variety of less sophisticated and less expensive ventilation strategies—variations on exhaust and supply ventilation systems—which are currently being evaluated for their effectiveness and impact on air movement and air exchange. No recommendations on these alternative systems can be made at this time, but builders are encouraged to seek the most current information from the NAHB Research Center or the Home Ventilation Institute.

Table 9 – Indoor Air Quality Checklist Summary

Criterion	Green Builder Programs				
	Austin	**Denver**	**Kitsap**	**Central New Mexico**	**Guide Recommendations**
Source Control					
Low/no VOC paints, solvents, adhesives	R	E	E	R	E
Formaldehyde-free/sealed particle board	E	E	E		E
Carpet area limitations	E		E		
Detached garage	E				E
Central vac	E				E
Vented, locked storage area	E		E	E	E
Radon slab venting		E			E
Ventilation					
Local Exhaust fans	E		R	E	R
Garage exhaust fan	E	E			R
Power venting for combustion furnaces and water heating eqpt.	E	E	E	E	E
Whole-house & heat recovery ventilation	E	E	E		E
Filtration					
Pleated, paper	R		E		R
HEPA		E	E		
Electrostatic	NO		E		E
Electronic	E	E	E		E

Filtration – Levels of air-born particulates can be reduced with air filtration systems. Homes with a central forced-air heating/cooling system have a filter that is primarily designed to protect the mechanical distribution system, not to enhance indoor air quality for occupants. These filters can, however, be easily replaced with much higher efficiency filters. The following chart describes the approximate particle size of some agents of poor indoor air quality that can be controlled with air filtration systems (hair and viruses are included for purpose of comparison):

Agents	Particle size (μm)[7]
1. Hair (diameter)	100
2. Environmental Tobacco Smoke	.1 - 1
3. Dust Mite Allergens	10 - 20
4. Pollen Allergens	15 - 25
5. Pet Dander Allergens	.5 - 1.5
6. Fungi and Molds	2 - 10
7. Endotoxins (from leaf litter)	<.1 - 1
8. Household Dust	1 - 100
9. Viruses	.001 - .1

In the past, the efficiency of air filters has been characterized according to three different tests:

1. Weight-arrestance - The weight-arrestance test is not very useful for evaluating a filter's impact on a home's indoor air quality because it is heavily biased towards "larger" particles (8 microns and up)—a rating of even "95% efficiency" tells little about how this filter works on many of the agents listed above.

2. Dust-spot efficiency - The dust-spot efficiency test is a better measure because it reflects particle sizes from 0.3 to 6 microns—a dust spot efficiency of even 60% reflects a filter capable of handling most respirable elements including tobacco smoke.

3. DOP smoke test - The best test for characterizing the efficiency of "super" filters is the DOP test—this test is often used for high efficiency particulate air (HEPA) filters. HEPA filters are generally considered to pick up at least 99% of all particles down to less than a single micron. True HEPA filters are not commonly used in residential applications.

The general problem with all three tests is that none accurately characterizes the full range of filter efficiency with varying particle size – they only report on a small portion of the spectrum. A new standard ASHRAE 52.2 – Method of Testing General Ventilation Air-cleaning Devices for Removal Efficiency by Particle Size, has been designed to give a complete rating of a filter's efficiency. The so-called MERV rating will be the best characterization and consumers/builders should request this information when selecting an air filter.

There are four alternative types of residential air filtration systems—pleated, electrostatic, electronic, and HEPA.

1. Pleated filters: In general, the finer the mechanical filter, the harder the fan motor has to work to overcome the added resistance. One way around this is to pleat or fold the filter, increasing the surface area of the filter. Pleated filters are available for residential HVAC systems from the standard 1-inch thickness up to 4-inch deep cartridges. 1-inch pleated filters can be substituted for conventional filters without modification; the deeper 4-inch cartridges involve a separate carriage which must be linked into the HVAC system. Most 1-inch pleated filters have a dust-spot efficiency of around 20%; the deeper cartridges have medium efficiencies of up to 65%. One program has a performance filtration specification of a minimum 25% dust spot efficiency that

[7] μm is the symbol for a micron. A micron is one millionth ($1x10^{-6}$) of a meter.

could be met with some 1-inch pleated filters and another program has a requirement of a minimum 1-inch pleated filter.

C/A/P: Pleated 1 inch filters are a little bit more expensive than standard 1 inch filters—standard filters are generally less than $2 and 1-inch pleated less than $4—but pleated filters last up to twice as long. The pleated filters are not always available at local building supply centers but can be readily ordered from national distributors.

2. Electrostatic filters: Many small particles have or easily acquire a static electrical charge and can be filtered out by passing the air through an electrically charged medium—either a filter that becomes charged as air passes through it or a filter that comes with pre-charged constituents. The advantage is that finer particles can be removed without increased air resistance. Electrostatic filters are not powered in any way and must be replaced or at least cleaned frequently to maintain effectiveness. "Reusable" or "washable" electrostatic filters have not been proven to develop sufficient charge to achieve a dust spot efficiency greater than 10%. Permanently-charged, electrostatic filters generally have a dust-spot efficiency greater than 25%—one manufacturer reports an average dust-spot efficiency of approximately 35%—and must be replaced every 2-3 months.

C/A/P: Electrostatic filters can be substituted for standard 1inch filters. Reusable or washable electrostatic filters are about $4 to $5. Permanently charged filters range from $10 to $20, depending on manufacturer and efficiency. The reusable, washable, electrostatic filters are not recommended.

3. HEPA or HEPA-like filters: These filters are also pleated, mechanical filters but their ultra-high efficiency can come with the price of very high air resistance.

C/A/P: Residential filters that range from medium efficiency to HEPA efficiency are available for new construction and retrofit for about the same installed cost (reported by one manufacturer in the range of $350 to $500). Replacement filter cartridges (annually) are around $50. This item is likely to be relevant only for special customers such as chronic allergy or asthma sufferers.

4. Electronic filters: Electrostatic precipitators use high-voltage electric current to create an electrostatic field that picks up charged small particles. There is no increase in air resistance with this type of filtration system.

C/A/P: This system's high efficiency is very dependent on frequent cleaning of the filter. Ozone generation is a natural outcome of the high-voltage electrostatic generation but the best systems produce very little. This system also has the operational cost of electricity usage. Electrostatic precipitators, although used in homes, are more commonly found in commercial HVAC systems.

<u>Homeowner Education/Actions</u> – Any investment that a builder makes towards indoor air quality in the *construction* of a house can be negated or significantly reduced by the *activities* of the home owner/operator. One program requires a "starter kit" for home owners, suggesting items such as "low-toxic cleaning supplies". Other items that could be included: "cracking" windows when operating the dryer or central vacuum system (types of exhaust fans) or kitchen/bath fans, airing out high VOC new purchases (drapes, furniture, etc.) Three programs give credit when the builder "airs" out the house prior to occupancy.

Guide Recommendations

1. Require: garage exhaust fan Or air-sealed garage-living space common wall Or detached garage Or no garage. This recommendation is based on the relative significance of the garage as a single source of air contaminants.
2. Require bath exhaust fans and a kitchen exhaust fan IF range top and/or oven are gas-fired. This recommendation is based on the significance of excessive moisture as a condition for many sources of poor indoor air quality.
3. Require indoor air quality information in homeowner's manual. Controlling indoor air quality is often in the hands of the occupants—moisture control, cleaning activities, home furnishing selection, exhaust fan use, home hobbies, etc.
4. A recommendation for carpet area limitations is not made based on cost and difficulties in fairly implementing the limitation. Consider giving credit for the use of carpets bearing the CRI IAQ label.
5. Credit for washable electrostatic air filters should not be given based on their over all lack of proven effectiveness.
6. A recommendation for HEPA filter systems is not made based on cost and their appropriateness in most residential applications.

Resources:

Understanding Ventilation, John Bower, The Healthy House Institute, 1995, $32. This text provides a thorough, easy-to-understand overview of indoor air quality considerations for the design and operation of buildings.

American Journal of Respiratory and Critical Care Medicine Volume 156, No. 3, [September, 1997] Part 2 Supplement: American Thoracic Society Workshop Report - Achieving Healthy Indoor Air):

Introduction to Indoor Air Quality: A Reference Manual, US Environmental Protection Agency, Office of Air and Radiation, Indoor Air Division, 1991, EPA/400/3-91/003.

Environmental Building News Product Catalog, a publication of E Build, Inc., Brattleboro, VT. Indoor air quality considerations for building materials are included under the category, Building Operations.

Building Materials for the Environmentally Hypersensitive, Canada Mortgage and Housing Corporation, 1995, $25. This is a directory of building materials commonly used in cold climates based on their contribution to indoor air quality for environmentally-sensitive individuals. The analysis of each building material is based on published reports and the practical, lay experiences of hyper-sensitive individuals.

Appendix I – A Discussion of Air Filtration for Residential Application, ASHRAE 62.2P – Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Building. This new standard is forthcoming and Appendix I is a good summary of filter media.

Model Standards and Techniques for Control of Radon in New Residential Buildings (15 pages). USEPA 402.R-94-009, March, 1994. A concise summary of the radon-residential features for homes.

Websites:

http://www.nrg-builder.com – Building Envelope Science and Technology. In addition to providing information on a wide range of green building topics, the site gives a good overview of IAQ concerns and ways to mitigate potential problems in the home.

http://www.epa.gov/iaq/homes.html – The Environmental Protection Agency site contains information on many indoor air quality topics – specific contaminants and pollutants, exposure, risk, and mitigation.

http://www.carpet-rug.com – The environmental section of the website provides information about the CRI IAQ labeling program.

http://www.its-canada.com/reed/iaq.htm – This site, also discussed in previous sections, provides many IAQ and related topics – sources, pollutants, controls, ventilation, and filtration.

9. Waste Management

Overview/Discussion

Waste management is a topic that extends from clearing the site to providing the homeowner with a kitchen recycling center. The focus of this content area, however, tends to be construction waste—cut-off scrap and packaging materials. HBAs are strongly encouraged to obtain copies of three Research Center publications:

- *Residential Construction Waste Management: A Builder's Field Guide*—the cost savings and other benefits associated with waste reduction and recycling of construction waste are presented through builder case studies from across the country.

- *Residential Construction Waste Management: A Coordinator's Guide to Conducting Workshops at the Local Level*—to be used with the Builder's Field Guide. This hand book takes individuals through the steps required to systematically and comprehensively explore obstacles and opportunities in waste reduction and recycling with key community players.

- *On-Site Grinding of Residential Construction Debris: The Indiana Grinder Pilot*—This report documents the environmental, technological, and economic feasibility of grinding all clean wood, cardboard, and drywall waste on the job site for use as soil amendment and erosion control material. In areas of the country where outlets for recycling wood, cardboard, and drywall are not available, this alternative to conventional landfilling can be cost-effective and convenient.

Waste management follows a hierarchy—reduction, reuse, recycling:

Waste Reduction – The biggest opportunities for builders to reduce waste are with efficient framing techniques and contract language. Wood waste, by volume or weight, is the single largest portion of the construction waste stream and there are lots of opportunities for most builders to use wood more efficiently. Contracts with various trades can be written to either impose or encourage waste reduction, regardless of whether the builder (general contractor) provides a general construction waste container.

Reuse – Reuse is different than recycling in that materials are not processed and keep their functional value or close to their intended use. Excess or slightly damaged building products can be reused at the job site, donated for a tax deduction to non-profit building supply centers, or transported to another job site.

Recycling – Cardboard, wood, drywall, metals, and some plastics are all recyclable, but their recyclability depends on quantity, quality, and the inherent value of the waste material. The issues for builders center around collection, separation, and transportation. The low value of some construction waste (wood and drywall) and the small quantities generated per site of others (metals and plastics) present challenges to the building and the waste management industries.

Review of Local Programs

Table 10 – Waste Management Checklist Summary

Criterion	Green Builder Programs				
	Austin	**Denver**	**Kitsap**	**Central New Mexico**	**Guide Recommendations**
Posted job-site recycling plan			R		R
Packaging waste	E		E		
Contract Language			E		E
Reuse, donate, sell excess materials	E		E		E
Recycle various cut-off wastes	E	E	E	E	E
Hazardous waste management					E
Homeowner recycling system	E	E	E	E	E

Job-site Recycling Plan – If done correctly, a recycling plan posted at the job-site accomplishes two things: it reminds anyone working on the site that the builder is serious about waste management and ensures that the approach is tailored to the conditions of that particular job site. A more appropriate title for this item is probably "waste management plan" because the job-site plan can, and in most cases does, include more than just recycling.

NOTE: The NAHB has partnered with the Keep America Beautiful (KAB) campaign to develop a program called Build America Beautiful. In addition to job site safety and general housekeeping items, the program gives credit for job site recycling. The program revolves around an annual recognition award program.

Cost/Availability/Practicality (C/A/P): This is a pretty flexible concept. The plan can be tailored to meet the conditions the builder faces—disposal and recycling costs, availability of outlets, and the feasibility of changing worker disposal habits. The plan is important because it is the first step a builder takes in recognizing and addressing waste as a management issue.

Packaging Waste – Packaging, mostly in the form of cardboard, can make up one-quarter of a job's waste by volume. Looking for ways to limit packaging waste or looking for products packaged in easily recyclable material such as cardboard can have a significant impact on disposal costs. Cardboard is generally a good packaging material because there are so many outlets nationwide for cardboard recycling.

C/A/P: Builders won't know what suppliers and manufacturers can do to limit packaging until they ask. No builder is going to select a building material solely on the type and amount of packaging but as a customer, a builder can get the word up the chain: the way that products are packaged affects a builder's bottom line.

Contract Language – The system that most efficiently discourages waste generation is one in which one individual or entity is responsible for purchasing, installing, and disposing of materials. The builder's contracts with various trades can tighten this loop of responsibility for waste generation.

C/A/P: One builder documented in Research Center study reduced disposal by 80% using contract language to shift disposal responsibility to trade contractors and eliminating container placement at the job site. Specific contract language for any line item depends on the type of job, the type of trade, and the degree of influence the general contractor has with the trade contractor. In general, larger and/or commercial builders have been more successful with this approach than smaller and/or residential builders.

Reusing Materials – Mis-ordered or slightly-damaged doors, windows, and cabinets are finished goods with high-reuse potential. Commodity items such as drywall and framing often result in large quantities of less valuable, reusable cut-off waste.

C/A/P: The feasibility of donating building materials most often depends on the availability of a used building supply center and the capability of this retailer to pick up the materials in a timely fashion. The feasibility of reusing cut-off materials on a job site is based on a balance between labor costs/labor quality and material purchase/disposal costs.

Recycling Land Clearing Materials – Stockpiling site top soil for distribution after homes are built is a standard practice in many developments and is discussed under site development. The burying and burning of land clearing debris is not the environmentally-preferred option and illegal in many jurisdictions across the U.S.

C/A/P: Special grinders and/or splitters are required for large-dimension "weed" trees and stumps. Not all wood processors have the type of equipment required for land clearing materials. Economies of scale can make site-processing of woody landclearing debris more relevant for tract builders. Alternatively, builders/developers can investigate wood-processing capabilities of local haulers and landfills for processing these materials off-site.

Recycling Construction Waste – Wood, drywall, and cardboard make up 75% of the total waste from most residential construction sites. To get a good sense of how materials are handled on their job sites, builders can "audit" their own site waste containers to determine waste management opportunities.

C/A/P: Most builders think of job site recycling as requiring job site separation, lots of training, and multiple containers on site. Other more practical and widely economical approaches such as clean-up services and soil application of jobsite grinded wood and drywall are emerging. Refer to the resources for a complete discussion of the conditions that determine the cost-effectiveness and feasibility of construction waste recycling.

Hazardous Waste Management – Although the regulatory definition of hazardous waste puts the onus on the builder to make the determination (see NAHB publication under Resources), construction can generate small quantities of solvents, lubricants, paints, and coatings that can be classified as hazardous. While the quantities generated at construction sites generally don't require special consideration, there are two basic approaches to active construction hazmat management:

1. Use or switch to non-hazardous substitutes.
2. Recycle/dispose of hazardous waste at permitted facilities.

C/A/P: Water-based paints and finishes have come a long way in terms of performance and price—in both cases a subcontractor eliminates solvents and clean-up materials that can be considered hazardous. You can deal with the lion's share of potentially hazardous waste by making sure that your painting subcontractor has a waste management plan.

Homeowner Recycling System – These systems are typically base cabinet set-ups in kitchens or bin systems in garages. Several kitchen cabinet manufacturers produce these set-ups and bins for garages can be as simple as multiple containers color-coded for materials accepted at local facilities.

C/A/P: Depending upon individual preference and situation, costs can vary widely. New cabinetry and counter tops would be in the range of $30-$45 per lin. ft. Loose storage bins could be purchased for less than $10 apiece.

Guide Recommendations

- Require a posted job site waste management plan – Given the range of waste reduction and recycling options available to builders, the posted plan should not be too onerous and lets both customers and trade contractors know where the builder stands on the overall importance of this issue.
- Require an item of choice from this section and/or from efficient framing items.
- Consider NAHB Build America Beautiful program.

Resources:

Residential Construction Waste Management: A Builder's Field Guide, NAHB Research Center, January, 1997.

Waste Management: A Remodeler's Guide, NAHB Research Center, July, 1998.

Residential Construction Waste Management: A Coordinator's Guide for Conducting Local Workshops, NAHB Research Center, July, 1998.

The Regulation of Solid and Hazardous Wastes: A Builder's Guide, NAHB, March, 1994.

Build America Beautiful program: NAHB, (800) 368-5242, ext. 484.

Websites:

http://www.nahbrc.org – All of the Research Center materials can be found under Publications and the topic "Construction Waste Management."

http://www.oikos.com/library/waste/index.html – The site provides useful information about types and quantities of construction waste and disposal costs in the construction industry. Also, available are publications and brochures that can be helpful to builders in developing jobsite waste management plans.

http://www.ciwmb.ca.gov/ – Sponsored by the California Integrated Waste Management Board, this site provides lots of information regarding waste reduction and recycling. A searchable database locates published materials on specific topics.

http://www.recycle.net/recycle/build/index.html – This site contains a Recyclers' Exchange for used building materials.

http://ubma.pangea.ca/ – The Used Building Materials Association is the North American organization representing this industry. Good resource on salvaged building materials.

10. Water Efficiency - Indoor Use

Overview/Discussion

Although the relative importance of residential water usage as an environmental issue is very dependent on geography and geology, water conservation is an important element of all the green builder programs. The following table presents some average residential water consumption quantities:

Table 11 - Typical Indoor Household Water Use - 1998

Type of Use	Daily Use, gallons per person	Approximate % of total indoor use
Toilets	19.3	26.1
Clothes Washer	16.8	22.7
Showers	13.2	17.8
Faucets	11.4	15.4
Leaks	9.4	12.7
Other	1.6	2.1
Baths	1.3	1.8
Dishwashers	1.0	1.4
TOTAL	**74.0**	**100**

Source: water miser – 1998 American Water Works

NOTE: This table does not include residential water uses outside the home. Including outside uses brings the typical total to about 105 gallons per person per day (Typical residential water consumption for lawns, gardens, and car washing is highly variable across the country ranging from as low as 25 and up to 200 gallons per person per day).

This breakdown of water uses can be used to prioritize water conservation efforts:

1. Low-flow toilets are important because of the total number of gallons used in a typical home.
2. Horizontal axis clothes washers are important to consider because they use 30% less water and 40%-50% less energy.
3. Low-flow showerheads are the most important faucet type to consider because of the rank this form of bathing has in household water use. Their importance is increased by the added resources required for hot water.
4. Plumbing maintenance is important to include in home owner education because of the way in which small, constant leaks add up.
5. Lawns and gardens can be the largest consumer of unheated water—the types of plants selected, watering strategies employed, and irrigation technologies installed are all critical to water conservation. Outdoor water uses become increasingly important in arid regions where the demand can be greater and the supply more critical. Outdoor water use is covered in the next context area.

For homes on public water and sewage, water efficiency can be an important community issue. Just about every gallon of water that your local government purifies to meet consumption needs must also be treated after it is "used". In this way, two environmental issues are involved with water efficiency.

Review of Local Programs

The following table summarizes items on water efficiency from the five programs (NOTE: Items on lawn and garden plant selection are included in the discussion on the content area Landscaping).

Table 12 – Water Efficiency (Indoor) Checklist Summary

Criterion	**Green Builder Programs**				
	Austin	**Denver**	**Kitsap**	**Central New Mexico**	**Guide Recommendations**
Low flow toilets				R	
Low flow faucets (< 2.5 gpm)		E		R	E
Horizontal axis washer	E			E	E
Dishwasher w/ conservation cycle	E			R	
Hot water recirculation system				E	E
Homeowner Info	R	E			R

Low Flow Toilets – One program lists 1.6 gallons per flush (gpf) or less as a requirement, despite the fact that 1.6 gpf toilets are required by federal law for all new construction.

Cost/Availability/Practicality (C/A/P): Builder and consumer complaints on the performance of low-flow toilets are not uncommon. The lower the flow, the more important the design of the toilet becomes. Not all toilets are created equal—some brands/styles perform better than others. See the references at the end of this section for reports comparing various brands. Ultra low flow toilets exist (<1.6gpf), but are not widely marketed, nor included in most programs.

Low-Flow Faucets – Federal law requires that faucet and shower heads have flow rates no greater than 2.5 gallons per minute (gpm). Faucet and shower heads with flow rates of 2.0 and 1.5 gpm are available.

C/A/P: Performance complaints with reduced flow rates from consumers are most often associated with the "feel" of showerheads and clogging associated with equipment that reduces flow rate with small hole screening. Faucet and shower heads with flow rates less than 2.5 gpm that have the "feel" of higher flow and that are guaranteed against clogging are available—once again, not all brands are created equal. The added cost of higher-performance, low-flow heads is minimal, generally less than $25 per house.

Horizontal-Axis Washers – Residential, front-loading, tumbling washing machines can use as little as one-third the water compared to a conventional top-loading, center-agitator machine. They also save on drying requirements because they spin at much faster speeds, removing significantly more water than conventional washing machines. They also use as little as a quarter of the detergent normally required per load of clothing.

C/A/P: Several brands of residential horizontal-axis washers have been available for a number of years and so have performance track records. Drawbacks include mainly the first cost (they can be as much as twice as expensive as a conventional machine) and the less convenient front door for loading and unloading. A recent *Consumer Reports* reviewed 3 domestic h-axis clothes washers.

Water-Conserving Dishwashers – National efficiency standards for dishwashers established in 1994 mean that dishwashers use about 7 - 10 gallons per cycle. Energy- and water-efficiency are closely related in dishwashers except for booster heating and drying cycles. The most water-efficient dishwashers use as little as 3.9 gallons per cycle at the economy setting. Some of the most efficient dishwashers also operate significantly more quietly than the average dishwasher.

C/A/P: If you are going to supply this appliance to the home owner, you could probably market the choice from several perspectives: performance, water and energy efficiency, ease of use, total features, quiet operation, and reliability. This is a perfect example of where referring to *Consumer Reports* can really pay off. See the references at the end of this section.

Hot Water Recirculation System – With faucets distant enough from the water heater for significant heat loss, as much as 3 - 4 gallons of cooled water can be run down the drain waiting for hot water. There are a number of different systems/setups that address this problem. One system uses a timed pump and an extra recirculating plumbing run to keep the water in the line hot and recirculate cooled water back to the water heater rather than being wasted. Another uses the cold water line and a timed valve and pump to return cooled water to the hot water tank.

C/A/P: Some information is available on the performance of recirculation systems (See the references at the end of this section). This is one of the great examples of a energy and water conservation system that is also more convenient and provides greater comfort. Some have designs that result in both water and energy saved—others have designs that save water only and may have an energy penalty. One manufacturer reports an installed cost of approximately $350 for their system and annual energy savings of about $180 (there are many variables that will affect net costs and savings—price of water, sewer, and energy; distance between water heater and point of use, length of branch line from trunk, and user behavior).

Homeowner Education – Water efficiency is one of the content areas of green builder programs where there is the greatest opportunity for adding home owner actions to the conservation efforts of the builder. Suggestions for future landscaping, use of fertilizers and pesticides, watering techniques, and maintenance (leaks account for as much as 10% of total water use in existing homes) can all be important elements of a home owner manual.

C/A/P: A home owner manual or “starter” kit as one program describes it, can be incorporated into a builder’s marketing materials at a nominal cost. Local government agencies or county extension agents usually have resources ready for builder use.

Guide Recommendations

- Consider requiring at least one item of choice in addition to one requirement for homeowner education materials.
- Give credit for fixtures (toilets, faucets, showerheads) only if flow rate is below federal standard.
- Since all dishwashers on the market have energy and water-saving settings, only give credit if water consumption on normal wash setting is below federal standard.

Resources:

"An Energy-Saving Product That's Actually Convenient?," *Energy Design Update*, July, 1997, pg. 8. This article reviews one hot water recirc-system.

"Dishing Out Dollars," Consumer Reports, March, 1998, pg. 37. A comprehensive review of energy and water-efficient dishwashers.

"*Water Efficiency: Shopping for a Good Toilet or Showerhead*" a web site summary of several reports on low- flow toilets including 1995 Consumer Reports, Fine Homebuilding, and customer surveys from California and New York. *http://home.earthlink.net*

The Water Smart Home Program, Greater Atlanta Home Builders Association. This program is a well-designed and comprehensive water conservation program developed in partnership between the HBA and the Georgia Water Wise Council.

Websites:

http://www.plumbingworld.com – This company offers plumbing materials and supplies of all kinds for both inside the home and out. Very good for hard-to-find parts and supplies. Also, offers a line of drip irrigation materials.

http://www.consumerreports.org – Consumer Reports can now be obtained on-line for a fee. Reports on appliances are updated on a regular basis to reflect new products.

http://www.sustainable.doe.gov/index.html – Sponsored by the Department of Energy this site provides information, resources, and links regarding a number of green building topics including: resource-efficient materials, indoor air quality, waste management, water efficiency, codes and ordinances. Case studies of successful projects around the country offer examples of how communities have implemented various strategies.

http://www.waterwiser.org– This site is a good jumping off point for accessing information on all aspects of water conservation. Sites pertaining to water conserving appliances, drip irrigation, xeriscape, landscaping, and community water conservation programs are listed by category.

http://www.water.usgs.gov – The U.S. Geological Survey provides extensive information and data regarding state and regional water use and water quality. In addition to numerous fact sheets, information about the condition of local streams and waterways is available.

11. Water Efficiency - Outdoor Use

Overview/Discussion

In regions of the country where annual rainfall is less than 25 inches per year (typically the western U.S.), outdoor watering often comprises over 50% of a household's seasonal water use. Purifying water to the point we can drink it, and then running it through the garden hose to water the grass and the roses results in potentially unnecessary pressure upon both our natural and our municipal resources.

Currently, the price that is paid for water does not necessarily reflect either the costs of purification and treatment or supply and demand. For example, although Utah has the second highest per capita potable water use in the country (308gpd), its water rates are the nation's third lowest ($1.16 per 1,000 gallons). And, estimates indicate that current supply will be inadequate, given expected population growth and demographics. Future needs will necessarily be met by importing water from neighboring Wyoming and Idaho and through desalination of irrigation water. This will require major expansion of existing infrastructure at an expense of several hundred million dollars.

Such a scenario is not peculiar to the more arid western states. Across the country, we are depleting aquifers faster than they are being replenished. Competing uses of potable water will need to be more carefully prioritized and sensible practices developed, especially in more densely populated areas.

Even in areas where there is adequate rainfall, choosing native plants can reduce required maintenance and the need for extensive use of fertilizers and pest control. Although the agricultural sector is most often labeled as the worst offender with respect to pollution resulting from petroleum based chemicals, studies have shown that the runoff water from many urban and suburban areas are major sources of pesticides, petroleum products, and other chemicals.

Review of Local Programs

Communities have several objectives in mind with respect to the landscaping and outdoor water conservation portions of their green building programs:

- To encourage the use of turf and other landscaping materials that are climate and soil appropriate.
- To reduce reliance upon chemical fertilizers and pesticides.
- To preserve or re-introduce native plant species.

Table 13 – Water Efficiency (Outdoor) Checklist Summary

Criterion	Green Builder Programs				
	Austin	**Denver**	**Kitsap**	**Central New Mexico**	**Guide Recommendations**
Planting & irrigation design plans				E	E
Local water budgets				E	
Native &/or drought resistant plants	E	E	E	E	E
Retain existing vegetation	E		E		E
Plant trees for shade, buffer	E		E		E
Minimize turf grass area &/or choose low water varieties	E	E			E
Drip irrigation	E		E	E	E
Rainwater catchment or alternative supply for irrigation	E		E	E	E
Automatic timers/irrigation technology	E			E	E
Patios & pathways of pervious materials		E	E		E
Appropriate plant & landscaping materials, care		E			E

Planting & Irrigation Plans – Typically, the home owner does not give a great deal of thought to landscaping details until the home is almost complete. In many cases, the builder is not involved in this portion of the project at all. By considering the location and type of plants, grasses, and trees early in the design phase of the project, one can gain several advantages:

- Topsoil can be placed strategically, drainage patterns created, and contours shaped during the backfill and grading phases.
- Adequate holes for planting trees can be dug while a backhoe is on site.
- Provision for landscaping costs can be made early in the project and included in the budget.

Cost/Availability/Practicality (C/A/P): A Landscape Architect can provide useful information about soil type, plant varieties, and light, nutrient, and water requirements. Planting and irrigation plans do not necessarily require the services of a Landscape Architect which could add $600-$800 to design costs. Principles of landscape planning are well described in the references at the end of this section. Information regarding specific plant varieties is also available through local nurseries, soil and water conservation departments, and numerous published sources.

Local Water Budgets – The average household in the U.S. uses 100 gallons of water per day for outdoor uses alone. Some communities have developed budgets specifying allowable water use by various sectors and impose financial penalties if these amounts are exceeded. The state of California has mandated all cities and counties to implement landscape conservation requirements and

incorporate them into their building permit process. The city of Austin's approach to water budgets is discussed in Section 13 – Home Owner Opportunities.

Separate metering of outdoor water lines is another way in which home owners can monitor and control their outdoor water usage. By clearly indicating the proportion of water that literally runs into the ground, a separate meter can provide incentive to reduce the need for additional watering or to find alternative sources of water supply.

C/A/P: The cost of developing and implementing a formal community-wide water budget would fall primarily upon the municipality. A builder or owner might also develop their own informal budget in order to help control usage more effectively. As indicated in Section 13, developing individual water budgets is fairly time-consuming for the contractor.

The cost of installing a separately metered outdoor hose bibs for a 30'x 40' house would be in the range of $300-$500. Currently, financial incentive for such a measure does not exist. With the average water rate in the U.S. at $1.87 per 10,000 gallons, the payback period does not support this option.

Native and/or Drought Resistant Plants – Native plants have evolved and survived in certain areas precisely because they are suited to a particular environment without the input of additional nutrients, fertilizers, or water. Even plants that are not necessarily found in the particular region but are from areas similar in climate, rainfall, and soil type are preferable to those that are "forced."

C/A/P: Local nurseries and mail order seed companies are sources of both information as well as plants and seeds. The cost of varieties of plants that will thrive in particular areas depends upon individual preferences.

Plant Trees for Shade or Buffer – Trees not only add aesthetic value to a property but also provide wildlife habitat and a means of micro-climate control. Trees serve as a natural air conditioner and cleanser by providing shade and evaporate cooling. Strategically locating deciduous trees on the south, east, and west sides of a home will shade glazed areas during the summer months but allow for solar gain throughout the heating season. Stands of evergreen trees should be placed to the north or west as buffers to prevailing winter winds.

C/A/P: Depending upon size and type, trees can range in cost from $25 to several hundred dollars. Local nurseries usually have a large selection of species that are suitable for a particular area. Larger trees can be transplanted but require a backhoe to increase the chances for survival.

Minimize Turf Grass Area/Choose Low-Water Varieties – It has been estimated that the well-manicured lawn can require as much as 5-10 pounds of pesticides per acre per year. Recent studies show that gas-powered lawn mower can create as much pollution in 30 minutes as a car driven 172 miles. Replacing resource intensive turf grasses with species of native plants and grasses or wildflowers not only reduces required maintenance and the need for chemical applications but also can aid in the restoration of species that may be threatened with extinction. The Denver Water Board gives an overall outdoor efficiency rating based on scores in the following areas:

- Total turf area (higher score for less square footage)
- Irrigation method (higher score for systems with sensors and zones)

- Irrigation controller (more points for automated digital control)
- Turf type and xeriscaping (more points for appropriate turf and turf replaced with xeriscape)
- Turf root plug (soil amendment for deeper turf plugs and higher applications of beneficial (soil amendment)
- Maintenance (more points for well-maintained landscaping)
- Slope treatment (more points for lower-sloped turf/landscaped areas)

C/A/P: The selection of seed or sod is based on a variety of factors: cost, appearance, maintenance requirements, and water requirements. There are no set relationships among these factors; drought-tolerant or lower water-needs turf grasses are not necessarily more or less expensive than other grass varieties. Builders' or homeowners' best bet is to contact their local county extension agriculture agent for guidance.

Drip Irrigation – 30% to 70% of the total water applied by conventional spray watering systems can be lost to evaporation and run-off. Drip irrigation systems can be surface or buried—surface systems can be installed after home completion by the owner whereas subsurface systems are completed as part of contractor's landscaping plan. The reduced flow rate and elimination of airborne delivery makes these systems significantly more efficient—their efficiency is, however, very dependent on proper installation. Another advantage of drip irrigation systems is the lowered potential for leaf mold/ mildew growth and weeds because the water is targeted for the root zone of the planted vegetation.

C/A/P: Depending upon soil type and the number of emitters, the materials for a drip irrigation system will cost approximately $250 per 1,000 lin. ft. Materials are readily available from plumbing suppliers and can be installed from existing hosebibs relatively easily. With a drip irrigation system, there is also the added convenience of eliminating the need to continually move hoses and sprinklers.

Rain Water Recovery – For watering purposes, a rain water recovery system can be as simple as roof gutters with downspouts directed into catchment barrels. More sophisticated systems for meeting whole-house potable water needs have significant requirements—minimum catchment area, specific roofing material, protected and large storage tanks, water treatment etc.).

C/A/P: Rain water recovery systems attached to some type of distribution system will most likely require a pump and therefore a filtration system to protect the pump. Simple rain barrel systems that connect directly to gutters and have a garden hose outlet range from approximately $100 to $200.

Greywater Recovery – Although definitions vary, generally greywater is all the waste water from a residence except the waste water from toilets (this water is often referred to as black water). This accounts for at least 60% of the water demands of a typical house. The "cleaner" nature of greywater means that, with minimal treatment, it can be used for below-grade irrigation.

C/A/P: Greywater recovery systems are not accepted or recognized in many state building codes. The system's performance is closely related to what homeowner's put down the drain (cleaning agents, diaper washing, etc.). The added cost of greywater systems, particularly for homes with public sewage, and the regulatory hurdles, makes the systems relevant only in limited regions.

Automatic Timers/Irrigation Technology – Programmable switches, timers, and rain sensors can all improve the efficiency of the delivery system. Automated irrigation systems that are not in some way responsive to watering needs can actually result in higher than average water use.

C/A/P: Separate timers for watering systems run between $30 and $50. Irrigation controllers (which can include a programmable timer, switching valves, and rain delay system) run.

Pervious Materials – Using pervious materials for patios, paths, and driveways allows for natural drainage and enables water to be re-absorbed into the soil. Among suitable materials and methods are stone dust, gravel, crushed stone and combinations of clay and sand as a hard base. Paving stones or brick laid in a pervious material will also allow for more uniform drainage than those set in mortar.

C/A/P: Typically, sand, gravel, and crushed stone will be relatively low in price. However, a surface suitable for automobile use may require a clay-type base and cost as much as 40% more than asphalt. Some dislike the use of strictly granular materials for paths and walks due to the fact that dirt and dust can be tracked indoors more easily. Brick, stone, and slate will be significantly more expensive than asphalt or concrete with materials ranging in price from $1.50/sf to $3.50/sf.

Appropriate Plant and Landscaping Materials – By providing the home owner with a list of plants that are well-suited to the local environment, the builder increases the likelihood that such materials will be used. Owners often build their own decks, patios, or outdoor sheds. Providing them with information about more environmentally benign building materials that are suitable for outdoor use can also be helpful.

C/A/P: The main cost associated with this measure consists of the time involved in gathering information regarding materials and sources of supply. Local nurseries and Ag-Extension offices are good sources of information.

Guide Recommendations

- Consider requiring one item of choice from this content area.
- Do not offer credit for items required by other local regulations, for instance, existing water or tree ordinances.

Resources:

The Resource Guide to Sustainable Landscapes and Gardens, Environmental Resources, Inc., Salt Lake City, Utah. Lists over 1,100 environmentally responsible landscaping materials.

Guide to Resource Efficient Building Elements, 6th Edition, Center for Resourceful Building Technology. This book provides a listing of resource efficient building materials and systems according to product category. Names of suppliers are given with addresses and phone numbers. A section is specifically devoted to Landscaping materials. Information on cost is not provided.

Websites:

http://www.plumbingworld.com – This company offers plumbing materials and supplies of all kinds for both inside the home and out. Very good for hard-to-find parts and supplies. Also, offers a line of drip irrigation materials.

http://www.floridaplants.com – Although oriented to Florida as the name implies, this site offers numerous books on all topics from draught tolerant plants and grasses to landscape design to pest management. In addition to printed publications, there is good information about specific trees, plants, and grasses – soil, water, and light conditions as well as disease control. A useful site whether you live in Florida or not.

http://cru43.cahe.wsu.edu – Sponsored by the Washington State Cooperative Extension, this site provides solid information about all types vegetation particularly well-suited to climates within the state. Information regarding drip irrigation, organic fertilizers and pest control, and other topics pertinent to reducing water use for the lawn and garden is available. Similar sites can be found for most states across the country.

http://www.sustainable.doe.gov/index.html – Sponsored by the Department of Energy this site provides information, resources, and links regarding a number of green building topics including: resource-efficient materials, indoor air quality, waste management, water efficiency, codes and ordinances. Case studies of successful projects around the country offer examples of how communities have implemented various strategies.

http://waterwiser.org – This site is a good jumping off point for accessing information on all aspects of water conservation. Sites pertaining to water conserving appliances, drip irrigation, xeriscape, landscaping, and community water conservation programs are listed by category.

http://www.water.usgs.gov – The U.S. Geological Survey provides extensive information and data regarding state and regional water use and water quality. In addition to numerous fact sheets, information about the condition of local streams and waterways is available.

http://www.rio.com/ – This web site hosts a powerful web search tool that gives access to many water conservation resources. Type in “rain barrel” for access to several distributors of rain water catchment systems, “drip irrigation” for access to many resources on this topic.

12. Home Owner Opportunities

Overview/Discussion

A natural extension of resource-efficient design and construction is resource-efficient home *operation*. If a builder makes an investment in the first two, it makes sense for the home owner to at least be aware of all the opportunities there are to continue the process. A home owner's manual created by the green builder program and/or the individual builder can accomplish three objectives:

1. ***Highlight*** many of the resource-efficient techniques, materials, or systems that the builder has included in the home.
2. ***Provide*** information on resource-efficient operation, maintenance, and eventual repair/replacement of materials or components in the home.
3. ***Connect*** the purchase of a home from a builder member of the program to the ongoing maintenance and potential future renovation of the home by other members of the same green building program.

For many topics—water conservation, landscaping, energy conservation—local government agencies will have resources that builders can include in their home owner's manual. The cost to the builder for most items under the home owner content area is just the initial cost of developing the manual—the informational materials are often free. And equally important, most of the information on resource-efficient home ownership and operation *saves* the home owner money.

Review of Local Programs

Only one HBA green builder program—the Build a Better Kitsap—has a content area dedicated to the homeowner's role. The Kitsap program requires builders to develop a "home owner starter kit" with suggestions to builders on the contents of the kit. All other HBA programs have recommendations on specific information that builders can pass on to their homeowners and these recommendations are elective elements of the programs individually addressed under the appropriate content areas.

Lawn & Garden Design/Care – Most of the information that builders can provide to home owners on this topic pertains to climate and soil, appropriate selection of grasses and plants, and environmentally-benign pest management. Builders might offer lists of local suppliers of mulch, native plants and grasses, and draught-tolerant turf grass. Given the widespread use of chemical fertilizers, pesticides, and herbicides by the home gardener, information regarding organic plant protection and Integrated Pest Management would be particularly useful. Free informational materials on lawn and garden care are usually available from county agricultural extension agents or local Soil Conservation Service offices.

Cost/Availability/Practicality (C/A/P): The relationship between the first-time cost of climate/soil appropriate grasses and plants and other varieties can vary widely. In the long run, however, the selection of grasses and plants that require less water and fertilization saves time and money for the home owner. The comparative aesthetics of one type of grass or shrub to another is left to the preferences of the home owner and are difficult to incorporate into costs.

Table 14 – Homeowner Opportunities Checklist Summary

Criterion	Green Builder Programs				
	Austin	**Denver**	**Kitsap**	**Central New Mexico**	**Guide Recommendations**
Lawn & garden design/care	R	E	E	R	E
Water conservation tips/water budget	R/E		E	R	E
Appliance selection	E	E	E		E
HVAC operation/ maintenance	R		E		R
Proper hazmat management			E		E
Household cleaning			E		E
Energy conservation tips			E		E
Furnishings selection					
Recycle/compost bins		E	E	E	E
Future remodeling tips					E
Painting and finishing tips			E		E

Water Conservation Tips/Water Budget – Information on water conservation can range from the proper operation of dishwashers to the maintenance of faucets to irrigation systems for lawn and garden. The Austin program gives a spreadsheet and sample water budget in their builder's Sourcebook and the SMBIA program gives elective credit to builders supplying home owners with a water budget.

C/A/P: Many counties and states provide free information on water conservation and the U.S. Dept. of HUD has information on residential water budgets from a 1984 project. The cost-effectiveness and practicality of water-saving appliances and landscaping are covered in other content areas. The Austin program has found the development of individual water budgets by builders for home owners to be time-consuming—providing home owners with general information on the relative savings from various systems and techniques is more practical.

Appliance Selection – Several programs give credit for builders providing a list of more energy-efficient major appliances—stove, refrigerator, washer, dryer—appliances which the builder may not provide with the sale of the house. Lists of this type may be available from local utilities or government agencies.

C/A/P: Appliances are covered in the Energy content area of this report. The development of a list may involve an initial cost or not, depending on the availability of free information from local sources.

HVAC Operation/Maintenance – The provision of information on proper HVAC operation and maintenance can lead to significant savings and greater comfort for the home owner. This information is particularly important if the system is different—in size, appearance, mechanical properties—from conventional units.

C/A/P: The builder has a vested interest in showcasing the superior performance, durability, comfort or energy savings if the system is operated and maintained properly. This is a perfect example of how the builder can capitalize with the home owner on his initial investment in resource-efficient construction.

Proper Hazmat Management – There are many special waste materials—waste oil, anti-freeze, waste solvents, lead-acid or nicad batteries—that home owners can generate. All of these materials can be recycled or warrant special disposal. Information on the handling of these materials is usually available from a local solid waste department or public works for inclusion into the home owner's manual or starter kit.

C/A/P: The cost to the builder is the minimal investment in gathering the information. In most cases, local agencies gladly provide these resources in bulk for use in builder programs.

Household Cleaning – Common cleaning products vary widely in their impact on solid waste management, waste water management, child safety, and indoor air quality. Information on cleaning agents which are more benign can demonstrate the commitment to the environment that the builder is looking to share with the home owner. With this information, the builder has the opportunity to showcase the selection of building materials which require less maintenance or cleaning.

C/A/P: Biodegradable cleaning products are available for many day-to-day cleaning tasks. Laundry and dishwashing soaps are readily available at most retail stores. Furniture waxes and polishes made from natural ingredients may have to be purchased from the manufacturer via mail order. Costs of these products vary considerably. Local resources such as water quality and sewage treatment departments may have information about products that are less harmful to the environment.

Energy Conservation Tips – There are a variety of actions which home owners take that affect household energy consumption—thermostat and water heater settings, appliance and lighting uses, etc. It can be useful to the homeowner to know the impact of their energy use actions. Examples include the percent of savings associated with a one degree change in thermostat set point or the energy saved with fluorescent instead of incandescent lighting.

C/A/P: This type of information is usually readily available at the local level. Resources cited at the end of this section may help with that endeavor.

The costs to the home owner will vary depending upon the item. Setting back thermostats on HVAC or water heating equipment can actually save money in fuel costs. Likewise, depending upon the climate, turning back the household thermostat 5º for even 8 hours will result in energy savings ranging from approximately 6% to 10%. Products such as programmable thermostats do vary widely in cost but those that will serve the basic purpose of an automatic night-time setback can be purchased for approximately $40-$60.

A compact fluorescent bulb will cost approximately $12 -$15 but will use 35% less electricity and will last more than 10 times as long. Furthermore, earlier objections to the quality of fluorescent light no longer hold much weight since newer bulbs produce a warm light very similar to incandescent and the electronic ballasts eliminate the hum, flicker, and delayed illumination time.

Furnishings Selection – If the builder is marketing his homes based on more judicious selection of building materials for their resource-efficiency or contribution to indoor air quality, then the builder can follow up on these actions with suggestions to the home owner on judicious selection of home furnishings such as curtains, carpets, furniture, etc.

C/A/P: Fabrics, carpets, and furniture that are made from natural organic fiber are becoming increasingly available. However, for materials that are completely free of any chemical residue whatsoever, it is likely that one would have to seek out a specialty manufacturer or distributer. The costs of such items typically start at the high end of the price range for conventional products.

Recycle/Compost Bins – Several programs give credit for the provision of recycling or compost bins. They represent concrete examples of connecting builder and home owner commitments to the environment. Local solid waste agencies or agricultural extension agents usually can give guidance on the acceptability and proper design and use of compost bins (there can be significant variation in amounts and types of materials that various compost units accept and that local jurisdictions permit).

C/A/P: Most millwork manufacturers include recycling centers within their cabinetry lines. The cost of including such an area within the kitchen varies depending upon the style desired. Installing bins in existing base cabinets or closets could be done fairly inexpensively. If one were to invest in new cabinetry that included factory installed pull-out bins, the cost could be approximately $30/lin. ft.-$45/lin. ft. There would also be the additional cost associated with the extra floor space that might be required in new construction. A backyard composting center could cost as little as the price of a pitchfork or approximately $60-$100 for a ready-made compost bin.

Future Remodeling Tips – If the builder has taken special steps to facilitate future additions or sees an opportunity to link existing "green" features of the home with subsequent potential renovation, the homeowner's manual gives the builder the opportunity to make the case to the home owner. Examples include:

1. Builder located home on lot to easily accommodate a gable end addition. This can be presented as a resource-efficient feature of the home in terms of giving the home greater long-term utility and permitting structural renovation without large headers for new openings.
2. Builder has carefully designed home with modular dimensions. Builder reminds home owner of this resource-efficient design feature and the idea to build on this commitment by considering modular dimensions in any subsequent additions.

C/A/P: Such measures typically will add little, if any, to the initial cost of the project. In fact, in most cases, savings will be realized. In addition, the home owner's options for future renovation or expansion are likely to increase since alterations will be easier to incorporate given the existing building.

Painting and Finishing Tips – Similar to tips on household cleaning, tips on painting and finishing—activities that can involve environmental considerations from the waste disposal and indoor air quality perspectives—can build on the builder's efforts within the green builder program.

C/A/P: With increasing concern for indoor air quality and chemical sensitivities, a wide range of non-toxic low-VOC paints, stains, and finishes is available. Several large paint manufacturers have added a line of low-VOC paints to their conventional paints. The performance and durability of these products

have been comparable to conventional products with anecdotal evidence suggesting a range of performance. Typically, the paints and water-based urethanes are available in the usual finishes; however, color selection may be more limited. The cost of these paints and finishes varies from being comparably priced to significantly more expensive than conventional products.

Guide Recommendations

1. We strongly recommend that a homeowner handbook is developed as part of the program materials, and that its distribution with each project is a requirement of the program.

Resources:

Environmental Building News Product Catalog, joint publication of E Build, Inc. and What's Working, 1997/98, $59. This catalog provides environmental, cost, and availability information for over 70 building materials. The catalog is set up in a 3-ring binder format for easy growth of the catalog. As with the well-known Sweet's catalog, product literature from the manufacturer is provided but added is the editors' environmental profile of the product base on their green material selection criteria. An environmental overview for each major building material category (following CSI classification) starts each section of the catalog.

Green Building Resource Guide, John Hermannsson AIA Architect, Taunton Press, 1997, $37.95. The *Green Building Resource Guide* lists over 600 building materials. Names and addresses of suppliers are given as well as a brief description of the product. Cost information is provided on a relative basis as compared to a similar conventional product. The *Guide* is also available on CD-ROM.

Consumer Guide to Energy Savings, Alex Wilson and John Morrill, American Council for Energy Efficient Economy, 1998. This book provides excellent tips on ways to conserve energy around the home. Topics regarding tightening up your house, heating and cooling your home more efficiently, lighting options, cooking, and food storage are included. Options ranging from simple things the home owner can do at no cost to replacement of inefficient equipment is discussed.

The Green Pages: The Contract Interior Designers' Guide to Environmentally Responsible Products and Materials, Andrew Funston, Kim Plaskon Nadel, Jory Prober, New York, NY. Listings of environmentally responsible building materials from 536 manufacturers. Includes information on flooring, furnishings, fabrics, paints, appliances, lighting, and more.

The Borrowers' Guide to Financing Solar Energy Systems, (DOE/GO-10098-660), Dr. Patrina Eiffert, National Renewable Energy Laboratory, Golden, CO, September, 1998.

Websites:

http://www.floridaplants.com – Although oriented to Florida as the name implies, this site offers numerous books on all topics from draught tolerant plants and grasses to landscape design to pest management. In addition to printed publications, there is good information about specific trees, plants,

and grasses – soil, water, and light conditions as well as disease control. A useful site whether you live in Florida or not.

http://www.ctr.uvm.edu/ctr/gd – This site of the University of Vermont Extension Center offers comprehensive information about lawn and garden pests and diseases. Causes, symptoms, and control methods are given about specific species and varieties. There is also good information regarding Integrated Pest Management (IPM).

http://www.gvrd.bc.ca/waste/bro/dlcde.html – Sponsored by the city of Vancouver, British Columbia, this site provides information on waste reduction with sections specifically addressing opportunities for the construction site and the home owner.

http://www.hammock.ifas.ufl.edu/sustain/consum.html – This University of Florida web site describes a homeowners' manual entitled Eco Home with focus areas including energy conservation, household waste management, and product selection.

http://www.greenmoney.com/pub/greenpub.htm – This site gives a very broad range of resources on green consumer publications. While many of the resources can certainly not be characterized as mainstream, readers can do their own sorting through the material.

http://www.emagazine.com/ - This is the web site for the Environmental Magazine. This, too, is a very broad-ranging resource that does include access to information on resource-efficient home operation systems and products.

http://www.oikos.com/ – In addition to being a useful site for the builder who is trying to locate environmentally responsible building materials, the searchable database provides home owners with name and phone numbers of green products for use both inside and out. Among types of the products are paving and landscaping materials, furnishings, floor coverings, paints and stains. The library, bookstore, and back issues of Energy Source Builder magazine also may provide information of interest.

http://www.realgoods.com/products/ – The Real Goods catalog store offers a variety of resource-efficient home products ranging from composting bins to fluorescent lighting to bio-degradable cleaning agents.

13. Business Operations

Overview/Discussion

It is certainly possible for builders themselves to incorporate some of the practices recommended for home owners into their own offices and businesses. Whether a program chooses to qualify projects or builders, points could be awarded for measures that a contractor takes to practice what is preached.

A growing number of businesses -- primarily in industrial or manufacturing processes -- have found that many practices which are more environmentally sustainable make economic sense as well. While initial investments or retooling costs may be higher, savings are found in operational and waste disposal costs. Payback periods can be relatively short. In addition, many companies have found that employee's attitudes and motivation improve when they feel their work environment and their actions have beneficial implications on a larger scale.

Several EPA sponsored programs are available to assist businesses in developing more environmentally conscientious practices.

- Waste Wi$e provides businesses with information on ways to reduce the amount of waste generated. In addition to electronic and printed material, a hotline is available to offer technical assistance. A builder makes no financial investment to become a Waste Wi$e member. Instead, he makes a commitment to develop and implement a waste program specifically tailored to the size and nature of his business. He is then given recognition in various trade journals and publications and opportunity to use the Waste Wi$e logo in advertising.

- EPA's Green Lights program helps business and industry partners incorporate more energy efficient lighting in their buildings. A business makes a commitment to install energy efficient lighting if and where it is cost effective. Numerous publications as well as a hotline are available to provide information on various types of lighting, guidelines to assess current electricity use and potential savings, and specific steps to take in implementing lighting upgrades. Through this program, a builder has access to a wealth of information regarding efficient lighting strategies which can be used in his own office as well as in his customer's homes.

Review of Local Programs

Although none of the existing Green Builder programs include a section regarding business operations, many of the same elements that apply to the construction, operation, and maintenance of a home apply to the office or jobsite as well. A list of possible measures that builders can take in their own day-to-day operations includes the following:

Waste Management/Resource Efficiency

- Develop a company waste reduction and recycling program and implementation plan.
- Target waste reduction goals, e.g., 10%, 20%, 30%.
- Increase the percentage of office supplies/furnishings that contain recycled or renewable materials.

Waste Reduction – Specific waste reduction items for the office can include:

1. Bulk purchases to reduce packaging waste.
2. Double-sided photo copying.
3. Reusable coffee cups, utensils, etc.

Program development committee members can develop items based on their own business and practices.

Cost/Availability/Practicality (C/A/P): By reducing the amount of waste generated, a builder not only reduces disposal costs but also the amount of new material purchased. This applies to the office as well as the job site.

Recycling – Recycling paper, cardboard, plastics, and aluminum can be accomplished as easily in the office as in the home. Clearly marked boxes or containers must be placed at convenient locations and arrangements made for curbside pickup.

C/A/P: The availability of curbside recycling for businesses varies widely. When available, municipal curbside recycling is usually free and can result in lower waste disposal costs. Commercial haulers will often give a different rate for a paper/cardboard container, given sufficient quantities.

Recyclable/Renewable Content – This aspect applies to both day-to-day supplies as well as the more permanent "attached" materials within an office. Obvious examples of supplies would be paper, while examples of the latter might be carpet, upholstered furniture, or the building materials themselves.

C/A/P: Many office supplies such as paper, folders, notebooks, and other miscellaneous items made from recycled paper or plastic are readily available at little or no additional cost. Carpet and pads that are made of recycled plastic are becoming more widely available at costs comparable to conventional carpet. Other flooring materials such as natural linoleum or bamboo are more difficult to find and their cost would range from slightly less than to approximately the equivalent of hardwood.

<u>Cleaning/Maintenance of Tools, Equipment, and Vehicles</u> – Regular maintenance of electrical tools and combustion engine equipment vehicles is not only an energy saving measures but are safety and cost saving features as well. Chain saws, concrete saws, and other two cycle engine equipment are the worst offenders in terms of the pollutants they emit. The environmental benefits of keeping engines well tuned and blades or chains sharpened can simply be added to the efficiency gains.

If equipment maintenance is performed in-house, it is likely that waste materials requiring special disposal will be generated. It is important that business owners obtain accurate information regarding proper handling of material and then ensure that employees follow these guidelines. Credit might be given for such measures as:

- Development of a maintenance schedule for all combustion engine equipment.
- Implementation of an employee training program regarding the proper handling of hazardous materials, e.g., waste oil, paints, stains, thinners.

C/A/P: Any additional costs associated with a regular maintenance program are more than outweighed by the savings with respect to efficient operation and/or replacement. Primarily, a builder must be

willing to give the time and commitment necessary to actually implement a maintenance program. Employees must be trained and given time on a daily/weekly/monthly basis to adequately care for equipment; it may be necessary to forgo the use of certain tools while they are being professionally serviced. If such time is planned, it is certainly more efficient than unexpected breakdowns.

Energy and Resource Conservation – Many of the same efforts to promote energy and resource conservation within the home apply to the office as well. Some measures that might be implemented are as follows:

- Installation of low-flow plumbing fixtures.
- Installation of fluorescent lighting.
- Installation of programmable thermostats and/or night-time setback.
- Installation of high efficiency heating and cooling equipment.
- Incorporation of passive solar heating/natural ventilation strategies.

C/A/P: While most of the above products are readily available, there is a wide range of variation with respect to their costs and practicality. The costs of these items were discussed previously in the Energy Efficiency and Home Owner Sections.

Indoor Air Quality – Many people spend a third or more of their time in the workplace where they typically have little control over their environment. Therefore, it is equally as important that attempts are made to provide for healthy indoor air in the office as in the home. Many of the same options available to the home owner apply to the business owner.

- Minimal use of carpet or when installed, use materials with low-VOC emissions.
- Use of paints and/or stains with low VOC emissions.
- Furnishings made of natural or organic materials.
- Air filtering and/or adequate ventilation.

The latter two measures may have slightly different implications for the office as compared to the home. Frequently, there are rooms where several copy machines and/or printers are located. It is important that these areas are provided with additional ventilation and that HVAC ducts to this area are not tied to the rest of the building.

Air quality at the job site can also be a concern for workers' health. Large amounts of dust can be created during excavation, cutting or sanding operations, insulating, and drywall finishing. Fumes are present when painting, staining, or finishing is being done. While not all of these situations can be avoided, precautions can be taken to reduce a worker's exposure. Wetting down areas where site work is occurring, keeping indoor areas well ventilated while nasty work is underway, and wearing respirators are ways a worker can be protected. Safety glasses and ear protection can also prevent injury.

C/A/P: The costs, availability, and practicality of the above actions are discussed in the Indoor Air Quality (Ch. 8) and Home Owner Opportunities (Ch. 12) sections.

Cleaning – Most conventional cleaning products contain harsh chemicals which remain on surfaces and in the air even after they have dried. They can be potentially harmful or create discomfort both to

those using them and to those occupying the space. Often, outside agencies are hired to clean commercial buildings and/or homes once they are completed. So, employees or the business owner himself may have little knowledge of the specific types of products used.

C/A/P: As discussed in the Home Owner section, some benign cleaning products are available at common retail suppliers. However, a wider selection of materials can be found through manufacturers specializing in natural and non-toxic products. It is likely that the business owner will have to make special arrangements with the cleaning company and possibly provide materials for them.

Guide Recommendations

1. Include the above items as options. Consider requiring one item of choice from this content area.
2. Include as an option: development of a plan to incorporate waste management, energy conservation, and/or use of environmentally sensitive products into business operations.

Resources:

Environmental Building News Product Catalog, joint publication of E Build, Inc. and What's Working, 1997/98, $59. This catalog provides environmental, cost, and availability information for over 70 building materials. The catalog is set up in a 3-ring binder format for easy growth of the catalog. As with the well-known Sweet's catalog, product literature from the manufacturer is provided but added is the editors environmental profile of the product base on their green material selection criteria. An environmental overview for each major building material category (following CSI classification) starts each section of the catalog.

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Websites:

http://es.epa.gov/new/business/sbdc.htm – This area of the EPA site provides information and tips regarding waste reduction for the small business.

http://www.gvrd.bc.ca/waste/bro/dlcgde.html – Sponsored by the city of Vancouver, British Columbia, this site provides information on waste reduction with sections specifically addressing opportunities for the construction site and the home owner.

http://www.epa.gov/OSWRCRA/non-hw/reduce/wstewise/ - This is the EPA Waste Wi$e web site with all the information companies need to participate in this voluntary program. Or call 800 EPA-WISE (372-9473).

http://www.epa.gov/greenlights.html/ - This is the EPA website for the Green Lights voluntary program. Although geared for large office buildings, participation is based on per cent savings and even smaller building firms can participate.

14. Land Development

Overview/Discussion

Land Development may be the most difficult program content area for an HBA or community to address. Along with greater challenges, however, come greater opportunities to incorporate environmentally–sound practices into existing methods. And land development—its patterns and contribution to environmental quality—is not as an issue central to the continued health and progress of the residential building industry.

Most programs have chosen to develop and implement the previously discussed content areas first. Content areas #1-#13 are confined to resource-efficient criteria for a single structure on an individual lot. After developing and implementing programs within this context, it becomes easier to tackle more complicated and larger land development issues.

The difficulties pertaining to land development issues are primarily due to two factors:

- the wide range of green building issues that need to be considered under the topic of Land Development.
- the fact that many of these elements are "governed" by diverse agencies, institutions, or interests - among them local building departments, county planning departments, public health departments, highway departments, state soil and water conservation departments, lending agencies, and the community at large.

Once a residential development is under construction, the casual passerby may not realize the numerous and varied challenges that the developer faced earlier in the planning stages.

- The physical aspects of the site—topography, vegetation, soil type, surface and underground reservoirs—must be investigated.
- Aspects pertaining to the development potential of the site—demographics, economic and business characteristics, schools and public services, transportation patterns, and utility availability—must be assessed.
- The specifics related to the actual design of the development—lot size and density, street layout, architectural style—must be drawn to optimize the most advantageous features while working within existing constraints.
- Finally, the developer must comply with all local, state, and federal codes and regulations.

The current political, financial, and cultural fabric of a community is likely to present as varied a set of conditions as the site itself. Lines between cities, town, and counties are not necessarily drawn according to natural boundaries such as contours, waterways, vegetation, and soil type. Land use ordinances, local building codes, property taxes, and even public attitudes toward development often differ within miles of one another. The responsibility to initiate and promote green development lies not only with the building community but with those who have control over the politics of land use and development as well.

The following government entities and public agencies have significant influence over the design, layout, and construction methods and materials that typically characterize residential developments.

Planning Boards – Local zoning ordinances can have an enormous impact upon the character of developments and subdivisions. A green building program can provide the forum for a municipality to review existing local laws and perhaps re-evaluate the implications of some of their current ordinances. Several areas of zoning and planning that typically relate to green building issues are:

- Density
- Mixed use
- Lot size
- Setback
- Street width
- Required parking
- Water treatment
- Sewage treatment
- Stormwater management

Lending Institutions – Banks and lending institutions are other players that can have a significant impact upon the nature and course of land development. Typically, lenders are fairly conservative in the risks they take with respect to property development and construction loans. Although green developments may differ from conventional developments in certain key ways, some lenders are realizing that green building projects are a smart and safe investment.

Building Departments/Codes – In addition to installing primary utilities, the land developer frequently designs AND builds the homes on the property. Some aspects of state and regional building codes limit the application of some of the measures discussed in sections 1-13. This is most apparent with respect to allowable building materials. For instance, structural insulated panels require an engineer's stamp which can significantly increase design fees. Used or rough-cut lumber cannot be used for structural purposes if it is not graded and stamped. Required areas for natural ventilation may not be necessary in homes with heat recovery ventilators. The fact that the building codes tend to leave much to the interpretation of the particular code enforcement officer can be both advantageous and difficult.

Obtaining local code approval is an extremely time-consuming, lengthy, and expensive process in most cases. It will not be a viable route for most builders. However, there are some designers, builders, and educators who are performing the required testing for approval by local building departments. Proposing code changes at the state or regional level is an even more daunting task.

Highway/Transportation – For many communities and municipalities, the costs for the construction and maintenance of streets and related infrastructure constitute the largest portion of their budgets. In developments or subdivisions where road maintenance will be taken over by the city, local authorities are very particular about the design and specifications for streets. There are several reasons for this:

- Ease and cost of regular maintenance such as street cleaning and snow removal.
- Cost and frequency of repair.
- Potential liability in the case of accident or injury.

Perhaps the most effective approach that a “green” developer might take in obtaining approval for an unconventional design is twofold:

- Obtain a thorough understanding of the rationale behind the regulations in your municipality.
- Support your own proposal with lots of examples of similar designs in other cities providing concrete data regarding cost of maintenance, repair, and safe performance.

It does not take long to recognize the complexity of land development and planning considerations - a decision regarding one aspect is likely to have implications or possibly unanticipated consequences for another. An integrated team approach is critical to creating a successful project. Developers, builders, designers, and engineers, municipal and regulatory officials, and lending representatives can all inform and educate one another regarding their particular areas of expertise. Whether a developer chooses to propose his green project via an application for a variance or through longer-term structural changes to local laws and regulations, it is certain that a dialogue between the various interested parties will be essential.

Review of Local Programs

Currently, only two of the green builder programs address planning and development as large property development from the perspective of the land developer or the community at large. Austin does include several items related to land development but places greater emphasis upon the issue of "Community." The new Build a Better Clark program of the Clark County, WA HBA divides their green developer part of the program into two sections: "Build Pedestrian/Transit Oriented Neighborhoods" and "Protect Ecosystems, Conserve National Resources": The SMBIA Building Green program has six land development categories, with most of the criteria and points in the "Environmental Protection" and "Road Design" categories.

Cluster Development – Clustering buildings not only leaves larger areas of open space for wildlife habitat, native vegetation, and/or recreational use, but can also foster an increased sense of community in a tighter knit neighborhood. In connection with this is the idea of allowing multiple dwellings on a single property. This also can preserve open lands and reduce utility installation costs as well as minimize total site disturbance.

Cost/Availability/Practicality (C/A/P): Clustered development can reduce infrastructure costs by reducing roadways, the length of utility lines, and the amount of earth moved. At the same time, the remaining large areas of open space can add value to the property. Market studies as well as numerous real-life examples have shown that people do place value on items such as these which enhance quality of life.

It can be difficult, however, at the local level to fight the "large lot" zoning ethic. Local zoning ordinances may limit opportunities for cluster development in some areas due to minimum lot size, building setbacks, and permissible number of dwelling units. The developer or builder may have to expend more effort either to change these laws or obtain variances. However, at the same time, leaving large areas of land undisturbed is likely to be viewed favorably by planning officials and community members.

Mixed Use Development – Allowing and encouraging multiple uses within a neighborhood can benefit a community economically as well as enhance the quality of life. Pressure on existing infrastructure may be reduced by minimizing private automobile use. People are able to travel by foot or bicycle more often. With the potential for the workplace to be closer to home, commute time may be reduced.

Table 15 – Land Development Checklist Summary

Criterion				
	Austin	**Clark County**	**Suburban Maryland**	**Guide Recommendations**
Cluster Development	E	E	E	E
Mixed Use/Multiple Dwellings	E	E		E
Renovation	E			
Infrastructure				
Expansion not required	E			E
Stormwater Management		E	E	E
Public Transportation	E	E		E
Minimum Lot/Land Disturbance	E	E		E
Paved Areas				
Pervious Materials			E	E
Reduce Sidewalks		E	E	
Recycled Materials			E	E
Ecosystem Preservation		E	E	E
Ecosystem Enhancement		E	E	E

C/A/P: Costs to municipalities, developers, and residents can be lower with respect to initial infrastructure costs, ongoing maintenance and repair, and transportation. While mixed use developments may provide greater opportunities for families to live, work, and recreate within a small community, the actual reduction in automobile use will depend on the relationship between job centers and non-vehicular systems and the personal preferences and behaviors of residents.

Renovation/Infill – Renovation of existing buildings vs. new construction not only conserves material resources, it can help to increase the supply of affordable housing.

C/A/P: Renovation and/or infill can be cost-effective since utilities, streets, sidewalks, etc. are already in place. In addition, construction costs and resource use may be reduced given that existing building shells and/or foundations may be usable as well. The NAHB's City Housing Task Force Report, January, 1998, presents recent successful infill residential projects and discusses the obstacles and opportunities of urban infill.

Infrastructure – Roads, sidewalks, water, sewer, gas, electric services, and ongoing maintenance are all new requirements for developments into new areas. There are several opportunities for developers to reduce both their costs and environmental impact associated with infrastructure development.

A. *Expansion not required*: One program gives credit for projects that do not require the expansion of existing infrastructure. This might be achieved through construction in areas of already existing development or use of alternative systems that do not rely on those of the municipality (e.g., stormwater management).

B. *Stormwater Management*: The miles of pipes used to carry excess water away and thereby prevent flooding can be very costly to a community as well as to a private developer. Minimizing paved areas, using permeable materials wherever possible, and creating natural swales with native vegetation can significantly reduce the investment in stormwater management infrastructure.

C. *Public Transportation*: By locating subdivisions and developments in close proximity to means of public transportation, a community can benefit in multiple ways. Traffic congestion is not increased; new roadways do not have to be constructed, thereby saving public lands and public funds; and there is potential for increasing local jobs.

Minimum Lot/Land Disturbance – With minimum disturbance to the site, existing vegetation and wildlife can be preserved. Additionally, water runoff and erosion can be minimized. Cluster development goes hand in hand with this element and will help to reduce the amount of land that is disturbed.

Paved Areas – A planning rule of thumb is that approximately 22%-27% of the available land area in a typical single family subdivision is related to vehicles. Streets, parking areas, signage, and stormwater management require one quarter of the property that could otherwise be used more directly by and for the people who live there. When streets are narrower and somewhat curved, motorists slow down. Large areas of asphalt and concrete are costly for the developer as well as for the environment. In addition to the direct costs associated with the paving itself—excavation, asphalt, cement—there are also the associated costs of stormwater management and control.

C/A/P: Existing development projects have shown that the amount of land required for paved areas and associated uses can be reduced by as much as 50%. Not only do such reductions bring lower economic costs but also leave more land for other uses and/or amenities.

A. *Storm water management*: Moving from channeling and paved drainageways to systems that encourage sheet flow reduces the need for expensive stormwater piping and associated earth wood. Open grass scales, permeable paving materials, and use of natural vegetation all can reduce the total hard paved areas in a development.

B. *Reduce sidewalks*: Eliminating or restricting sidewalks to one side of the street reduces the amount of pavement.

C. *Recycled Materials*: The reuse of concrete or asphalt as road base or in the asphalt itself can conserve material resources as well as reduce the amount of waste to be disposed. Typically, when locally available, recycled aggregate is less expensive than its virgin counterparts.

Ecosystem Preservation – Protecting existing ecosystems not only pertains to isolated natural features, but to areas large enough to sustain multiple layers and levels of wilderness and wildlife. By protecting woodlands, prairies, wetlands, streams, and waterways, species diversity of both vegetation and wildlife is maintained. It is essential that open spaces be large and interconnected enough to support such diversity. While it is impossible to define universally what constitutes "large enough", the importance of buffers and "green corridors" should be considered.

Both the Clark County and Suburban Maryland programs contain specific measures to preserve existing ecosystems. Examples of program elements include:

- Preserve x% of lowlands and areas with mature vegetated soils.
- Use infiltration basins, detention ponds, check dams, vegetative swales and buffers.
- Label storm sewer inlets.
- Design for no curbs or gutters.
- Preserve 30% of existing native vegetation.
- Enlarge wooded areas.
- Extend buffers to protect mature forests, wetlands, and other sensitive environmental features.

C/A/P: The financial costs of implementing measures to preserve existing natural features and wildlife will depend upon specific characteristics of the project, the property, and the surrounding landscape. It is difficult to identify "costs" associated with reduced number lots vs. "benefits" associated with ecosystem preservation or enhancement. Several of the resources listed at the end of this section contain case studies documenting the increased desirability and value resulting from implementation of the above measures. Certain of the above program elements are likely to involve policy changes at the local, state, or regional level.

Ecosystem Enhancement – Many "natural" or green areas are far from their uncultivated state. For instance, agricultural lands in the midwest have replaced much of the tall grass prairie. Restoration of such areas can be undertaken as part of a development project. This can result in both the reintroduction of native species and the enhancement of quality of life issues for those people who live nearby.

Both Clarke County and Suburban Maryland offer program credit for the creation or enhancement of local ecosystems.

- Provide wildlife corridors.
- Construct small-scale pools and wetlands.
- Enhance wooded areas and wetlands.
- Create wildlife sanctuaries.

C/A/P: The issues surrounding the cost, availability, and practicality of ecosystem enhancement are similar to those of ecosystem preservation discussed above.

The following topics are not mentioned in the Green Builder programs that were reviewed. However, they are issues that many communities face when land and property development projects are proposed. While they may not apply in all situations, they represent aspects that communities should consider when developing green building programs and/or long range plans. These issues are generally addressed at the state or regional level and move more to the level of policy.

1. Brownfields Development – The repair of damaged areas can also apply to the clean-up of industrial or commercial areas to create a cleaner, healthier place for human habitation. There is indication that Superfund liability may be easing. The EPA has funded site assessments and the development of remediation plans prior to cleanup Federal tax incentives are available and some communities have established revolving loan funds to finance the environmental clean up. This may be an opportunity for developers to work in cooperation with local agencies rather than in conflict. As with any property, developers must simply balance the advantage of a brownfields site–most typically prime location and government subsidy–with the disadvantages of a contaminated site. Not all brownfields properties are created equal; developers are encouraged to neither ignore the obstacles nor the opportunities these sites can present. Examples of successful residential brownfields redevelopment are readily available (see Resources for this section).

2. Agricultural Lands – Although commercial agriculture has certainly contributed to the decline of natural ecosystems and species diversity, farming is central to the economy and way of life of many communities. Many counties are struggling to find a pattern of development or "smart growth"; one that equitably resolves potentially competing forces of urban renewal farm level preservation and residential development.

Guide Recommendations

1. Since these items may have implications for many sectors of a community, it is recommended that a builder program be implemented first. The issues regarding land development can then be discussed thoroughly and in light of community response to the green builder program.

Resources:

The following case studies provide concrete examples of how others have approached and resolved a variety of existing conditions within the framework of environmentally-sensitive land development.

Land Development magazine, NAHB – Land Development Services and Environmental Policy Departments. Every issue of this quarterly publication contains articles on resource-efficient land development. For example, the winter, 1999, issue has articles on Streamlining the Development Approval Process, Smart Growth Policies, and Brownfields Development.

Affordable Land Development - A Guide for Local Government and Developers, Vol. 1, prepared by NAHB Research Center, Upper Marlboro, MD.

Proposed Model Land Development Standards and Accompanying Model State Enabling Legislation-1993 edition U.S. Dept. of HUD-1413 PDR, August, 1993

Site Planning and Community Design for Great Neighborhoods, Frederick D. Jarvis, Home Builder Press, National Association of Home Builders, Washington, D.C.

Lessons from the Field by the Northeast Midwest Institute, With profiles of 20 brownfield projects across the country, the 230-page book also identifies "lesson learned," including innovative financing strategies, regulatory mechanisms, institutional arrangements, cost-effective technologies, and public-private partnerships.

The following references are broader in nature. Yet, they all provide clear and thorough discussions of "green" issues related to land development. They would be of interest to government and regulatory officials as well as builders and developers.

Land Development, Eighth Edition, D. Linda Kone, Home Builder Press, 1994. The book provides a thorough overview of the numerous issues to be considered when planning and implementing a large development project. Everything from market analysis to assessment of the physical features of the site to legal ordinances and procedures is covered. The book is written more from the conventional framework of cost effectiveness and feasibility rather than environmental or green building concerns.

Green Development, Rocky Mountain Institute, John Wiley and Sons, Inc., 1998. This book offers a comprehensive discussion of every stage of the development process. The authors' extensive knowledge regarding sustainable building issues is apparent through their thorough treatment of conventional planning and development considerations from a "green" perspective. Detailed discussion with examples regarding market research, financing, site planning, building design, construction and maintenance, as well as the approval process. The project profiles, contacts, and additional references can be particularly useful.

Conservation Design for Subdivisions, Randall G. Arendt, Island Press, Washington, D. C., 1996. This book is written with the developer in mind. The primary focus is upon how to preserve open space and special features of a property without reducing overall density and profitability. Much of the emphasis is placed upon maximizing views as the primary amenity of a conservation subdivision, Arendt does provide some specific suggestions for street layout, lot size and shape, and building placement and design. Examples of several different sites illustrate contrast between conventional and conservation design. Possible house designs for narrow lots are also included. A good deal of attention is given to regulatory improvements and local planning processes.

Landscape Ecology Principles in Landscape Architecture and Land-Use Planning, Wenche E Dramstad, James D. Olson, Richard T. T. Forman, Island Press, 1996. A concise, well illustrated description of four basic principles of landscape design - patches, boundaries, corridors, and mosaics. A good introduction for planning officials and developers.

Websites:

http://www.uli.org – This site of the Urban Land Institute may be of particular interest to property developers in that it offers access to a discussion group whereby one can exchange ideas and questions with others working in the field. Also offers a good list of books, publications, and workshops specifically dealing with the concerns of larger property development.

http://www.plannersweb.com – This site covers many topics pertaining to planning and development issues – zoning, transportation, controlling sprawl, conservation subdivisions. Both developers and community officials may find this site useful.

http://www.co.san-diego.ca.us/cnty/cntydepts/general/cob/policy/F-50.html – This site contains a copy of the policy adopted by San Diego County to encourage resource-efficient construction and renovation practices. Although the voluntary guidelines are fairly general in nature, they are an example of important steps that must be taken by local jurisdictions to facilitate the implementation of sustainable building practices.

http://www.smartgrowth.org – Sponsored by EPA's Urban and Economic Development Division this site has a wide variety of resources, profiles and case studies on land development and special topics such as brownfields.

http://www.nemw.org – The Northeast-Midwest Institute has resources including case studies on brownfields redevelopment.

APENDIX A – SUMMARY PROFILES OF SIX HBA PROGRAMS[1]

PROGRAM TITLES: Variations on "green" except Build a Better Kitsap, Build a Better Clark
PROGRAM START DATES: 1991, 1995, 1997, 1997, 1998, 1998
HBA MEMBERSHIP: 300 - 850
PROGRAM MEMBERSHIP: 10 - 50 (builders)

PROGRAM COSTS:

Builders (HBA members): $0 - $295 annual membership, $0 - $75 per project fee
Associates (HBA members): $0 - $295

PROGRAM COVERAGE:

Primarily residential builders, some cover major remodeling, one covers land developers separately

HBA PROGRAM DEVELOPMENT PARTNERS:

Four partner with various local government agencies, one with private industry, and one with no partners

SPONSORS OR ASSOCIATE MEMBERS:

Non-building members: architects, subcontractors, building suppliers, lenders

METHODS OF CERTIFICATION:

Most have builder pledged, self-certification, some have or are developing a random check system

RESOURCES:

Builder Handbook
Builder Resource Directory
HBA Resource Library
Builder Plaque
Homeowner Certificates
Builder Fact Sheets
Builder Training
Yard Signs, Window Decals
Program Newsletter
Web Site
HBA local media promotion
Camera-ready Artwork
Homeowner Manuals
Consumer Brochures

EDUCATION/TRAINING:

Initial orientation
Regular training seminars
"Green builder University"

[1] Information characterizing the programs was obtained during 1998. Contact each HBA for the most current information on their program.

APENDIX A – SUMMARY PROFILES OF SIX HBA PROGRAMS (continued)

BUILDER/CONSUMER SURVEYS:

Builder member, home buyer, general consumer phone and mail surveys
Builder and home buyer focus groups

OTHER ACTIVITIES (newsletter, awards program, parade of homes, etc.):

newsletter
awards program
parade of homes
school "green building" program

PROGRAM STRUCTURES:

Austin: Four rating levels with 170 items total, 18 items required for all levels
Denver: One level with 136 items total, 1 energy requirement
Kitsap: Three levels with 85 items total, 5 items required for all levels
Central New Mexico: Four levels with 70 items total, increasing requirements at each level
Suburban Maryland: Two program sections, both with one level: builders have 39 items total, developers have 33 items total

PROGRAM CONTENT:

Austin: 5 content areas based on environmental issues
Denver: 21 content areas focusing on Energy and Materials
Kitsap: 8 content areas based on major building issues
Central New Mexico: 4 content areas based on environmental issues
Suburban Maryland: 4 builder and 6 developer content areas based on both environmental and builder issues

UNIQUE FEATURES:

Austin: City developed and administered program, free program, very detailed resource book, community category including land development issues
Denver: Nearly total builder flexibility with program items, extensive marketing and education partnership with state gov't., HBA resource library, nearby Boulder city program
Kitsap: point weighting for items, handbook with carefully linked content areas and local resources, significant homeowner component, upcoming focus on remodeling
Central New Mexico: "write-in" option for builder flexibility, spot checking for compliance, item distribution required at all levels, private program development partners
Suburban Maryland: separate program sections for builders and developers, no partners—a stand-alone HBA program, review board and site visits

APPENDIX B – GREEN BUILDER PROGRAM CONTACT LIST

Existing Local Green Builder Program Contacts

Art Castle, Executive Director
HBA of Kitsap County
5251 Auto Center Way
Bremerton, WA 98312-3319
PH: 360-479-5778

David Bergman, Program Coordinator
Surburban Maryland BIA
1738 Elton Rd.
Suite 200
Silver Spring, MD 20903
PH: 301-445-5400

Kim Calomino, Program Coordinator
HBA of Metropolitan Denver
1400 S. Emerson St.
Denver, CO 80210
PH: 303-778-1400
www.hbadenver.com

Mark Richmond Powers, Program Coordinator
City of Austin Green Builder Program
206 E. 9th St.
Suite 17102
Austin, TX 78701
PH: 512-499-3029
www.ci.austin.tx.us/greenbuilder/default.htm

Karen Snekvik, Executive Director
Clark County HBA
5007 NE St. John's Rd.
Vancouver, WA 98661
PH: 360-694-0933

Anna Mayberry, Program Coordinator
HBA of Central New Mexico
5931 Office Blvd. NE
Albequerque, NM 87109
PH: 505-344-3294
www.hbacnm.com

Anthony Floyd, Env. Mgmt. Office
City of Scottsdale
7447 E. Indian School Rd.
Scottsdale, AZ 85251
PH: 602-941-6992

Mike Weil, Asst. Dir. of Env. Affairs
City of Boulder Green Builder Program
PO Box 791
1300 Canyon Blvd.
Boulder, CO 80306
PH: 303-441-4191
http://environmentalaffairs.ci.boulder.co.us/residential/gp_overview.html

APPENDIX C – SAMPLE PROGRAM CHECKLISTS

Home Builders Association of Central New Mexico
Green Builder Program

Green Builder Home Checklist

Please check all items which apply.

WATER CONSERVATION

	Points	
☐	**1**	Toilets that are 1.6 gallons per flush or less.
☐	**1**	Shower heads that are 2.5 gallons per minute
☐	**1**	Faucets that are 2.0 gallons per minute
☐	**1**	Dishwasher with a water conservation cycle, known as "light wash".
☐	**2**	A hot water recirculation pump and timer
☐	**1**	Clothes washer with a water conservation cycle known as Alight wash≅.
☐	**1**	Landscaping: Full compliance with Landscaping and Waste Water Standards. (See Resource Guide for specifics)
☐	**2**	Centrally located hot water heater.
☐	**2**	A pedal faucet controller.
☐	**2**	Recirculation Pump for Hot Water Heater with Timer
☐	**4**	Disruption of no more than 50% of the natural state of the lot.
☐	**4**	Grey Water recycling system
☐	**4**	Landscaping: 90% of the area to be landscaped shall utilize only medium and/or low water use plants with a "drip" or trickle irrigation system with automatic timer controls. Xeriscape landscaping is also allowed.

MATERIALS: CONSERVATION AND CONTENT

	Points	
☐	**1**	Paints & Finishes that are Low voc (Volatile Organic Compound).
☐	**1**	Expanded Polystyrene (EPS) Foam Insulation which does not contain chlorofluorocarbons (CFCs) or hydrochlorofluorocarbons (HCFCs) (ozone-depleting products).
☐	**1each**	Materials that are identified as containing recycled-content, please list: ❑_____ ❑_____ ❑_____ ❑_____ ❑_____ ❑_____
☐	**1each**	Materials that are engineered materials, please list: ❑_____ ❑_____

❑_____ ❑_____
❑_____ ❑_____

⌂ **1** Use of locally produced products, please list:
❑_____ ❑_____

⌂ **1** Concrete that contains at least 15% fly ash.

⌂ **2** Centrally located Electrical Panels

⌂ **4** Home construction using substantial portion of: adobe, straw bale, tires or cans, please describe: _____

SOLID WASTE REDUCTION

Points

⌂ **2** An in-home recycling center, i.e. 3 bin kitchen cabinet or center in garage

⌂ **1** Garbage disposal

⌂ **4** Recycle on-site framing lumber waste. *(This item is required.)*

⌂ **2** Recycle on-site cardboard waste.

⌂ **1** Back yard compost center

⌂ **1** Recycle on-site excess Carpet Pad & Metal

⌂ **2** Recycle Sheet-rock

ENERGY CONSERVATION

Points

⌂ **2** Windows that have a total-unit R-Value of R1.92.

⌂ **3** Windows that have a total-unit R-Value of R2.44.

⌂ **4** Windows that have a total-unit R-Value of R2.7.

⌂ **3** Cooling: *Select 1*

⌂a. Evaporative Cooler with Thermostat.

⌂b. Premium evaporative cooler w/celdek single media rather than multiple aspen pads, i.e. "Master Cool" or "Ultra Cool"

⌂c. Central A/C with a minimum of SEER 10.

⌂ **2** Heating: *Select 1*

⌂ a. Gas HVAC unit, 90% efficiency or greater with a programmable thermostat.

⌂ b. Gas boiler system, minimum 80% efficiency or greater with a programmable thermostat

⌂ c. Heat pumps require a minimum efficiency of 6.8 HSPF, programmable thermostat or outdoor thermostat required.

⌂ d. Radiant heat with a minimum of one thermostat per five hundred sq.ft.

⌂ **2** Duct Standards: *Select 1*

⌂a. Ducts must be located within the conditioned space.

⌂b. Taped with U.L. 181 tape. Or Sealed with latex, water-based mastic sealant; must be non-toxic & applied per manufacturer's specs.

ENERGY CONSERVATION **(continued)**

⌂c. Insulation should be R8 for homes with refrigerated air and R6 for homes with evaporative cooling and/or forced air heating.

⌂ **1each** Ceiling fans. (Up to a maximum of 3 points) # of Ceiling Fans: _____

⌂ **1** Water Heater that operates at a minimum .57EF (Efficiency Factor) for 30 gallon capacity, .55EF for 40 gallon and, .53 for 50 gallon

⌂ **1** Insulated Blanket/Wrap for Water Heater

⌂	**2**	R38 Insulation in the ceiling.
⌂	**2**	In addition to the previously established Wall and Ceiling Insulation standards, Full compliance with NAHB Thermal Performance Guidelines.
⌂	**2**	Insulation below heated slab with EPS (minimum R value of 2.5)

⌂	**1**	Insulation for hot water lines to/from recirculation pump
⌂	**1**	Florescent lighting in a minimum of 2 separate locations
⌂	**1**	Programmable thermostat.
⌂	**1**	Gas or EPA certified wood burning fireplace if installed (gas logs, gas appliance).
⌂	**1**	Insulated Blanket/Wrap for Water Heater
⌂	**1**	Insulate Garage
⌂	**1**	Install insulated garage door
⌂	**2**	Compact fluorescent lights used in recessed lighting (per 10 fixtures, maximum 4 points allowed)
⌂	**2**	Whole house fan system (one fan in the attic that draws air up and out).
⌂	**2**	Extended shades or awnings over southern and western windows. (See Resource Guide glossary for design standard of "extended shading".)
⌂	**2**	Radiant Floor Heating.
⌂	**3**	Built-in appliances must have operating cost in the lower 50% range of the Energy Guide Sticker.
⌂	**3**	Increase hot water heater to 90% efficiency.
⌂	**4**	Solar gain design, i.e. 11-25 SF of south-facing glass per 100 SF of space floor area.

APPENDIX C – SAMPLE PROGRAM CHECKLISTS

City of Austin
Green Building Program
Basic Requirements

A home must have the following measures to qualify for a rating:

Materials

☐ 1) One recycled-content material (minimum 50% recycled) See list. _____

☐ 2) Recycling center in kitchen, pantry, or utility room

Energy

☐ 3) City of Austin Energy Code requirements met

Note: Shading to Code may be accomplished by any of the 3 following measures:

a. Solar screens with 0.50 shading coefficient, or 0.445 solar heat gain coefficient, or lower

b. Glass with 0.50 shading coefficient, or 0.445 solar heat gain coefficient, or lower (low-e, tint, film)

c. Shading of the glass by roof overhangs sized according to code

4) Efficient and effective cooling and dehumidification system

☐ a. Home designed and specified to allow a minimum 600 sq. ft. of living space per ton of cooling

☐ b. Cooling system sized by Manual J (or equivalent computer analysis), based on actual design, specifications, and orientation.

☐ c. Installed cooling tonnage based on the Manual J or equivalent calculation (not to exceed one ton/600 sq. ft.)

☐ d. Duct installation to City of Austin Energy Code

☐ e. 12.0 SEER minimum cooling efficiency

☐ f. GBP ***Cooling System Information and Maintenance**** *instructions* presented to homeowner

☐ 5) 2 ceiling fans

Health, Safety

☐ 6) City of Austin Building Code requirements met

☐ 7) Low-VOC (volatile organic compound) paints used
(1998 standard: water-based paint VOC's not to exceed 150 grams per liter and solvent-based paint VOC's not to exceed 380 grams per liter)

☐ 8) No vapor barrier (including vinyl wallpaper) installed on inside of perimeter wall

☐ 9) GBP ***Indoor Humidity**** *information* presented to homeowner

☐ 10) One-inch minimum pleated-media filter installed in heating and cooling system

☐ 11) Any chemical termite control used is pyrethroid or borate based

☐ 12) GBP ***Integrated Pest Management**** *information* presented to homeowner

Water

☐ 13) GBP ***Lawn Care**** *information* presented to homeowner

* These materials are supplied by the Green Building Program.

ENERGY

High quality mechanical systems, efficient equipment, reduced need for mechanical systems

Design	3	E1	Home designer is a member of the Green Building Program
	2	E2	Design created by design team, including designer, builder and mechanical contractor
	3	E3	A mechanical plan has been made concurrently with, and is part of, the construction plans and specs
	4	E4	Size: maximum 1200 sq. ft. for 2 bedroom home + 250 sq. ft. maximum for each additional bedroom
	2	E5	House shaded on east and west by existing or planted shade trees (minimum 50% of wall is/will be shaded)
	2	E6	Buffer spaces placed on at least 50% of west wall (e.g. garage, covered porch, closets)
	2	E7	Operable thermal chimney / cupola / clerestory designed for stack effect
	3	E8	Glass on east and west is limited to 25% of total glass area: wall area_____, glass area_____, E+W glass_____
	4	E9	Passive solar heating design (in regard to minimum and maximum south-facing glass; overhang size) See instructions*.
	4	E10	Duct work is located within the thermal envelope (insulated space)
	2	E11	Home design allows for a minimum of 700 sq. ft. of living space per ton of cooling;
	4	E12	Or home design allows for a minimum of 800 sq. ft. of living space per ton of cooling
	1	E13	Raised-heel truss / rafter construction to allow for increased insulation and ventilation
	1	E14	Fireplace is sealed gas unit with outside combustion air; or house has no fireplace
	2	E15	Washer and dryer are located outside the home's heated and cooled space
	2	E16	Covered outdoor area such as porch or patio (minimum of 100 sq. ft.)
Thermal Envelope	2	E17	"Total fill" insulation in walls (e.g. wet-blown cellulose, BIBS, open-cell foam, cementitious foam), or wall is integrally insulated or requires no added insulation (e.g. ICF, SIPS, straw, earth)
	4	E18	Blower door test performed by qualified technician results in range of 0.35-0.45 Air Changes per Hour
	2	E19	Continuous ridge and soffit vents; or attic is included in heated and cooled space
	3	E20	Roof radiant barrier
	2	E21	No skylights (solar tubes okay; skylights into porches okay)
	2	E22	Double pane windows
	2	E23	Tile roof
	2	E24	Light colored exterior walls
Heating, Cooling, Water Heating	2	E25	Ceiling fans in all main rooms and bedrooms (not required in dining rooms)
	1	E26	Whole-house fan with insulated cover
	1	E27	13.0 SEER cooling equipment efficiency
	2	E28	Or 14.0 SEER cooling equipment efficiency
	3	E29	Or 15.0 SEER cooling equipment efficiency
	1	E30	Programmable or set-back thermostat
		*	***We recommend that items E31--E38 be included in mechanical system specifications.***
	2	E31	No main HVAC trunk lines made of flex duct and no flex duct take-offs over 10' long
	1	E32	Ducts cut to exact length and supported to manufacturer's specs
	2	E33	No turns in ductwork greater than 90 degrees
	2	E34	90 degree angles in rigid duct have turning vanes or long-radius curves; take-offs have air-grabbers
	2	E35	Air-balancing dampers installed at each start collar
	2	E36	Supply registers sized to deliver calculated air flow, return air grill sized to accomodate the system's CFM
	1	E3	System components matched according to ARI (Air-Conditioning & Refrigeration Institute)

		7	
	5	E38	Direct duct pressure test with "duct blaster" by qualified technician results in 5% or less air leakage
	3	E39	Energy recovery ventilator (Air Changes/Hour not to exceed 0.45 on blower door test)
	2	E40	Water heater in best 25% on Energy Guide Label;or gas WH has Energy Factor of 0.59 or higher; or 0.57 plus heat-trap nipples
	2	E41	Combo space / water heating system with minimum 76% Recovery Efficiency
	4	E42	Solar domestic hot water or swimming pool heating system
Lighting,	2	E43	All recessed can lights are IC sealed type (performance-tested); or no recessed cans are installed
Appliances	2	E44	Minimum of 3 light fixtures are provided with fluorescent lamps (compact or tube)
	1	E45	Outdoor lights are fluorescent, motion detector, or photovoltaic
	4	E46	Photovoltaics installed on home (garden pathway lights excluded)
	2	E47	Installed appliances are efficiency-rated in best 25% on Energy Guide Label
			or if none installed, information about Energy Guide Labels is presented to homeowner
Additions			
	0		**Total Energy Points**

MATERIALS

Durable, low-maintenance, engineered, certified, reused, recycled, recyclable, local, natural

Design,	4	M1	Size: maximum 1200 sq. ft. for 2 bedroom home + 250 sq. ft. maximum for each additional bedroom
Structure	1	M2	Engineered floor trusses/joists
	1	M3	Engineered roof trusses;
	2	M4	Or alternate roof structure (e.g. I-beams, LVL, SIPS)
	2	M5	Sill plate is alternative lumber (e.g. wood composite or plastic)
	1	M6	Wall stud framing is on 24" centers (as Code allows);
	2	M7	Or wall framing is by the "Optimum Value Engineering" method (as Code allows);
	3	M8	Or wall system (exterior) is engineered or alternative type (e.g. SIPS, ICF, ACC, straw, earth)
Finish	2	M9	Exterior wall finish is brick, stone, stucco, or cement-based (minimum 80%)
Materials	2	M10	Roofing has 40 year or more warranty
	2	M11	Porch / deck flooring: lumber is reused, reclaimed, or alternative (e.g. wood composite, plastic lumber)
	2	M12	Doors or cabinet wood is reused or local species (e.g. pecan, mesquite, Texas juniper)
	2	M13	Trim is finger-jointed or engineered or MDF or reused or local species
	1	M14	Recycled-content (50% or more content) or reused material (in addition to Basic Requirement choice: 1 point/material)
			_____ _____ _____
	3	M15	Floor is durable material for minimum of 1/2 of all flooring (e.g. concrete, stone, brick, wood, ceramic tile)
	2	M16	Structural floor is finish floor for minimum 1/3 of all floor (e.g. exposed concrete, single-layer wood)
	2	M17	Flooring: natural fiber carpet (e.g. wool, jute, grass); linoleum (not vinyl); cork; bamboo;
			local-species, or reused wood; or there is no carpet in the house
Excess	2	M18	Cut trees are reused, not sent to landfill (e.g. mulched)
Jobsite	2	M19	Wood scraps longer than 2 feet are reused/recycled
Resources	2	M20	Paper / cardboard packaging and aluminum cans are recycled (receptacles provided on jobsite)
	2	M21	Metals are reused/recycled
	2	M22	Excess building materials are reused, given/sold to salvage, or donated to Habitat for Humanity RE-store
Additions			
	0		**Total Material Points**

WATER			Conservation of all water; protection of water quality
Indoor	1	W1	Shower heads use no more than 2.0 gallons of water per minute (free from Water Conservation Dept.)
	3	W2	Horizontal axis clothes washer
	1	W3	Dishwasher uses no more than 7 gallons of water per load on normal cycle
	2	W4	Water heater is located within 20' of dishwasher, clothes washer and baths it serves; or demand-type hot water recirculator is installed and all hot water lines are insulated to Austin code
Outdoor	2	W5	Existing natural vegetation is essentially retained on at least 50% of pervious cover area
	2	W6	Turf grass/lawn does not exceed 50% of pervious cover area
	2	W7	Turf grass/lawn in sunny areas is low-water variety (buffalo or common bermuda); or there is no turfgrass
	1	W8	At least 90% of plants, shrubs and trees are selected from the City of Austin Xeriscape brochure list
	1	W9	All planting beds are mulched to minimum 2" depth
	2	W10	Dillo Dirt is used for soil amendment (6 cubic yards minimum per site)
	3	W11	Landscape requiring watering has a minimum 6" of top soil (includes turfgrass areas)
	2	W12	Gutters and downspouts installed and directed away from foundation to landscaping or catchment system
	4	W13	Rainwater catchment system installed
	1	W14	Irrigation system has a) a controller for 5-day programming, b) multiple start times, c) 2 or more independent programs, d) manual flow control valves, e) rain shut-off device, f) matched precipitation heads with head-to-head spacing, g) check valves for heads on slopes, and h) an "as-installed" plan provided to homeowner.
	1	W15	Drip irrigation system for non-turf areas *Take both irrigation points if you have no turf and only natural vegetation/native plantings.*
	4	W16	Greywater system
Additions			
	0	**Total Water Points**	
HEALTH, SAFETY			Improved air quality: reduced humidity, dust mites, and harmful chemicals
Molds,	3	H1	HVAC filter is electronic (not electrostatic); or 4" or thicker pleated-media type; easily accessed
Mites,	3	H2	No fiberglass fibers are exposed to the air stream in duct work. (Use metal or lined duct material.)
Fibers	2	H3	Humidistat installed in home
	3	H4	Central humidity control system in addition to cooling system (ERV with enthalpy qualifies)
	3	H5	Exhaust fans installed and vented to outside for cooktop/stove and any room with tub or shower (whether or not room has an operable window)
	1	H6	Laundry room exhaust fan installed, vented to outside (whether or not room has an operable window)
	2	H7	Bathroom fan connected to timer or humidistat
	2	H8	60% or more of finish flooring is hard surface material (not carpet)
Chemical	1	H9	Interior paint is super-low VOC (under 100 grams per liter);
Outgassing	2	H10	Or interior paint has no VOC's (under 10 grams per liter);
	3	H11	Or interior paint is natural (plant-based); or has no biocides
	2	H12	Cabinet, paneling, moulding and floor finishes are water-based
	2	H13	Construction adhesives have no VOC's
	2	H14	Formaldehyde-free or natural insulation--check Material Safety Data Sheet (MSDS)
	3	H15	Formaldehyde-free MDF for all interior uses (Check MSDS)
	2	H16	Lockable hazardous-material cabinet, sealed off from living space and attached garage, vented outside
	2	H17	Organized house ventilation procedure/commissioning conducted prior to occupancy
Combustion	3	H18	Garage has exhaust fan with timer; or is separate structure from house; or there is no garage
Gases	1	H19	No unvented gas logs (venting must be to outside of building shell)

		4	H20	House passes combustion safety/backdraft test as performed by qualified technician
		1	H21	Carbon monoxide detector installed
EMF's		1	H22	EMF-reducing wiring methods (See instructions)
		1	H23	Electrical main panel set ten feet or more away from bedrooms and areas of frequent occupancy
Integrated		1	H24	Any wood used (e.g. siding, trim, structure) is at least 1 foot above soil
Pest		1	H25	Fill dirt at foundation beams in plastic sand bags (not paper); no wood, cardboard or paper
Management				left in soil under or near foundation; "sono-tube" forms removed
		1	H26	Exterior wood-to-concrete connections are separated by metal or plastic; or there are no wood-concrete connections
		4	H27	Wood framing treated with a borate product to a minimum of 3 feet above foundation;
				or sand or diatomaceous earth barrier termite control system; or structure is not made of wood
Additions				
	0	**Total Health and Safety Points**		

COMMUNITY				Improved quality of life; improved community ties; reduced urban sprawl
General		3	C1	Remodeling of an existing structure
		2	C2	Home has a front porch large enough for family to use (100 sq. ft. minimum)
		4	C3	Site has more than one dwelling unit (e.g. duplex, condo, "granny flat")
		2	C4	Street, electricity, water, wastewater have been in place for a minimum of 15 years
		4	C5	Home is located in a *Traditional Neighborhood Design* or *Small Lot* subdivision
		2	C6	Public transit is within a 10-minute walk
		2	C7	A shopping area is within a 15-minute walk
		2	C8	Subdivision is adjacent to, or has a hike and bike trail or green belt or park
		2	C9	Backyard compost bin specified and provided (site-built or off-the-shelf)
		2	C10	Trees to be saved are protected with fencing at the drip line
		2	C11	Builder is member of Clean Builder Program or home owner is member of the City of Austin Solar Explorer
Additions				
	0	**Total Community Points**		

HBA METROPOLITIAN DENVER
BUILT GREEN CHECKLIST

HBA of Metro Denver, 1400 S. Emerson, Denver, CO 80210
Send comments, questions, or suggestions to: info@builtgreen.org

THE CHECKLIST

I. ENERGY REQUIREMENT
(One of the following must be included in each home)

Home receives energy rating of at least four-star as certified by Energy Rated Homes of Colorado or,

Home meets CABO MEC 93.

II. LAND USE: LOT (Choose 2)

Trees and natural features on site protected during construction.

Save and reuse all site topsoil.

Home placement saves east and south lot areas for outdoor use.

Home oriented on lot such that the long dimension faces within 30 degrees of south.

III. WASTE MANAGEMENT (Choose 1)

Built-in kitchen recycling center with two or more bins.

Minimize job site waste by using materials wisely and prohibit burying construction waste.

Recycle job site waste (>50%).

IV. ENERGY USE: ENVELOPE (Choose 2)

South glass area is between 5-7% of total finished floor area.

Advanced sealing package in addition to basic sealing practices (advanced package adds sealing at top and bottom plates, corners and between cavities at penetrations).

Provide south roof area designed for future solar collector use (20° of south). Home designed for passive solar heating (>20%). Energy heels of 6" or more on trusses. Two-foot overhang, between one and two feet above south windows.

Blower door test with 0.35 ACH or less.

House is wrapped with an exterior air infiltration barrier to manufacturer's specifications.

House meets EPA 5-Star Program Standards.

V. ENERGY USE: MECHANICAL (Choose 4)

Furnace centrally located, all duct runs reduced as much as possible.

No ducts in outside walls or attics unless ducts have minimum R-13 value.

Thermostat with on switch for furnace fan to circulate air.

Two properly supported ceiling fan prewires.

Sealed-combustion gas fireplace or sealed wood-burning fireplace or stove with outside combustion air.

Setback thermostat.

Furnace ductwork joints sealed with low toxic mastic.

Whole house fan installed.

Return-air ducts in every bedroom.

90% or higher energy efficiency furnace.

Active solar heating system (solar fraction >20%).

Two or more thermostats controlling separate heating and cooling zones from a single furnace (not an attic furnace).

Geothermal heating, cooling and water heating system.

Vl. ENERGY USE: INDOOR AIR QUALITY (Choose 2)

Sealed-combustion furnace or boiler.

Sealed-combustion domestic water heater.

Exhaust fan in garage on timer or wired to door opener.

Heat recovery ventilator or air-to-air heat exchanger.

Radon mitigation installed or vent pipe laid under slab for retrofit.

Mechanical room enclosed and insulated to R-1 1.

Provide range hood vented to outside.

Furnace and/or duct-mounted electronic air cleaner or HEPA filter.

House meets American Lung Association Health House Standards.

Vll. ENERGY USE: WATER HEATING SYSTEMS (Choose 2)

Gas water heater with energy factor of 0.60 or greater.

Insulate hot water pipes to R-6 in unconditioned spaces.

Water heater within 20 pipe feet of dishwasher and clothes washer.

Insulate all hot water lines to all locations to R-6

Rough-in for future solar hot water heating

Gas water heater with insulating blanket installed to manufacturer's specifications.

Insulate hot and cold water pipes 3 feet from the hot water heater.

Solar water heating system.

VIII. ENERGY USE: APPLIANCES (Choose 2)

Dishwasher with energy saving cycle.

Gas clothes dryer with electronic ignition Gas range, cooktop and/or oven with electronic ignition.

Refrigerator less than $66 estimated annual electric cost per year.

If appliances are not included, a list of energy efficient appliances is provided.

Provide gas rough-in for clothes dryer, range, cooktop and/or oven when those appliances are not included with the home.

Solar electric system provides 20% or more of the home's electricity.

IX. ENERGY USE: LIGHTING (Choose 2)

Light-colored interior walls, ceiling and soffit.

Light-colored carpet.

Furnish four compact fluorescent light bulbs to owners.

Halogen lighting substituted for incandescent down-lights.

Extended-life incandescent bulbs greater than 2000 hrs (e.g., traffic signal bulbs).

No can lights in insulated ceiling or Insulation Contact-Rated (IC Rated) can lights are used.

No can lights used in insulated ceiling or airtight can lights are used.

Solar-powered walkway or outdoor area lighting.

X. MATERIALS: STRUCTURAL FRAME (Choose 3)

Large dimension solid lumber (2x10 or greater) avoided in floors and roofs wherever possible.

Dimensional lumber from 3rd party certified sustainably harvested sources.

Engineered wood "I" joists used for floors.

Trusses or "I" joists used for roofs.

Structural insulated panels used for walls or roofs.

Reinforced cementitious foam-formed walls using flyash concrete.

Engineered lumber products for beams, joists or headers.

Reduced framing package (24" O.C. studs at interior non-bearing walls, and 3 stud corners).

Finger-jointed plate material.

Finger-jointed studs or engineered stud material.

Engineered alternatives to wood framing.

Outdoor structures, decking and landscaping materials made from pressure treated engineered lumber or non-CCA (chromated copper arsenate) dimensional lumber.

Outdoor structures, decking and landscaping materials made from recycled materials.

Outdoor structures, decking and landscaping materials made from 3rd party certified sustainably harvested lumber.

Xl. MATERIALS: FOUNDATION (Choose 1)

Non-asphalt based damp proofing (seasonal application).

Regionally produced block or brick.

Western coal flyash concrete (minimum 15%, seasonal application).

Frost-protected shallow foundation.

Aluminum foundation forms used.

Rigid insulation forms that provide permanent insulation to the foundation.

Insulated foundation with rigid R-10 foam insulation to footer.

XII. MATERIALS: SUB-FLOOR (Choose 1)

Urea formaldehyde-free subfloor and underlayment material.

Oriented strand board (OSB) made from fast growth material.

Recycled-content underlayment.

XIII. MATERIALS: DOORS (Choose 2)

No Luan doors (tropical hardwood).

Exterior doors insulated to R-5, or greater.

Reconstituted or recycled-content doors (hardboard) with least toxic binders.

Solid, domestically grown interior wood panel doors.

XIV. MATERIALS: FINISH FLOOR (Choose 2)

Recycled-content carpet pad.

Recycled-content carpet (tacked not glued).

Natural linoleum with low toxic adhesives or backing.

Ceramic tile installed with low toxic mastic and grout.

Recycled-content ceramic bile.

Natural material carpet (domestic cotton, wool) tacked not glued.

Domestic wood flooring made from 3rd party certified sustainably harvested sources.

XV. MATERIALS: EXTERIOR WALLS (Choose 2)

Recycled-content sheathing (minimum 50% pre- or post-consumer) or OSB.

Reconstituted or recycled-content siding (minimum 50% pre- or post-consumer).

Regionally produced brick.

Indigenous stone.

Natural stucco and/or synthetic plaster.

Cementitious siding.

Reconstituted or recycled-content fascia, soffit or trim (minimum 50% pre- or post-consumer).

Molded cementitious "stone".

R-3.5 or better-insulated exterior wall sheathing.

XVI. MATERIALS: WINDOWS (Choose 2)

Windows double glazed with 1/2" airspace.

Finger-jointed wood windows.

Low-E windows NFRC rated at u=0.37 or lower.

Exterior environmental/insulated window coverings.

No metal-frame windows in house, including basements.

XVII. MATERIALS: CABINETRY AND TRIM (Choose 1)

Any exposed particleboard is painted with water-based sealer inside

cabinets, underside of countertops.

Tropical hardwood trim or cabinets only if from 3rd party certified sustainably manageable forests.

Finger-jointed trim

On-site application of cabinet finishes done with least toxic finishes.

Domestic hardwood trim.

Cabinets made with formaldehyde-free particleboard or MDF (medium density fiberboard) or recycled agricultural product

XVIII. MATERIALS: ROOF (Choose 1)

Recycled-content roof material.

Minimum 30-year roofing material including concrete, slate, clay, composition, metal or fiberglass.

XIX. MATERIALS: FINISHES AND ADHESIVES (Choose 1)

Paints and finishes that have minimal VOC content. Standard is less than 250 grams/liter of VOCs.

Paints or finishes with recycled-content.

Only low toxicity, low solvent adhesives used throughout.

Water-based urethane finishes on wood floors.

Water-based lacquer finishes on woodwork.

XX. MATERIALS: INSULATION (Choose 1)

Recycled-content (minimum 25%) insulation.

Home has wet blown wall insulation such as cellulose or fiberglass.

Cellulose insulation with UL-rated fire retardant.

HCFC-free rigid foam insulation.

Formaldehyde-free insulation.

Non-toxic spray foam insulation.

XXI. WATER (Choose 1)

Permeable materials (40% of areas for all walkways, patios and driveways).

Grass that uses less water such as blue gramma or fescue in turf areas.

Xeriscape that is more than 60% of non-paved area.

Rainwater recovery from roof for watering.

Xeriscape with native drought resistant plants.

Provide a list of native drought resistant plants to homebuyers.

1.5 8pm faucets in bathrooms, installed to manufacturer's specifications.

2.0 8pm faucets in kitchen, installed to manufacturer's specifications.

Front loading, horizontal axis, clothes washer.

Passive or on-demand hot water deliver system installed at farthest location from water heater.

Build A Better Kitsap HOME BUILDER Self-Certification Checklist

Check items you will be including in this project to qualify for a *Build A Better Kitsap* star rating.

Requirements to Qualify at 1-Star Level
***(* All ★ items plus orientation):**

- Program Orientation (one time only)
- Section 1: Build to "Green" Codes/Regulations
- Earn 10 points from Sections 2 through 8, any items
- Provide an Operations & Maintenance Kit

Requirements to Qualify at 2-Star Level
(40 points minimum):

- Meet 1-Star requirements
- Earn an additional 30 points from Sections 2 through 8, with at least 3 points from each Section

***Requirements to Qualify at 3-Star Level* (70 points minimum):**

- Meet 2-Star requirements plus an additional 30 points
- Attend a BBK-approved workshop within past 12 months prior to certification

Section One: Build to Green Codes/Regulations

- ☐ (★) 1A **Meet Washington State Energy Code.**
- ☐ (★) 1B **Meet Washington State Ventilation/IndoorAir Quality Code.**
- ☐ (★) 1C **Meet Washington State Water Use Efficiency** Standards

Section Two: Treat Site Appropriately

Site Protection

- ☐ (1) 2A **Install temporary erosion control devices.**
- ☐ (1) 2B **Stabilize disturbed slopes.**
- ☐ (1) 2C **Install sediment traps.**
- ☐ (1) 2D **Save & reuse all topsoil.**
- ☐ (1) 2E **Balance cut and fill.**
- ☐ (1) 2F **Wash out concrete trucks in slab or pavement sub-base areas.**
- ☐ (1) 2G **Use low-toxic landscape materials and methods.**
- ☐ (1) 2H **Use less toxic form releasers.**
- ☐ (2) 2I **Do not leave any portion of site bare after construction is complete.**
- ☐ (2) 2J **Replant or donate removed vegetation.**
- ☐ (3) 2K **Grind landclearing wood & stumps for reuse.**
- ☐ (3) 2L **Phase construction so that no more than 60% of site is disturbed at a time.**

Site Design

- ☐ (1) 2M **Limit impervious surfaces to 3,000 sq. ft.**
- ☐ (1) 2N **Set aside at least 20% of site that will not be cleared or graded.**
- ☐ (1) 2O **Provide rear access off alley for multifamily housing.**
- ☐ (2) 2P **Provide an accessory dwelling unit or accessory living quarters**
- ☐ (3) 2Q **Use permeable options for driveways, walkways, patios & parking areas.**
- ☐ (3) 2R **Provide an infiltration system for rooftop runoff.**
- ☐ (3) 2S **Preserve existing native vegetation as landscaping.**
- ☐ (3) 2T **Build on an infill lot.**
- ☐ (5) 2U **Build in a *Build A Better Kitsap* certified development.**

_____ Subtotal for Section Two

Section Three: Reduce/Reuse/Recycle

Reduce

- ☐ (1) 3A **Use standard building sizes in design.**
- ☐ (1) 3B **Use quality tools and clean thoroughly between uses.**
- ☐ (1) 3C **Set up labeled bins for different sized nails, screws, etc.**
- ☐ (1) 3D **Provide weather protection for stored materials.**
- ☐ (1) 3E **Use drywall stops or clips for backing.**
- ☐ (1) 3F **Use two-stud corners.**
- ☐ (1) 3G **Use insulated headers.**
- ☐ (1) 3H **Use ladder partitions on exterior walls.**
- ☐ (2) 3I **Create detailed take-off and provide as cut list to framer.**
- ☐ (2) 3J **Use suppliers who use reusable or recyclable packaging.**
- ☐ (2) 3K **Use central cutting area or cut packs.**
- ☐ (3) 3L **Require subcontractors to participate in waste reduction efforts.**
- ☐ (3) 3M **Limit project size to under 1,800 sq. ft.**

Reuse

- ☐ (1) 3N **Use reusable supplies for operations.**
- ☐ (1) 3O **Reuse building materials.**
- ☐ (1) 3P **Reuse dimensional lumber.**
- ☐ (1) 3T **Sell or give away wood scraps.**
- ☐ (1) 3U **Sell or donate reusable items from your job.**
- ☐ (1) 3V **Move leftover materials to next job or provide to owner.**
- ☐ (2) 3W **Purchase used building materials for your job.**

Recycle

- ☐ (1) 3X **Recycle wood scrap.**
- ☐ (1) 3Y **Recycle cardboard.**
- ☐ (1) 3Z **Recycle metal scraps.**
- ☐ (2) 3AA **Recycle drywall.**
- ☐ (3) 3BB **Recycle asphalt roofing.**
- ☐ (3) 3CC **Recycle concrete/asphalt rubble.**
- ☐ (3) 3DD **Prepare a job-site recycling plan and post on site.**

_____ *Subtotal for Section Three*

Section Four: Purchase Resource-Efficient Products

- ☐ (1) 4A **Use drywall with recycled-content gypsum.**
- ☐ (1) 4B **Use recycled-content insulation.**
- ☐ (1) 4C **Use resource-efficient carpet and/or padding.**
- ☐ (1) 4D **Use recycled or "reworked" paint.**
- ☐ (1) 4E **Use resource-efficient siding.**
- ☐ (1) 4F **Use flyash in concrete.**
- ☐ (1) 4G **Use recycled-content vinyl flooring.**
- ☐ (1) 4H **Install materials with longer life-cycles.**
- ☐ (1) 4I **Use finger-jointed wood products.**
- ☐ (1) 4J **Use engineered structural products.**
- ☐ (2) 4M **Use structural panel systems.**
- ☐ (2) 4N **Use recycled concrete, glass cullet, or asphalt for base or fill.**
- ☐ (2) 4O **Use recycled-content plastic lumber.**
- ☐ (3) 4Q **Use recycled-content ceramic tile.**
- ☐ (3) 4R **Use linoleum, cork, or bamboo flooring.**
- ☐ (3) 4S **Use re-milled salvaged lumber.**
- ☐ (3) 4T **Use sustainably produced, certified wood.**
- ☐ (3) 4U **Use salvaged or recycled-content masonry.**

_____ Subtotal for Section Four

Section Five: Maximize Energy Efficiency

- ☐ (1-9) 5A **Improve energy efficiency of building components prescribed by code. (See Chart 5-1 in Resource Appendix)**
- ☐ (1-10) 5B **Improve energy efficiency of building components affecting code performance. (See Chart 5-2 in Resource Appendix)**
- ☐ (1) 5E **Optimize hot water heating system (beyond code).**
- ☐ (1) 5G **Provide an outdoor clothesline.**
- ☐ (1) 5H **Install timers for bathroom fans.**
- ☐ (1) 5I **Install lighting dimmers, timers, and/or motion detectors.**
- ☐ (2) 5M **Use compact fluorescent lighting.**
- ☐ (2) 5N **Use light tubes for natural lighting and to reduce electric lighting.**
- ☐ (2) 5O **Optimize air sealing techniques.**
- ☐ (2) 5P **Use blown-in insulation.**
- ☐ (2) 5Q **Install tankless (instantaneous) water heaters at taps.**
- ☐ (2) 5R **Centrally locate furnace and hot water heater.**
- ☐ (2) 5S **Orient building to make the best use of passive solar.**
- ☐ (3) 5T **Use building & landscaping plans that reduce heating/cooling loads naturally.**
- ☐ (3) 5U **Install air-to-air heat exchanger.**

_____ Subtotal for Section Five

Section Six: Promote Good Air Quality and Health

- ☐ (1) 6A **Use improved air filters.**
- ☐ (1) 6D **Supply workers with VOC-safe masks.**
- ☐ (1) 6E **Install CO detector.**
- ☐ (1) 6F **Exhaust central vacuum to outside; install equipment in garage.**
- ☐ (2) 6K **Use less polluting insulation products.**
- ☐ (2) 6L **Use foil-covered external insulation on metal ducting.**
- ☐ (2) 6M **Install exhaust fans in rooms where office equipment is used.**
- ☐ (2) 6N **Take measures during construction operations to avoid moisture problems later.**
- ☐ (2) 6P **Design buildings to keep water out and off.**
- ☐ (2) 6Q **Take measures to avoid problems due to construction dust.**
- ☐ (2) 6R **Create an "oasis" in family bedrooms.**
- ☐ (3) 6V **Reduce sources of interior formaldehyde.**
- ☐ (3) 6W **Use low-VOC, low-toxic, water-based paints, sealers, finishes, or solvents.**
- ☐ (3) 6X **Use low-VOC, low-toxic, water-based grouts, mortars, or adhesives.**
- ☐ (3) 6Y **Use low-toxic or less allergen-attracting carpets.**
- ☐ (3) 6Z **Limit use of carpet to one-third of home's square footage.**
- ☐ (3) 6BB **Install sealed combustion heating and hot water equipment.**
- ☐ (3) 6CC **Provide balanced or slightly positive indoor pressure using controlled ventilation.**
- ☐ (3) 6DD **If providing central heating and cooling, install whole house dehumidification.**
- ☐ (3) 6EE **Optimize air distribution system.**
- ☐ (3) 6FF **Meet code req.'ts for *higher risk* radon counties.**
- ☐ (10) 6HH **Certify house under the American Lung Association's *Health House Advantage* Program.**

_____ Subtotal for Section Six

Section Seven: Manage Hazardous Waste Properly

- ☐ (1) 7A **Use less or non-toxic cleaners.**
- ☐ (1) 7B **Use water-based paints instead of oil-based paints.**
- ☐ (1) 7C **Reduce hazardous waste through good housekeeping.**
- ☐ (2) 7D **Reuse spent solvent for cleaning.**
- ☐ (2) 7E **Recycle used antifreeze, oil, oil filters, and paint at appropriate outlets.**
- ☐ (2) 7F **Dispose of non-recyclable hazardous waste at legally permitted facilities.**

_____ Subtotal for Section Seven

Section Eight: Promote Responsible Oper. & Maintenance

- ☐ (1) 8A **Install environmentally friendly water filter at sink.**
- ☐ (1) 8B **Use drought-tolerant landscaping.**
- ☐ (1) 8C **Provide homeowner with a compost bin.**
- ☐ (1) 8D **Avoid solid fuel appliances.**
- ☐ (2) 8E **Install extra-efficient domestic appliances.**
- ☐ (2) 8F **Build in recycling area and chutes.**
- ☐ (2) 8G **Build a lockable storage closet for hazardous cleaning & maintenance products.**
- ☐ (3) 8H **Install high-efficiency irrigation system.**
- ☐ (3) 8I **Provide a rainwater collection system for irrigation.**
- ☐ (★) 8L **Provide owner with an Operations & Maintenance Kit**

_____ Subtotal for Section Eight

_____ Total Points for Project

Program Level Obtained:

1-Star ★ 2-Star ★★ 3-Star ★★★

APPENDIX D

EXECUTIVE SUMMARY OF FOCUS GROUPS WITH CONSUMERS ON "GREEN BUILDER" PROGRAM

PURPOSE

The purpose of this research was to determine home buyer perceptions of and interest in "green building" concepts to support the development of a builder program operated by local home builder associations.

METHOD

Two standard two-hour focus groups were conducted with consumers in Atlanta. A professionally trained moderator from the NAHB Research Center facilitated the groups.

GROUP	TARGET SEGMENT	DATE and TIME	NO OF RESPONDENTS
A	Consumers (purchased housed $170,000 or greater)	Tuesday, June 9, 1998; 6:00 p.m.	8
B	Consumers (purchased houses $170,00 or less)	Tuesday, June 9, 1998; 8:00 p.m.	9

KEY FINDINGS

There is an opportunity to develop a certified "Green Home" program for new construction that would help build a positive perception of builders among Atlanta's homebuyers. Homebuyers currently have negative perceptions of builders and the impact of new construction on the environment. Trees, greenery and a "natural" landscape were important to respondents and they perceived that builders were primarily if not solely responsible for clear-cutting trees during land development.

Many respondents in **Group A** built their own homes and had an overwhelming knowledge of construction issues. They were interested in an environmental home program, but weighed their decisions related to environmentally friendly products against cost and value. They were interested in program features related to the construction process like insulation and air infiltration detailing that could not be done after construction. They had a strong distrust of builders and felt that builders should be licensed like other professional groups. The idea of a voluntary environmental home

program appealed to them, but they wanted the program operated by a third party who would certify that the home and the builder met the established standards.

Respondents in **Group B**, were more likely to purchase less expensive existing homes. They were less knowledgeable of the construction process, but had strong notions of environmental responsibility. Established landscaping and trees were very important to them. They were very interested in an environmental home program that would help them learn about the products and materials that went into their homes. They felt that this would help them to make better decisions about homes.

RELATIVE VALUE OF NEW HOME FEATURES

- The first things that come to mind when respondents in both groups hear the word environment is their surroundings both indoors and out. "Environment" is largely considered a positive word, but respondents in Group A suggested that is was overused and too broad.
- Both groups suggested that pollution from traffic, overpopulation, and construction were among the factors that impacted the environment. They suggested that builders clear cut trees and that this harmed the environment. Respondents in group B were concerned with construction run-off.
- Group A respondents felt that "quality construction" was a well constructed home with properly installed features like insulation that was built by an honest reputable builder.
- Respondents were given the opportunity to go shopping for options in a new home the results are summarized in Attachment A. The most expensive items they purchased are outlined below. Group B was given less money and did not want to spend all of it on one option so they purchased many small options. Every respondent in this group purchased energy efficient window upgrades. This may have been a result of their low cost. Group A respondents largely chose items that were part of the construction process. Low maintenance and monthly savings on operating costs were important to them. Both groups felt that the features they chose would add to the resale value of their homes.

GROUP A - $7,000	GROUP B - $5,000
Deck (Pressure treated) Passive Solar Roofing **Upgraded appliances** **Xeriscaping**	Carpeting and Padding Deck (Pressure Treated) Health and Indoor Air Quality Upgraded appliances Windows Xeriscaping

REACTIONS TO NAMES AND CONCEPTS

- Respondents in Group A had more complicated political associations with words such as sustainable, green and environmental and felt that these were trendy, over-used words. Respondents in Group B had positive reactions to all words, but did not have any environmental associations with sustainable and green. They felt that sustainable meant long term and lasting, and green was money and trees.

- When asked about words to describe an environmental home program, homebuyers gave the following responses:

GROUP A	GROUP B
• Renewable • Healthy • Efficient • Protection • Biodegradable (-) • Natural	• Environmentally Friendly • Energy-wise • Integral • Cost-effective • Low-maintenance • Simple • Life Style

- Both groups had positive responses to the tag line "Building Environmental Quality Indoors and Out." They liked the use of the term quality and the inclusion of both the indoor environment, their landscape and their community.
- Group A liked the name GREAT Home, Greater Resource Efficiency and Advanced Technology, for an environmental home program. Group B on the other hand, felt intimidated by the words advanced technology. They associated those words with computers, not the environment.
- Group B preferred the name SAVE Home, Safely Assuring a Viable Environment. They suggested that this made them feel good, while Group A respondents felt the words were subjective and had little meaning.
- Group A referred to the program as GREAT Home. Group B developed a number of different names for the program and decided to call it "At Home with the Environment."

PROGRAM ATTRIBUTES

- Respondents suggested that a program certify both homes and builders and should have a consumer education component. Group A was very concerned that the program be responsive to customers needs and decertify builders who did not build homes that met established standards. Respondents developed the following lists of what an environmental home program should consist of:

GREAT Home	At Home with the Environment

• Class (education) for Public
  ➢ 3rd Party
• Certifies Homes
• Certifies/Decertifies Builders
• Manages Complaints
• Sets Standards
• Warranty
• Incentive
	• Energy Efficiency Options
	• Native Landscaping
	• Large Lots
	• House Spacing
	• Education Programs
	  ➢ Fact Sheets
	  ➢ Website
	• Access to Government Regulations
	• Advertisements

- Respondents wanted a certificate that their home met program standards.
- Group A respondents had differing reactions to incentives. Most preferred lower monthly operating costs since they felt this was a tangible number. Some preferred mortgage interest rate reductions and tax breaks but others were skeptical that interest rate reductions were just a financial game. Group B overwhelming preferred mortgage interest rate reductions because they felt it would save them a lot of money over the long term. Neither group was interested in

qualifying for a mortgage on a more expensive home that is the most similar to the currently available energy efficiency mortgages (EEMs).

- Generally respondents felt that there should be different levels of certification programs so that they had options from which to choose.
- Respondents suggested that an association of different disciplines including architects, building inspectors, utilities (including small, independent utilities) and the government should operate the program to ensure that builders met standards.

ATTACHMENT 1
LIST OF OPTIONS

ITEM	GROUP A	GROUP B	COST*	APPROX. SAVINGS*
10' x 14' Deck (pressure-treated wood)	1	2	$2,200	
10' x 14' Deck (low maintenance recycled content material)	1		$3,000	
Low-flow plumbing fixtures	2	5	$100	$25-30 / year
Xeriscaping (Native landscaping that requires less water and maintenance)	2	2	$3,000	$40 / year
Use of recycled and recyclable materials in the construction of the house		2	$1,000	
Built-in recycling bins for separation of materials		3	$150	
Increased insulation and air sealing	6	5	$1,000	$100 / year
Set-back thermostat	3	3	$100	$25-40 / year
Energy-efficient windows	6	9	$500	$30 / year
High efficiency heating / cooling equipment upgrade	5	6	$600	$50 / year
Hot tub			$3,000	
Whirl pool bath tub	1		$1,000	
Health and indoor air quality upgrade - Air sealing and mechanical ventilation to control humidity levels and filter the air	3	3	$1,200	$30 / year
Use of non toxic paints and adhesives	4	4	$500	
Aesthetic upgrade - Upgraded kitchen counters and cabinets	1		$2,500	
Aesthetic upgrade - Carpeting and carpet padding		2	$2,500	
High efficiency appliance upgrade (refrigerator, dishwasher, washer/dryer)	2	3	$1,200	$80 / year
Passive solar upgrade • Orientation of house on the site to maximize heat gain in the winter and natural cooling in the summer. • Trees and bushes for summer shade and wind breaks	3		$5,000	$400 / year
Low maintenance / resource efficient roofing materials (50 year warranty)	2		$3,000	Fire insurance savings
Low maintenance / energy efficient exterior finish (20 year warranty)		1	$2,000	$10 / year
Compact fluorescent lighting			$200	Lights last 4 time longer

*The costs indicated are not designed to reflect the market, but to generate discussion and decision-making among respondents. Assume that these are fair market prices.

APPENDIX D

FOCUS GROUPS WITH CONSUMERS ON "GREEN BUILDER" PROGRAM

GROUP	TARGET SEGMENT	DATE and TIME	LOCATION
A	Consumers ($170,000 or greater)	Tuesday, June 9, 1998; 6:00 p.m.	Quality Controlled Services, Atlanta, GA 800-227-2974
B	Consumers ($170,000 or less)	Tuesday, June 9, 1998; 8:00 p.m.	

DISCUSSION AGENDA

I. Introduction	10 minutes
II. Relative Value of New Home Features	30 minutes
III. Reactions to Names and Concepts	30 minutes
V. Program Attributes	30 minutes
IV. Closing	10 minutes

CLIENT NOTICE

Purpose of study: To determine home buyer perceptions of and interest in "green building" concepts to support the development of a builder program operated by home builder associations

NOTES TO MAKE OBSERVATION MORE MEAININGUL:

1. Do not expect the moderator to ask every question on the guide or to ask the questions in the same language as on the guide.
2. Do not expect every minute of each group observed to be meaningful.
3. Do not expect every question to have an immediate payoff in "providing insight."
4. Do not expect every comment, statement, response or interchange to relate directly to the topic being discussed.
5. Listen carefully to what respondents say, but avoid judging or evaluating those comments against an internal barometer. Be willing to listen to misinformation and find in it an insight to the thinking of respondents.
6. Avoid "selective listening" -- paying attention to only those points that support an already established or preconceived point of view.
7. Remember that qualitative research is intended to provide clients with the following:
   - A range of responses from varied groups of respondents
   - Insights into the thinking of individuals in a group setting
   - Exploration of issues in detail without coming to closure
   - Reactions after "exposure" to concepts, ideas, products, etc.
8. Keep talking to a whisper, since the rooms are not sound proof.
9. Prior to the end of the focus group, the moderator will visit the observation room. Please nominate one person from the observation room to provide the moderator with no more than three clearly stated questions in writing for the moderator to ask the group before dismissing them.

FOCUS GROUPS WITH CONSUMERS ON "GREEN BUILDER" PROGRAM

DISCUSSION GUIDE

I. INTRODUCTION

Our purpose today is:

to discuss your thoughts and experiences related to environmental friendliness in your homes and community.

GROUND RULES

Focus group facility (people behind one-way mirror, taping)
Speak one at a time, in a loud clear voice.
No wrong answers or stupid ideas, express opinions both positive and negative.
Encourage everyone to speak, work for **equal "air time."**
Avoid side conversations.
Move on.

SELF INTROS

First name
Occupation
How long you've been living in your current home
If you have any plans to purchase a new home in the next three years
Your favorite past time

SELF DISCLOSURE Round out introductions

II. RELATIVE VALUE OF NEW HOME FEATURES

When I say the word "environment," what comes to your mind?

What are the factors that impact the environment? These can be positive or negative.
To what extent do **new homes impact the environment**?
PROBE: In what ways do new homes impact the environment?

What does the term **"quality construction"** mean to you?
What is the **relationship between "quality" and "environmentally friendly" homes**?

You are going shopping for a new home this evening. Before we look at specific features of your new home, tell me **to what extent is the builder of a home important to your decision to purchase a specific home?**
PROBE: What do you look for in a builder? If reputation is important what makes a "good" reputation?

SCENARIO Give each respondent $7,000 Monopoly money after they sit down. PURPOSE OF EXERCISE: Have consumers make decisions and generate discussion on

You have just found a model home in a development that meets your needs as far as the number of rooms, bedrooms, floor plan and yard space. The location is convenient for your

relative importance of new home features.

needs. The builder has a reputation for quality construction, and, most importantly, the price is within your housing budget. Your only decision now is the options in this house. You have $7,000 in options to spend. The $7,000 is part of the mortgaged price of the house so you must make decisions about how to spend it. You cannot pocket this as cash, but you can make decisions that reduce your monthly operating costs.

See attachment #1 for list of options that appear on cards.

What I want you to do is take your money and go shopping around the table. Pick up the card that represents the feature you are purchasing and place the money next to it.

LIST AND TALLY ON CHART

Tell me what options you decided to purchase.

What drove your decision to purchase this? (PROBE: perception of quality; environmental impact; non-quantifiable benefits v. costs)

What value does it provide you?

What value does it provide the community?
How does it affect the resale value of your home?

What other options/features did you want to purchase, but were outside of your budget?

- How likely would you be to purchase these features at an additional cost?

III. REACTIONS TO NAMES AND CONCEPTS

See attachment #2A for list of names and words

I'm going to hold up some cards and I want you to tell me the first thing that comes to your mind after I read the card.

Positive or negative?

LIST

What would be some other words that describe a program for environmentally friendly homes?

LIST

What are some combinations of words or phrases that describe an environmental home program in which you would be interested in participating / purchasing a home / purchasing a home from a builder who participated in the program?

What do you think of the phrase **"Building Environmental Quality Indoors and Out"**

What works?
What are some other phrases that would work?

IV. PROGRAM ATTRIBUTES

Let's talk more specifically about an (environmental) home program. What is an (environmental) home program? (PROBE: what does it consist of? Resource efficiency, energy efficiency)
How do you, as a homebuyer, benefit from the program? (PROBE: What are the non-quantifiable benefits to you? Doing my part for the environment, healthier living conditions, etc.)

CERTIFICATION

What are the benefits/issues associated with **having homes certified** as being environmentally friendly?
What would be the benefits/issues of **having builders certified** as constructing homes that are environmentally friendly?
What would a builder need to do / provide for you to feel comfortable that you purchased an environmentally friendly home?
PROBE: certificate, list of features

LEVELS OF CERTIFICATION
Distribute worksheet #1

In which of the following levels of a program would you be most likely to participate?
For what reasons?

Does it make sense to have multiple program levels?
What are the benefits / issues associated with multiple program levels?
PROBE: simplicity v. options and differentiation, can the market handle 3 levels?

INCENTIVES

To what extent are you familiar with energy efficiency mortgages? (PROBE: knowledge, use)
On the worksheet in front of you, please rate your preference for a financial incentive for purchasing an (environmental / energy efficient) home. 1 is your preference and 4 is your least preferred.
How many preferred X? What do you like about it? (CONTINUE)
Which was the least preferred? What doesn't work about it?

Distribute worksheet #2; see for list of incentives

PROGRAM PARTNERS

What types of partnerships / who would you value / trust to establish and operate an environmental home program?
PROBE: local HBA, local government, EPA, local environmental group

MATERIALS /MARKETING

What materials / items would you want to have from the builder if you were to purchase an (environmental) home?
PROBE: Brochures, sales person knowledge, handbook,

framed certificate, decals with logo

BUILDER REPUTATION

To what extent is a builders' reputation affected by his/her participation in such a program?

PROBE: Examples

IV. CLOSING

CHOOSE RESPONDENT TO MODERATE AND VISIT OBSERVATION ROOM FOR ANY FINAL QUESTSIONS

What are the attributes of an ideal (environmental) home program?

ATTACHMENT #1

LIST OF OPTIONS

ITEM	COST*	APPROX. MONTHLY SAVINGS*
10’ x 14’ Deck (pressure-treated wood)	$2,200	
10’ x 14’ Deck (low maintenance recycled content material)	$3,000	
Low-flow plumbing fixtures	$100	$25-30 / year
Xeriscaping (Native landscaping that requires less water and maintenance)	$3,000	$40 / year
Use of recycled and recyclable materials in the construction of the house	$1,000	
Built-in recycling bins for separation of materials	$150	
Increased insulation and air sealing	$1,000	$100 / year
Set-back thermostat	$100	$25-40 / year
Energy-efficient windows	$500	$30 / year
High efficiency heating / cooling equipment upgrade	$600	$50 / year
Hot tub	$3,000	
Whirl pool bath tub	$1,000	
Health and indoor air quality upgrade - Air sealing and mechanical ventilation to control humidity levels and filter the air	$1,200	$30 / year
Use of non toxic paints and adhesives	$500	
Aesthetic upgrade - Upgraded kitchen counters and cabinets	$2,500	
Aesthetic upgrade - Carpeting and carpet padding	$2,500	
High efficiency appliance upgrade (refrigerator, dishwasher, washer/dryer)	$1,200	$80 / year
Passive solar upgrade Orientation of house on the site to maximize heat gain in the winter and natural cooling in the summer. Trees and bushes for summer shade and wind breaks	$5,000	$400 / year
Low maintenance / resource efficient roofing materials (50 year warranty)	$3,000	Fire insurance savings
Low maintenance / energy efficient exterior finish (20 year warranty)	$2,000	$10 / year
Compact fluorescent lighting	$200	Lights last 4 time longer

*The costs indicated are not designed to reflect the market, but to generate discussion and decision-making among respondents. Assume that these are fair market prices.

ATTACHMENT #2

LIST OF NAMES AND CONCEPTS

REACTIONS TO NAMES AND WORDS

- **Green**
- **Environment**
- **Ecology**
- **Environmentally-friendly**
- **Energy Efficiency**
- **Energy Conservation**
- **Indoor Air Quality**
- **Sustainable**
- **Healthy**

WORKSHEET #1

NAME: **DATE:**

Circle the program in which you are most likely to participate?

BASIC ENVIRONMENTAL HOME PROGRAM	**PLUS ENVIRONMENTAL HOME PROGRAM**	**ADVANCED ENVIRONMENTAL HOME PROGRAM**
COST OF PACKAGE IN THE MORTGAGE COMBINED WITH ANNUALIZED ENERGY SAVINGS EQUALS **SAVINGS OF $50 PER YEAR**	COST OF PACKAGE IN THE MORTGAGE **EQUALS** THE ANNUALIZED ENERGY SAVINGS	COST OF PACKAGE IN THE MORTGAGE COMBINED WITH ANNUALIZED ENERGY SAVINGS EQUALS A NET **COST OF $600 PER YEAR**

WORKSHEET #2

NAME: **DATE:**

PLEASE RANK YOUR PREFERENCE FOR AN INCENTIVE FOR PURCHASING AND ENVIRONMENTALLY FRIENDLY/ENERGY EFFICIENT HOME. 1 IS YOUR HIGHEST PREFERENCE AND 4 IS YOUR LEAST PREFERRED.

RANK	FINANCIAL INCENTIVE
	Tax breaks
	Lower monthly operating costs (lower utility bills)
	Qualify for a mortgage on a more expensive home
	Mortgage interest rate reduction

APPENDIX E – ATLANTA BUILDERS SURVEY

Greater Atlanta Home Builders Association

BUILDERS SURVEY RESULTS

1. To what extent do you typically utilize the following environmentally-friendly measures in your homes?

		NEVER	SOMETIMES	HALF OF THE TIME	MOST OF THE TIME	ALWAYS
a)	Efficient framing techniques (turn studs)	38%	24%	10%	14%	5%
b)	Energy conservation details	5%	29%	10%	24%	33%
c)	Site layout (solar & landscape preservation)	29%	38%	10%	14%	10%
d)	Resource-efficient building materials	19%	43%	14%	19%	0%
e)	Recycled content building materials	38%	43%	14%	0%	5%
f)	Construction waste management techniques	33%	38%	14%	24%	5%
g)	Landscaping techniques and plumbing fixtures for water conservation	29%	0%	14%	33%	24%
h)	Indoor air-quality	38%	14%	5%	29%	14%
i)	Passive heating/cooling systems	71%	10%	5%	14%	0%

2. Please check the FIVE attributes that **most** influence your decision to use environmentally-friendly measures or products in your homes.

90% a) Cost-effectiveness
38% b) Familiarity with the product
43% c) Product appearance
62% d) Compliance with building codes
19% e) Amount of technical training required for use
57% f) Consumer demand for specific features
19% g) Environmental impact
71% h) Product performance
48% i) Constructability
52% j) Availability of products or materials
0% k) Others:_____

3. Which of the following waste reduction techniques would you **like to practice or encourage more** in your projects but find impractical, cost prohibitive, or otherwise difficult?

62% a) Salvaging materials
24% b) Writing waste reduction into contracts
24% c) Double-checking measurements before cutting
48% d) Recycling
38% e) Re-using build materials
14% f) Re-using packing materials
24% g) Making sorted scrap piles
0% h) Others:_____

4. To what extent are the following environmentally-friendly measures requested by your customers?

		NEVER	SOMETIMES	HALF OF THE TIME	MOST OF THE TIME	ALWAYS
a)	Efficient framing techniques	81%	19%	5%	0%	5%
b)	Energy conservation & efficiency	33%	43%	14%	10%	5%
c)	Site layout (solar & landscape preservation)	48%	24%	10%	10%	5%
d)	Resource-efficient building materials	71%	24%	0%	0%	0%
e)	Recycled content building materials	67%	19%	10%	0%	0%
f)	Construction waste management techniques	71%	14%	0%	5%	0%
g)	Landscaping techniques and plumbing fixtures for water conservation	52%	19%	14%	10%	5%
h)	Indoor air-quality	33%	33%	14%	10%	10%
i)	Passive heating/cooling systems	67%	19%	0%	10%	0%

5. Which of the following issues make it more difficult for you to build resource-efficient homes?

10% a) There is no technical information available.
38% b) My practices meet code requirements.
14% c) My homes are already very efficient.
19% d) I don't know where to find better technology.
24% e) Home buyers need to be educated on the benefits.
71% f) There is no consumer demand.
33% g) It's too time intensive.
14% h) I would need more training.
0% i) Others:

6. Do you consider yourself an environmentalist?

29% YES
48% NO
19% DON'T KNOW

7. Would you be willing to participate in an environmentally conscious builder or "Green Builder" Program?

24% YES
24% NO
52% DON'T KNOW

8. If you **would** be willing to participate, which of the following marketing or promotional tools would be **most** valuable to you?

38% a) Use of the program logo
29% b) Program stickers and/or flyers
43% c) Compliance certificates
43% d) Information resources
19% e) Others:_____

9. Please check the FIVE environmental measures that you feel are **most** important in establishing a "Green Builder" Program?

57% a) Efficient framing techniques
33% b) Landscaping techniques for water conservation
24% c) Site layout (solar & landscape preservation)
71% d) Construction waste management techniques
38% e) Plumbing fixtures for water conservation
52% f) Energy conservation & efficiency
38% g) Recycled content building materials
33% h) Resource-efficient building materials
5% i) Passive heating/cooling systems
29% j) Indoor air-quality
38% k) Energy conservation & efficiency
0% l) Others:

10. How important would the following resources be as components of the "Green Builder" Program to help you improve the environmental impact?

	DON'T KNOW	NOT IMPORTANT	SOMEWHAT IMPORTANT	IMPORTANT	VERY IMPORTANT
a) National and/or local "green" products & suppliers directory	14%	10%	19%	14%	24%
b) Education about waste reduction techniques	5%	0%	10%	33%	38%
c) Education about environmental degradation	10%	5%	24%	24%	19%
d) Support for stronger legislation	24%	19%	10%	14%	10%
e) Distribution of statistics on cost-savings	10%	0%	33%	24%	19%
f) Distribution of examples of how other builders have reduced their waste	5%	0%	10%	38%	29%
g) Initial and/or on-going training	5%	0%	24%	33%	14%

h) Others: 10% 0% 0% 14% 0%

11. Do you think a "Green Builder" program would benefit Metro Atlanta?

38% YES
5% NO
48% DON'T KNOW

12. What should the program be called?

14% The Build a Better Atlanta
19% The Build a Greener Atlanta
5% The Eco Builder
5% The Green Builder
19% The Enviro - Builder

13. Would you allow your homes to be randomly inspected for program compliance?

52% YES
10% NO
29% DON'T KNOW

14. Would you provide technical ideas and resources to incorporate into the program?

29% YES
29% NO
38% DON'T KNOW

15. In general, what do you see the THREE **greatest** obstacles to a beneficial and successful "Green Builder" program?

10% a) The technology is not tested.
38% b) Technology is not widely available.
33% c) Its too time intensive.
48% d) Traditional practices are simpler & reliable.
38% e) Lack of expertise exists for services and assistance.
24% f) Company policies favor standard practices.
62% g) Public doesn't understand or accept it.
33% h) Building codes don't allow innovations.
19% i) Others:

16. If you believe the "Green Builder" program will be beneficial and successful, would you be willing to participate in an advisory council and/or focus group to help develop the program?

29% YES
33% NO
33% DON'T KNOW

17. Please provide the information below.

NAME:_____
COMPANY NAME:_____
WORK NUMBER:_____

18. What price range do you typically build?

10% less than $100,000
52% $100,000 to $200,000
24% $200,000 to $300,000
10% $300,000 to $400,000
29% more than $400,000

APPENDIX F – ATLANTA HOME BUYERS SURVEY

Greater Atlanta Home Builders Association

HOMEBUYERS SURVEY RESULTS

(*SAMPLE SIZE = 137 RESPONDENTS*)

1. I associate an environmentally-friendly home with the following:

82% Resource Efficiency	35% Increased Comfort	49% Lower Monthly Costs
39% Positive Builder Reputation	7% High Monthly Cost	84% Less Pollution
13% Lower Cost to Purchase the Home	29% Higher Cost to Purchase the Home	73% Quality Construction
90% Energy Efficiency		

2. Please check the FIVE attributes that most influence your decision to use environmentally-friendly measures or products in your homes.

a) I think that purchasing an environmentally-friendly home make a difference to Atlanta's environment.	93% AGREE	4% DISAGREE
b) Operating my home in resource and energy-efficient way is important to me.	93% AGREE	3% DISAGREE
c) A certificate from my builder stating that my home is environmentally-friendly has value to me.	80% AGREE	12% DISAGREE
d) Information on how to operate my home in an energy-efficient manner has value to me.	91% AGREE	4% DISAGREE
e) I think it is important to purchase a home from a builder who participates in an environmentally-friendly construction program.	10% AGREE	10% DISAGREE

3. As a homeowner, I am willing to undertake the following measures to operate my home more efficiently:

a) Water lawn at night or every other day to conserve water.	87% YES	3% NO	7% DON'T KNOW
b) Recycle aluminum, glass, and paper.	93% YES	3% NO	2% DON'T KNOW
c) Use less gas or electricity and water by taking shorter showers.	66% YES	22% NO	7% DON'T KNOW
d) Use less gas or electricity by turning off lights.	93% YES	2% NO	2% DON'T KNOW
e) Eliminate/reduce the use of lawn fertilizer chemicals.	82% YES	9% NO	13% DON'T KNOW
f) Install products that use less energy such as a set-back thermostat.	87% YES	4% NO	7% DON'T KNOW

4. **The following attribute have the indicated degree of importance to my decision to purchase products for my home:**

	DON'T KNOW	NOT IMPORTANT	SOMEWHAT IMPORTANT	IMPORTANT	VERY IMPORTANT
a) Cost	1%	1%	12%	41%	43%
b) How long it works	0%	0%	4%	38%	53%
c) How well it works	0%	0%	3%	18%	74%
d) How it looks	1%	7%	32%	37%	18%
e) Its environmental impact (i.e., non-toxic, energy- and resource-efficient)	1%	1%	8%	46%	40%
f) Recycled content or recyclable	1%	4%	31%	38%	22%
g) Your familiarity with the product	0%	9%	35%	40%	13%

6. The following attributes have the indicated degree of importance to my decision to purchase my next home:

	DON'T KNOW	NOT IMPORTANT	SOMEWHAT IMPORTANT	IMPORTANT	VERY IMPORTANT
a) Price	0%	1%	5%	33%	56%
b) Monthly payments	0%	3%	10%	29%	63%
c) Location	0%	0%	3%	18%	74%
d) Design including exterior appearance and floorplan.	0%	0%	3%	35%	64%
e) Energy-efficiency (i.e. appliances that use less energy, properly installed insulation)	0%	1%	7%	43%	43%
f) Resource-efficiency (i.e. use of engineered Lumber, builder recycles)	1%	2%	18%	43%	31%
g) Indoor air-quality (i.e. mechanical ventilation, use of low toxic paints)	1%	1%	10%	32%	50%
h) Water conservation (i.e. low flow toilets, natural landscaping	0%	2%	13%	40%	40%
i) Wooded lots or trees	0%	4%	10%	32%	50%
j) Extras such as hot tubs, skylights or decks	1%	19%	23%	22%	31%
k) Builder reputation	1%	3%	14%	29%	49%

7. In what price range did you purchase or are you considering purchasing your new home:

6% Less than $81,000 44% $81,000 - $170,000 37% $170,000 - $340,000 7% Greater than $340,000

8. I would be willing to pay:

	DON'T KNOW	THE SAME	$200 - $400 MORE	$400 - $1,000 MORE	MORE THAN $1,000
a) for a home with water smart features	11%	18%	25%	22%	7%
b) for a energy-efficient home to save on my monthly operating cost	6%	10%	13%	27%	28%
c) for a resource-efficient home to help protect the environment	8%	13%	12%	28%	21%
d) for a "Green Home" that is both energy and resource-efficient.	10%	10%	7%	20%	37%

9. Were you a primary decision-maker in the choice of you're current home or will you be a primary decision-maker in the choice of your next home?

90% YES
2% NO

10. In what age range do you fall:

0% Less than 18years of age 9% 18-30 years 76% 30 – 55 years 11% Greater than 55 years

11. **Would you be interested in participating in a focus group discussion with other homebuyers? The focus groups will last approximately two hours and you will receive monetary compensation as a token of our appreciation for your time and opinions.**

82% YES
10% NO

APPENDIX G

General Green Building Resources

The resources listed below have been selected for the breadth and depth of their coverage of environmental building issues and practical information on resource-efficient building techniques and materials. Their selection should not be considered an endorsement.

NAHB Research Center HOME BASE Services – This is a suite of information resources including a CD product directory, a quarterly newsletter (HOME BASE News) and the HOME BASE Hotline (800 898-2842 or on the web: *homebase@nahbrc.org*). All of the services can be accessed through the HOME BASE Hotline, staffed 11 hours every business day by a building research professional. Although this resource is not limited to environmental building issues and information, green building is one of the major areas of coverage.

Environmental Building News (EBN)– Started in 1992 as a bi-monthly newsletter, EBN has grown to include the EBN Product Catalog, the E Build Library (on CD), an on-line green building discussion list, and a new CD resource, The Green Building Advisor. All are comprehensive and practical resources for resource-efficient construction. Their target audience includes both residential and commercial architects, building scientists, and builders. *www.ebuild.com* or PH: 802 257-7300.

Iris Communications, Inc. – Best accessed through their web site, Iris Communications specializes in the *how* of green building. Resources include a library/bookstore, green building product data base, and co-sponsorhip of the internet green building discussion list. All resources are updated frequently and kept current. *www.oikos.com* or PH: 541 767-0355.

Environmental Design & Construction – A newcomer to the green building industry, this magazine is a bi-monthly publication covering both residential and commercial construction. While the EBN publication is a news-only, text-focused resource, this publication is a healthy complement with product advertising and full-color layout. *www.edcmag.com* or PH: 248 362-3700

Sustainable Building Sources – This is a strictly internet resource for information on green building. Although some of the information might be considered "fringe" by the mainstream builder, there are many useful resources to consider, such as a first-of-its-kind green building professional directory. *www.greenbuilder.com*

APPENDIX H

City of Austin Green Builder Program
Katz Builders (Barley and Pfeiffer Architects)
3104 Haden Bend

Program Items	Points
Materials	
R 2 engineered materials (I-joists and OSB sheathing)	
R 1 recycled-content material (cellulose insulation)	
R Concrete 20% fly ash content	
R Kitchen recycling center	
• Engineered materials (decking, trim, doors)	3
• OVE framing	2
• Exterior finish is local stone	2
• Exterior siding has recycled-content (wood fiber)	2
• Roofing material has 40+ year warranty	2
• Luan and tropical hardwoods avoided	1
• Vinyl flooring is avoided	1
• Finish floor is durable (for a minimum of 1/3 total flooring)	2
• Finish floor is structural floor	2
• Cut trees at site used for mulch at site	2
• Reusable building materials donated	2
Materials Subtotal	**20**
Energy	
R City of Austin Energy Code requirements	
R Design for minimum 600 sq. ft. of living space per ton cooling	
R Cooling system sized by Manual J	
R Duct installation to City of Austin Energy Code	
R 12 SEER minimum cooling efficiency	
R 2 ceiling fans	
R GBP homeowner HVAC info and maintenance instructions	
• Home design created by team: designer, builder and HVAC contractor	4
• Operable clerestory-type windows for chimney effect cooling	2
• Designed cross ventilation	2
• Buffered space on west wall (porch and covered patio)	2
• Total fill insulation (blown in cellulose)	2
• Roof radiant barrier	2
• Continuous ridge and soffit vents	2
• No skylights	1
• Double glaze windows	1
• Ceiling fans in all main rooms	2
• Light exterior walls	1

APPENDIX H

City of Austin Green Builder Program
Katz Builders (Barley and Pfeiffer Architects)

• Programmable thermostat	1
• Recessed lights IC sealed type	2
• More than 3 fluorescent lights	1
Energy Subtotal	**25**

Health and Safety

R No CFC or HCFC insulation or sheathing materials	
R Low VOC paints used (250 g/l or less)	
R Cooktop/stove and bath exhaust fans vented to outside	
R 1 inch minimum pleated HVAC air filter	
R No high toxicity pesticides used	
R GBP *Integrated Pest Management Info* given to homeowner	
• 50% or more finish floor is hard surface	2
• 4 inch pleated HVAC filter	2
• Vented, lockable chemical storage cabinet	2
• No unvented gas logs	1
• Sand barrier termite control	3
• Vinyl wallpaper avoided	1
• Formaldehyde-free insulation	2
• Pressure-treated lumber avoided	1
• Water-based cabinet and floor finishes	2
• Electric panel more than 10 ft. from bedrooms	1
• All foundation and exterior wall penetrations sealed	1
• No wood or cardboard left or buried on site	2
Health and Safety Subtotal	**20**

Water

R GBP *Lawn Care Info* presented to homeowner	
• Turf grass low water variety	2
• Landscaping plants selected from preferred plants list	1
• Gutters and down spouts installed with direction to landscaping	1
• Efficient irrigation system	2
Water Subtotal	**6**

Community

• Backyard composting in place for homeowner	1
• Front porch large enough for family use	1
Community Subtotal	**2**
Project Total	**73**
Size Multiplier (3500 sq. ft.) 73 X .80	**58**
GBP Rating	**2 - 3 Star**

APPENDIX H

Metropolitan Denver "Built Green" Program
Wonderland Homes
McKinley Park

Program Items	Approximate Installed Cost Premium
I. Energy Requirement - ERHC (Rating: 93 on a scale of 100)	
II. Land Use: Lot	
• Trees protected during construction	$ 0
• Job site waste minimized	$ 0
• Top soil saved for reuse	$ 0
• Home placement saves east and south for outdoor use	$ 0
III. Solid Waste: Inside	
• Built-in kitchen recycling center with two bins	$ 60
IV. Energy Use: Envelope	
• Blower door test for ACH < .35	$ 200
V. Energy Use: Mechanical Systems	
• Furnace centrally located for reduced runs	$ 0
• Thermostat switch for recirculating fan	$ 0
• Sealed combustion fireplace or wood stove	NA
• Set back programmable thermostat	$ 50
• Low toxic mastic duct sealing	$ 100
VI. Energy Use: Indoor Air Quality	
• Sealed combustion furnace	$ 600 - 900
• Sealed combustion water heater	$ 500
• Radon retrofit installed	$ 100
• Range hood vented to outside	$ 75
VII. Energy Use: Water heating	
• Gas water heater: > .60 energy factor	$ 0 (see IAQ)
• Hot water pipes have R6 insulation in unconditioned space	$ 50
VIII. Energy Use: Appliances	
• Dishwasher with energy saver cycle	$ 75
• Home owner list of energy-efficient appliances	$ 0
IX. Energy Use: Lighting	
• Light-colored walls, ceilings, soffits	$ 0
• Light-colored carpet	$ 0
• Recessed light fixture treatment	$ 0
X. Materials: Structural Frame	
• No solid sawn lumber > 2X8s	$ 0
• Engineered wood I-joists	$ 0 - 100
• OVE	$ 0

APPENDIX H

Metropolitan Denver "Built Green" Program
Wonderland Homes
McKinley Park

XI. Materials: Foundation	
• Western fly ash content > 15%	$ 0
XII. Materials: Sub-floor	
• OSB sub-floors	$ 0
XIII. Materials: Doors	
• No luan interior doors	$ 0
XV. Materials: Exterior Walls	
• OSB sheathing	$ 0
• Recycled-content siding	$ 0
XVI. Materials: Windows	
• Double-glazed with ½ inch air space	$1000 - 5600*
• Wood frame	$ 0 - 1000
XVII. Materials: Cabinetry & Trim	
• No tropical hardwoods	$ 0
• Finger-jointed trim	$ 0
XVIII. Materials: Roof	
• Fiberglass Class A roofing shingles	NA
XIX. Materials: Finishes & Adhesives	
• Paints < 250 g/l VOC content	$ 0 - 150
TOTAL # ITEMS	**36**
TOTAL REQUIRED	**35**
Total Estimated Cost Premium	**$2810 to 8960**
ERHC Estimated Annualized Energy Savings (28 year weighted life measure, loan rate 8%)	**$ 431**
Estimated Annualized Cost Premium `	**$ 252 to 803**

* Window packages can vary widely and the range of features and subsequent costs cannot necessarily be ascribed to qualification or participation in the green builder program.

APPENDIX H

Build a Better Kitsap Program
Woodside Custom Homes (Doug Woodside, Builder)
Baker View Lane

Program Items	Points	Cost Premium/ Savings
Build to "Green" Codes		
R Meet Washington State Energy Code		
R Meet State Ventilation/IAQ Code		
R Meet State Water Use Efficiency Code		
Treat Site Appropriately		
• Use good erosion control measures	1	$0
• Wash concrete trucks in garage sub-base	1	$0
• Reduce impervious surfaces	2	$0
Site Subtotal	**4**	**$0**
Reduce/Reuse/Recycle		
R Prepare & post job site recycling plan		
• Use central cutting area	1	$0
• Use & maintain quality tools	1	$0
• Weather protect stored materials	1	$0
• Use drywall stops or clips	1	-$100
• Use two-stud corners	1	(see AF)
• Use insulated headers	1	(see AF)
• Use ladder partitions on ext. walls	1	(see AF)
• Detailed cut list provided to framer	2	(see AF)
• Use complete Advanced Framing system	3	-$1400
• Use suppliers w/ reusable/recyclable pckg	2	$0
• Require subs to participate in 3Rs efforts	3	$0
• Use reusable tools & equipment	1	$0
• Reuse materials	1	$0
• Reuse dimensional lumber	1	$0
• Sell or give away wood scraps	1	$0
• Move leftover materials to next job or provide to home owner	1	$0
• Recycle wood, OCC, & metal	3	-$50
• Recycle drywall	2	$0
3R Subtotal	**27**	**-$1550**
Purchase Resource-efficient Products		
• Drywall w/ recycled-content	1	$0
• Resource-efficient carpet &/or padding	1	$0

• Resource-efficient siding	1	$0
• Concrete with fly ash	1	$0
• Materials w/ longer life cycle (roofing)	1	$200
• Finger-jointed wood products	1	$150
• Engineered structural products	1	$0
Resource-Efficient Products Subtotal	**7**	**$350**
Maximize Energy Efficiency		
• Improve energy efficiency of building components affecting code performance (1 - 10 points possible)	7	
92 % efficient gas furnace		$500
upgraded windows		$450
upgraded insulation		$175
• Optimize water heater beyond code	1	$200
• Install air-to-air heat exchanger	2	$1000
Energy Efficiency Subtotal	**10**	**$2325**
Promote Good Indoor Air Quality and Health		
• Use improved air filters	1	$80
• Supply workers w/ VOC-safe masks	1	$0
• Use low VOC paints, sealers, adhesives	3	$100
• Balance ventilation with installed air exchanger	3	(see heat exchanger)
IAQ Subtotal	**8**	**$180**
Manage Hazardous Waste Properly		
• Use less or non-toxic cleaners	1	$0
• Use water-based paints	1	$0
• Reduce hazardous waste thru good housekeeping	1	$0
• Recycle used antifreeze, oil, oil filters, and paints at appropriate outlets	2	$0
Promote Responsible Homeowner		
R Provide homeowner w/ "starter" kit		
• Install environmentally-friendly water filter at sink	1	$150
• Use drought-resistant landscaping	1	$0
• Build recycling area into residence	2	$0
• Build lockable hazardous household products storage closet	2	$0
Responsible Home Owner Subtotal	**6**	**$150**
Baker View Total: 3 Star Home	**67**	**$1455**

APPENDIX I

I. GENERAL PRESERVATION SPECIFICATIONS FOR NEW CONSTRUCTION SITES

Isabelle Greene & Associates, Santa Barbara
License #2120

Attention is called to the fact that construction equipment and processes can compact soil, damage roots, break branches and scar tree trunks, as well as cause the more obvious death of or destruction to valuable elements existing on the site. Alteration of grades by a few inches or water-logged condition of roots for short periods can kill trees and shrubs. Other non-living landscape elements can be similarly damaged or destroyed in the course of site construction.

1. Initial site walk-through will be performed with Landscape Architect prior to construction to determine landscape elements and plant material to be preserved. The contractor assumes responsibility for all existing elements deemed valuable in this walk-through. Any tree removed or irreparably damaged during construction must be replaced with tree of like species (except Oak trees, which must be replaced with three trees of like species), and equal size or value (minimum 24" box for all Oaks), the survival of which must be bonded with the County of _____ for a period of at least three years. Other landscape features shall be similarly guaranteed in value.

2. When the site is ready for construction, any trees, shrubs, and other elements deemed valuable by Landscape Architect, shall be protected during construction process. A temporary fence of chainlink or other approved fabric shall be erected around each area to be protected, or between the area and any proposed construction as shown on plans. The height of the fence shall be no less than six feet. Sturdy fence support posts shall be installed at a maximum spacing of eight feet. Fencing shall be inspected and approved by Landscape Architect or qualified Arborist, prior to start of construction.

   (a) Where construction is to occur outside a tree's dripline (an imaginary perpendicular line that extends downward from the outer-most tip of the branches to the ground), the fence shall be erected at the dripline.

   (b) Where construction is to occur <u>within</u> the dripline of a tree or shrub, prior approval must be secured from the Landscape Architect or a qualified Arborist, and the fence shall be erected no further than five feet from the edge of the work and shall protect at minimum two-thirds (2/3) of the tree or shrub's dripline.

3. Where walls, footings or curbs are to be built within six feet of the trunk of any tree, a root control barrier ('Deep Root' or equal) shall be placed between the tree and the wall or curb. Barrier shall extend from ground surface to bottom of new structure. Any curb or wall adjacent to a tree shall be built with footings directed outward from the tree to avoid damaging roots. Where necessary, footings shall be bridged over the root zone or individual roots.

4. All roots encountered during trenching operations shall be cleanly cut. Roots over two inches in diameter shall be sealed with approved tree seal. Roots over four inches in diameter require approval of Landscape Architect or a qualified Arborist before cutting. Trenches for all curbs and walls adjacent to trees shall be backfilled with porous topsoil from the site.

5. All work within the driplines of trees and shrubs shall be performed with hand tools only, and approved or directed by the Landscape Architect or a qualified Arborist.

6. Fencing constructed uphill of trees shall include 'Silt Stop' fabric, securely attached to the fence fabric. 'Silt Stop' shall be installed with the bottom six inches below grade.

7. At locations where fence does not surround trees or shrubs, the fence must extend at least ten feet beyond the dripline, and a sign shall be securely attached at each end of the fence, stating "No Construction or storage of any kind beyond fence," in both English and Spanish ("No se permite construcion o' almacenace de qualquiera tipo mas de este surco.") Signs shall each be at least two square feet in area.

8. Photographic documentation of protective fencing of the trees shall be provided to the Resource Management Department, County of _____, prior to start of construction.

9. No underground water, power, utility lines or leach fields shall be installed within dripline of any tree, unless approved by Landscape Architect or a qualified Arborist.

10. Any damage to existing water pressure lines, garden valves, and irrigation systems shall immediately be repaired and Landscape Architect and maintenance contractor notified. 24 hours advance notice should be given to Landscape Architect and maintenance contractor before any disruption in water service of more than one day's duration.

11. Any alteration of grades shall result in positive drainage away from affected trees, shrubs, or other plantings. Do not allow root crowns to stand in water. Any grade change of greater than four inches within the dripline of any tree must be approved by Landscape Architect or a qualified Arborist.

12. No chemicals or herbicides of any kind may be applied, dumped or dispersed within 50 feet of any tree, shrub, or other planting without approval of the Landscape Architect or Arborist (this includes common construction materials such as lime, plaster, cement washings, paints and solvents). No storage of equipment inside barricade; No burial of debris within 100 yards of barricade; No fires within 100 yards of barricade.

13. Dust and dirt shall be washed off all trees , shrubs and other plantings within fifty feet of the construction area at four-week intervals, May through October, and at the end of the construction period. Washing shall occur in the morning to allow the plants to dry during the day.

14. Pruning of trees or shrubs shall be performed only under the direction of the Landscape Architect or Arborist.

15. Landscaping adjacent to any tree shall be limited to inert materials or to plants with similar cultural requirements to the tree.

16. Protective fencing may not be removed until the Certificate of Occupancy is obtained from the County of _____.

17. Any damage resulting from construction, and not replaced or repaired to the satisfaction of Landscape Architect, will be deducted from contractor's payment contract.

II. PRESERVATION SPECIFICATIONS FOR OAK TREES

1. In addition to meeting all of the requirements outlined in Section I. GENERAL PRESERVATION SPECIFICATIONS FOR NEW CONSTRUCTION SITES, the following requirements must be satisfied with regard to Oak trees.

2. No underground irrigation or utility lines shall be installed within fifteen feet of the trunk of any Oak tree, except drip irrigation tubing laid on the surface of the ground. In no case shall any irrigation occur within six feet of the trunk of the tree.

3. In no case shall irrigation wet trunk or soil within four feet of the trunk of any Oak tree.

4. For any Oak tree that is removed or irreparably damaged during construction, see Section I. GENERAL PRESERVATION SPECIFICATIONS FOR NEW CONSTRUCTION SITES, item 1.

APPENDIX I

TREE PROTECTION DURING CONSTRUCTION

SITE EVALUATION

- Evaluate health of trees (are there old or sick trees?)
- Evaluate site conditions (are there soil or other problems?)
- Smaller trees may tolerate disturbance better than old ones
- Younger trees have a longer useful life
- When a stand of trees is opened, remaining trees may suffer or die due to desiccation of bark and sun scald

DESIGN

- Site buildings and roads away from root zone of trees
- Consider suspended structures
- Use piles or spot footings rather than continuous footings
- Consider turf block or gravel instead of paving for driveways & parking
- Retain original contours as much as possible
- Locate utilities in a single trench

CONSTRUCTION

- Locate materials storage and worker parking away from root zones
- Don't stockpile soil over tree roots
- Avoid unnecessary soil moving or grading
- Keep ALL equipment away from root zone
- Where appropriate, keep trees watered during construction
- Fence off root zones with orange plastic mesh
- Use a 4"-6" layer of wood chips to protect roots (avoid diseased chips)
- Permit no traffic of any kind in root zone
- Don't store toxic materials near trees
- Don't nail signs, utility boxes or fencing to trees
- Tunnel or hand dig trenches where possible
- Pump concrete to keep trucks off site

IF DAMAGE OCCURS

- If roots are severed, cutoff square, bury and water immediately
- If bark is damaged, replace still-moist bark, cut off loose bark
- Prune broken branches back to lateral branch
- Aerate soil in compacted areas
- Avoid fertilizing stressed trees; evaluate in a year
- Plant young trees in case existing ones die

SIGNS OF DECLINE IN MATURE TREES

- Epicormic growth (first year after damage)
- Undersized leaves, tip & branch dieback (second year)
- Early fall color on deciduous trees, yellow leaves (third year)
- Complete collapse (third or fourth year)

LANDSCAPING UNDER TREES

- Avoid planting lawns and high water use plants under native trees, esp. oaks
- Don't over fertilize in root zone of native trees
- Keep water from sprinkles away from trunks
- Use permeable paving materials (gravel, decomposed granite, etc.)
- No trenching in root zone
- Don't attach structures to trees
- Give the tree room to grow

RULES TO LIVE BY

- PLAN AHEAD
- DEVELOP A LINE OF COMMUNICATION
  (Owner/Builder/Architect/Arborist)
- HIRE A CERTIFIED ARBORIST TO OVERSEE FROM START TO FINISH
- STAY ON THE JOBS AT ALL TIMES
- EDUCATE WORKERS, DRIVERS AND OTHERS AND KEEP ON TOP OF THEM
- DON'T BE IN A HURRY
- THE EXTRA COST OF PROTECTING TREES WILL USUALLY BE MORE THAN PAID FOR BY INCREASED PROPERTY VALUE

APPENDIX J - ADVANCED WALL FRAMING

Some of the techniques described below may not be allowed under some circumstances (i.e., high winds or seismic potential) or in some localities. Be certain to consult local building officials early in the design phase to verify or obtain acceptance of these techniques.

WHY USE EFFICIENT FRAMING?

- Reduce Material Cost - *buy fewer studs and top plates, use smaller headers*
- Reduce Labor And Construction Time - *carry and install fewer studs, make fewer cuts*
- Save Energy - *replace wood with better insulating materials*
- Save Natural Resources - *less wood used = fewer trees cut, shipped ,and processed*
- Reduce Waste - *less scrap from fewer cut studs, full use of modular sheathing and drywall*
- Increase Comfort - *reduce or eliminate cold surfaces*
- Reduce Drywall Cracking - *fewer drywall-to-framing attachments = fewer cracks*

SAVINGS POTENTIAL

- Energy: 2-3% per year (of heating and cooling costs)
- Materials: $500 to $1,000 (for 1,200 sf and 2,400 sf houses, respectively) are achievable if fully implemented
- Labor: 3-5% cost savings

BASIC TECHNIQUES

- Two-Foot Module
- Single Top Plates
- Reduced Use of Cripples, Jacks, Drywall Backers
- 24-Inch On-Center (oc) Framing
- Properly Sized (and insulated) Headers
- Insulating Sheathing

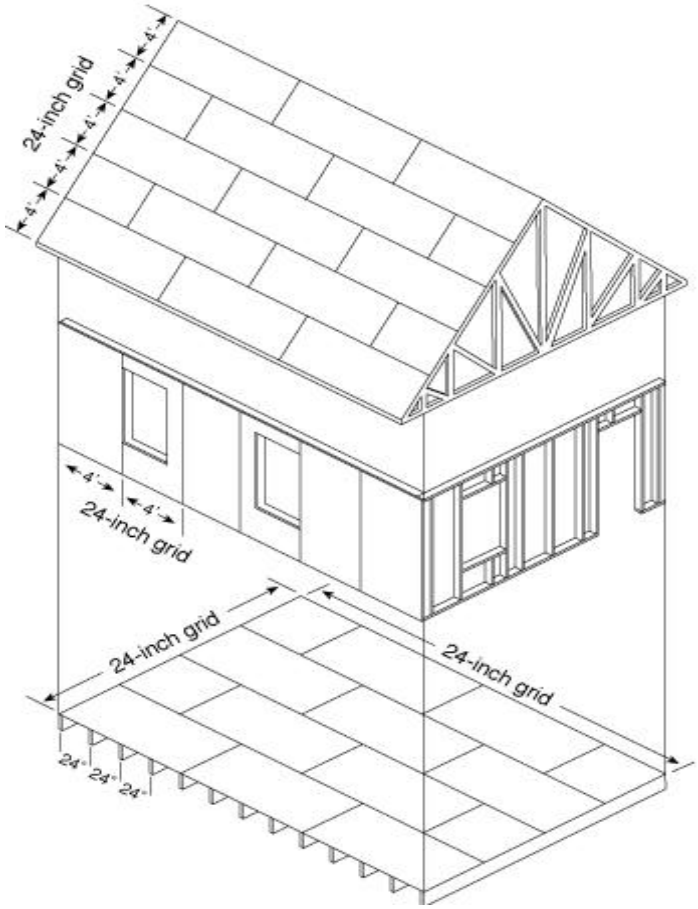

Figure 1 – Two-Foot Module

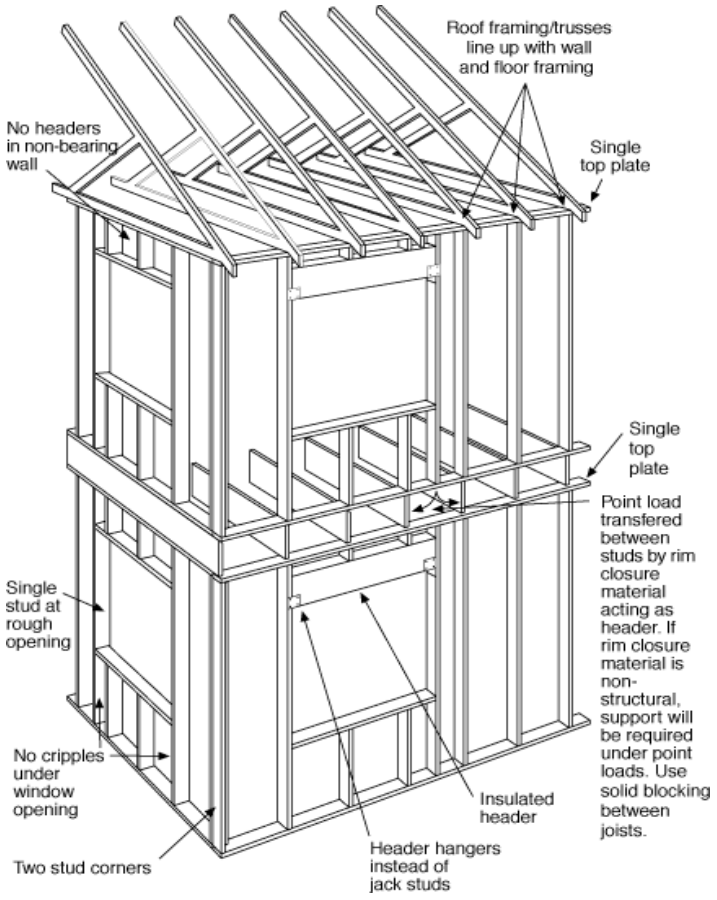

Figure 2 – In-Line Framing

PLANNING

Two-Foot Module **-** Building on a two-foot module (Figure 1) reduces material use, labor, and waste since many products come in multiples of two feet. For example, with proper planning, the cutoff from a sheet of plywood cut in half can be used in full somewhere else, saving an additional cut and eliminating waste.

In-Line Framing - This refers to aligning floor, wall, and roof framing members directly above or below each other, allowing direct downward transfer of loads from one to the next (Figure 2). In-line framing allows elimination of double top plates and is often thought of in the context of 24-inch on-center studs placed directly below roof trusses, which are most commonly placed at 24 inches on-center.

Window and Door Layout **-** Windows with rough openings of 22-1/2" are available. These windows can fit between studs that are on a standard 24" oc layout. Headers can then be eliminated with this method when using in-line framing. For windows or doors wider than the stud spacing, only one extra stud is required if one side of the window or door is placed against a stud which is on the standard layout and metal header hangers are used (Figure 2).

Other items - Careful planning of roof length and width (i.e., altering pitch and/or overhang width) can also reduce labor, material use, and waste (consider spacing required for ridge vent - Figure 1). Detailed plans that indicate the presence of each piece of wood, cross bracing, etc. in the house and locations for all other items such as wiring, ducts, and pipes can eliminate conflicts over space, speed installation, and eliminate the need to alter or move studs, joists, etc. later.

FRAMING

Stud Spacing **-** In many cases, increasing stud spacing from 16 inches oc to 24 inches oc is structurally acceptable and accepted by codes. The CABO *One- and Two-Family Dwelling Code* allows the following for studs up to 10 feet long:

1995 CABO One- and Two-Family Dwelling Code	
Walls supporting roof and ceiling only:	2x4 @ 24" oc (except utility grade studs)
Walls supporting one floor only (i.e., 1st fl. of a 2 story house w/non-bearing gables):	2x4 @ 24" oc (except utility grade studs)
Walls supporting story above:	2x6, 3x4, or 2x5 @ 24" oc; 2x4 @ 16" oc

Lumber plus labor costs for 2x6 @ 24" oc are similar to those for 2x4 @ 16" oc. 2x6 @ 24" oc walls allow more cavity insulation but will require extension jambs (unless drywall returns are used). Also consider 2x4 @ 24" oc walls with foam sheathing when allowed.

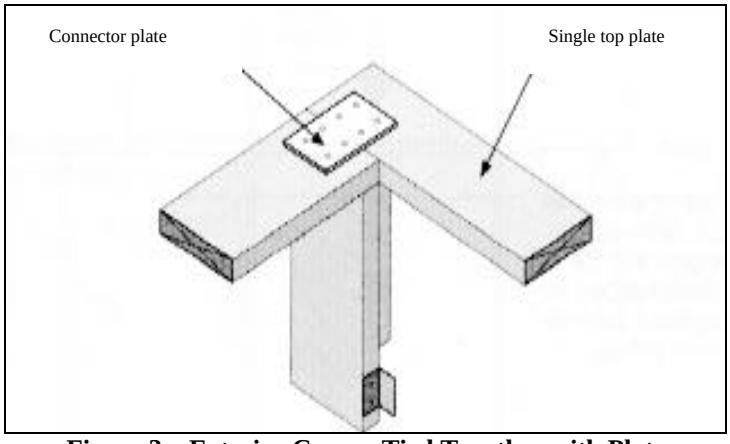

Figure 3 – Exterior Corner Tied Together with Plate

Single Top Plates **-** If used in conjunction with in-line framing, single top plates are usually acceptable from a structural standpoint, and accepted by model building codes such as CABO and BOCA. These codes require that 3"x 6", 0.036-inch-thick (20 Ga.) galvanized steel plates be nailed across wood plate joints with three 8d nails at each side (Figure 3).

Single top plates affect sheathing and drywall needs and installation due to changed wall height. In some areas, 94-1/4" studs (often used for interior walls) are available that allow installation of sheathing and drywall without cutting. Use of 96" studs necessitates cutting to length or adding a strip of drywall at the bottom of the wall. Pre-cut 92-5/8" studs will require "ripping" approximately 1" off the sheathing and drywall. If 94-1/4" studs are not available, using 92-5/8" studs requires the least labor and creates the least waste.

Jacks (shoulder studs/cripples) **-** Jacks can be eliminated when structural headers are eliminated or when metal hangers, such as shown in Figure 7, are used to support structural headers. Elimination of jacks reduces the available nailing area for siding and trim if nailable sheathing (plywood or OSB) is not used - there may be as little as 1-1/2 inches of nailable width next to a window. If needed, a wood backer may be installed behind the sheathing.

Outside and Inside Corners **-** Corners can be framed to decrease lumber use and enable more complete insulation, compared to typical practice (Figures 4 & 5). Attachment of exterior trim and siding at corners should be considered if nailable sheathing is not used. For example, vinyl-siding corners require nailing at a point several inches from the corner. If foam or other non-nailbase sheathing is used, it may be necessary to add a wood nailer behind the sheathing.

When drywall clips are used, they should be installed above the level of the interior trim so trim nails will not hit them. The non-coped trim piece should be installed first, against the drywall that bears on the clip, so that the final coped trim piece can be nailed to the stud.

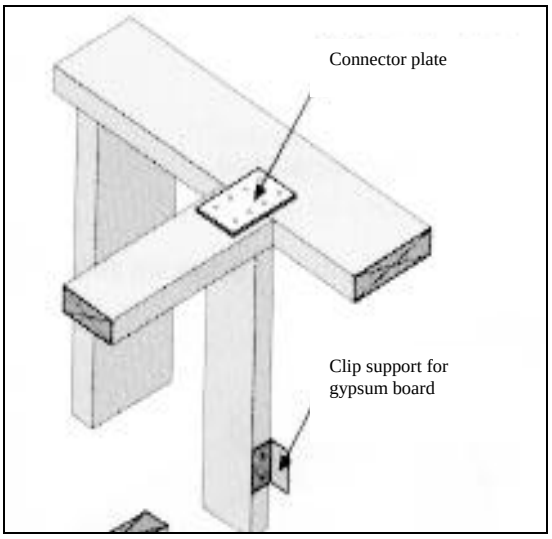

Figure 4 – Corner With Drywall Clips

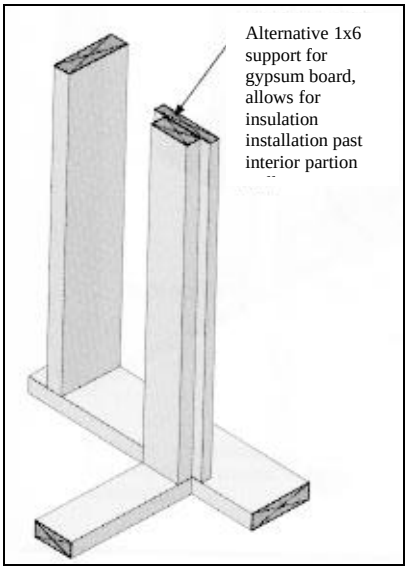

Figure 5 – Corner W 1X or 3X Backer

Partition Connections to Exterior Walls (T's) **-** These are often made by adding studs at each side of the partition, which serve only to attach drywall. In addition to wasting wood, this creates an area that is very hard to insulate. Alternatives include installing "ladder blocks" (Figure 6), drywall clips, or a full length 2x6 or 1x6 behind the first partition stud.

Intermediate Blocking **-** Installing horizontal blocks between studs is generally not required for structural strength or fire/draft stopping in platform framing, at least with standard eight foot high walls.

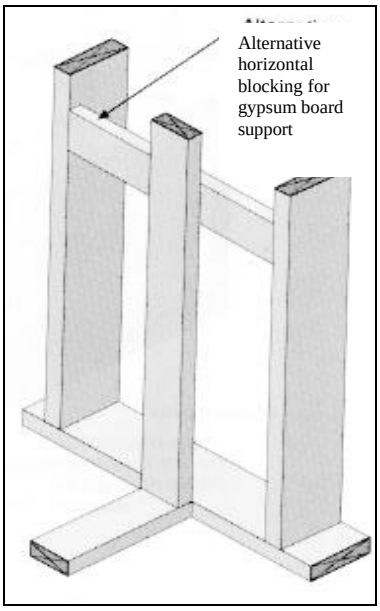

Figure 6 – T-Intersection

Headers **-** Structural headers are often oversized or installed where not needed, largely for convenience. Properly sizing headers allows better insulation and saves wood. In some cases, single-ply (single 2x6, for example) headers can be used, allowing even better insulation. Headers are not required in non-bearing walls, including most interior walls and gable-end walls with only non-bearing trusses directly above. The following table and accompanying language outlines some header requirements in the 1995 CABO code:

Derived from Table 602.6 of the *1995 CABO One- and Two-Family Dwelling Code*
Maximum Spans For 2-Inch Double Headers (Feet) [a]

Header Size	Supporting Roof Only	Supporting One Story Above	Supporting Two Stories Above	Not Supporting Walls Or Roofs
2x4	4	0	0	[b]
2x6	6	4	0	[b]
2x8	8	6	0	10
2x10	10	8	6	12
2x12	12	10	8	16

[a] Also applies to nominal 4-Inch single headers. Based on No. 2 lumber with 10-foot tributary loads. Not to be used where headers support concentrated loads.

[b] Load-bearing headers are not required in interior or exterior nonbearing walls. Single flat 2-inch-by-4-inch members may be used as headers in interior or exterior nonbearing walls for openings up to 8 feet in width if the vertical distance to the parallel nailing surface above is not more than 24 inches. For such nonbearing headers, no cripples or blocking are required above the header.

Insulated headers are possible by using foam sheathing as a spacer in place of plywood or OSB, either between or on one side (preferably exterior) of doubled headers. This is an excellent way to re-use scrap foam sheathing, reducing waste. For assistance in designing headers, consult local structural engineers, code officials, lumber suppliers, or others such as the Western Wood Products Association (WWPA).

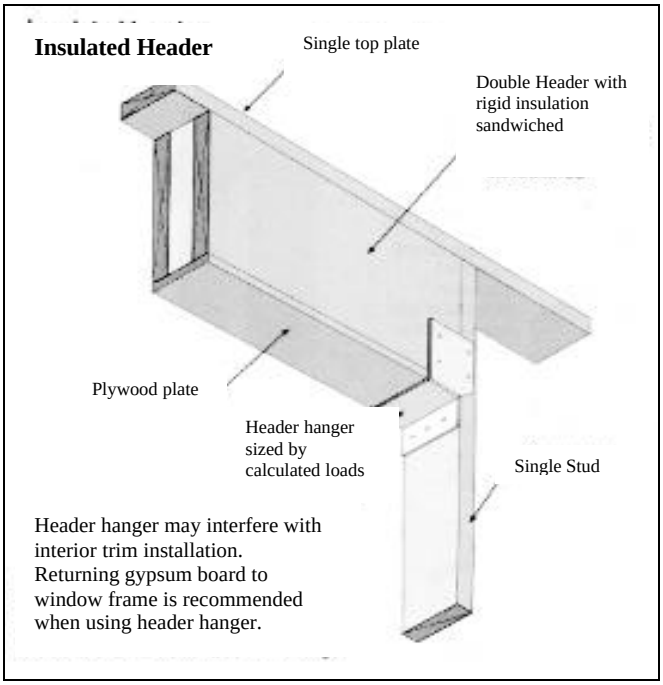

Figure 7 – Insulated Header with Header Hanger

SHEATHING

OSB or plywood sheathing is typically used to provide racking resistance to walls (lateral resistance to wind or seismic loads). Often, some other type of sheathing is used to cover the remainder of the framing. One way to increase the insulating value of a wall is to replace non-insulating sheathing with insulating (foam) sheathing, while still providing racking resistance by one of the following methods:

- Use structural sheathing at corners and intermediate points as required (typically every 25 feet), with foam sheathing at all other locations.
- Use thin, structural paperboard sheathing at corners, covered completely with foam sheathing.
- Use full foam sheathing with cross bracing (flat metal straps, let-in T-shaped metal straps, or let-in wood 1x's).

Note that the choice of sheathing impacts the ability to nail siding and affects the air leakage and moisture performance of the wall assembly.

MORE INFORMATION

NAHB Research Center: sells *Cost-Effective Home Building* and *EEBA Builder's Guides* (series of practical books for various climates). Contact their HOMEBASE SREVICES Hotline: 800-898-2842; http://www.nahbrc.org; homebase@nahbrc.org
Energy Efficient Building Association: P.O. Box 22307, Eagan, MN 55122. 651-994-1536; http://www.eeba.org
Southern Pine Council: P.O. Box 641700, Kenner, Louisiana 70064. 504-443-4464; http://www.southernpine.com
Southface Energy Institute: 241 Pine Street, Atlanta, Georgia 30308. 404-872-3549; http://www.southface.org
Western Wood Products Association: 522 SW Fifth Ave., Suite 500, Portland, Oregon 97204. 503-224-3930; http://www.wwpa.org