



# Remodel Handbook



A handbook for



A green building program  
for remodelers

Developed by builders for  
builders

December 2000

Revised August 2009

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## Mission Statement

To work in partnership to improve and protect the valuable natural features and environmental resources within King and Snohomish Counties' cities and communities to promote safer, healthier buildings, through:

- Using a non-regulatory, market-driven approach to optimize the use of innovative, industry-based solutions to potential environmental problems and minimize impacts of construction, design, and development.
- Actively promoting the use of environmentally sound design, construction, and development practices by design and building professionals in King and Snohomish Counties, in particular by members of the Master Builders Association, in an attempt to make these practices the preferred consumer standard.
- Creating a credible program that reflects the Master Builders Association's commitment to building better communities through environmental responsibility.
- Creating a program that attracts broad-based participation of existing and potential Master Builder Association members.
- Creating a model for approaching environmental concerns that the Counties may face.

## Disclaimer



The Master Builders Association of King and Snohomish Counties (MBA) has provided this Handbook as part of the BUILT GREEN® program. Foremost, it is a tool for licensed builders and contractors to use as an aid to certifying projects. It is also intended as an educational document for homeowners considering or embarking on a home remodel.

The Handbook is not intended to eliminate or substitute for the builder's own judgment or accepted engineering and construction practices. Each building may have characteristics that could make any one or more of the Action Items suggested in the Handbook inappropriate. It is the responsibility of the builder to choose the Action Items that are appropriate in each case. Furthermore, product information provided in the Handbook is not intended to act as or imply a recommendation for using a particular product in a specific application. Where appropriate, products should be tested before installation. All products should be used according to the manufacturer's recommendations.

In addition, local, state, and federal regulations must be followed and are not to be superseded by any recommendations made in this Handbook. Every effort was made to ensure consistency with the standards of King and Snohomish Counties and its incorporated municipalities at the time of this writing. Several regulatory reviewers were provided drafts of all or part of the Handbook.

Health and safety-related measures described in the Handbook are not intended to offer medical advice or to substitute for professional medical consultation.

The BUILT GREEN program is a self-certification and third party certification program. The MBA does not warrant whether or not a builder or developer has taken a specific action. The builder or developer or the independent Built Green Verifier warrants the builder's or developer's actions by signing the appropriate Checklist and providing the executed checklist to the customer or customer's representative. A Checklist has been provided for this purpose at the front of the Handbook.

## Acknowledgments



This Handbook was originally developed for the BUILT GREEN® Program of the Master Builders Association (MBA) in partnership with King County and Snohomish County in 2000. It represents nearly a decade's worth of effort by several committees composed of MBA members and representatives from King County, Snohomish County, and various environmental and community organizations. We wish to thank the members of the BUILT GREEN® Remodel Checklist Revision Committee for their time and hard work:

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# Introduction

BUILT GREEN® is an environmentally-friendly, non-profit, residential building program of the Master Builders Association of King and Snohomish Counties, developed in partnership with King County, Snohomish County, with input from the building community, environmental groups and other agencies in Washington State. BUILT GREEN provides consumers with easy-to-understand rating systems, which quantify environmentally friendly building practices for remodeling and new home construction, communities and multifamily development units.

This Handbook is a tool for remodeling professionals enrolled in the BUILT GREEN program of the Master Builders Association of King and Snohomish Counties (MBA). It is also meant as a resource for homeowners considering a green remodel. At the core BUILT GREEN is a Checklist used to certify projects. The Remodel Checklist contains over 340 Action Items and functions as a menu of environmentally friendly elements to include in a remodel project. In addition, the Handbook contains specific, detailed information about each Checklist Action Item, including suggested external resources to provide additional detail. Further information about the BUILT GREEN Remodel program and its Action Items is provided through technical seminars and the BUILT GREEN Resource Library housed at the MBA Education Foundation office. See [www.builtgreen.net](http://www.builtgreen.net) for more information.

BUILT GREEN is a market-based program; consumer education and outreach is critical to using it successfully. Please contact the MBA Education Foundation office for marketing tools to promote BUILT GREEN Remodel projects. In addition, the MBA provides support through marketing seminars and a public marketing campaign.

## Why BUILT GREEN?

A BUILT GREEN Remodel provides benefits to both people and the planet. Both the homeowner and the remodeling professional gain from using the strategies listed in the BUILT GREEN Remodel Checklist.

## Homeowner Benefits

Built Green remodeling strategies result in a healthier, more efficient and environmentally responsible home. Direct financial benefits, such as reduced utility bills, easier maintenance and more durable design are coupled with indirect benefits, such as increased comfort and health. BUILT GREEN homes also result in a smaller environmental footprint, with Action Items related to:

- Energy efficiency that reduce a home's carbon impact.
- Water conservation to leave more water in lakes and streams for people and fish.
- Materials selection choices that reduce resource use and protect forests.
- Site protection strategies that help a property maintain a healthy relationship with downstream ecosystems.
- Design, construction and materials selection strategies that protect both indoor and outdoor air quality.

Additionally, the value of BUILT GREEN homes is showing itself in the marketplace, in terms of increased sales price per square foot and reduced time on market. Two recent studies of Built Green projects based on both NW Multiple Listing Service data and Assessors data of BUILT GREEN homes revealed an increase in per square foot home value, coupled with a reduced time on market for certified homes compared to their non-certified counterparts.

## Remodeler Benefits

Remodeling professionals with the skills to pursue Built Green certification possess a competitive advantage in the marketplace. Market analyses show a continued increase in demand for and interest in environmentally friendly products and services by the American public, and this is especially true in the Pacific Northwest. The BUILT GREEN Remodel Handbook gives remodeling professionals a quick reference tool for green building strategies, and provides additional resources for further learning. Experience on BUILT GREEN Remodel projects serves as a knowledge base and expanded skill set, offering remodeling professionals access to this quickly growing niche market. The green consumer is well educated and skeptical, and will likely ask many questions of prospective builders. Showing knowledge and expertise in green building design and construction may help tip the scales in favor of one firm over another for a project.

Additionally, when correctly applied, many BUILT GREEN Action Items can help reduce the likelihood of callbacks and construction defects. The BUILT GREEN program takes a “building science” approach to green building, paying special attention to the interaction of moisture, heat, and ventilation in a home.

## Handbook organization

Section I of the handbook gives an overview of the BUILT GREEN® Remodel certification process and overarching information on conducting a green remodel, along with general resources for independent learning.

Section 2 is a comprehensive list of BUILT GREEN Remodel Checklist Action Items, arranged to provide quick access to information on specific Action Items within the Remodel Checklist. Action Items are organized to reflect the remodeling process, from pre-design to occupancy, helping the user identify where in the process to focus on specific activities, and to identify critical path issues. The fifteen sections (project phases) identified in this Handbook are:

1. Design
2. Operations
3. Site/Foundation
4. Framing
5. Windows
6. Roofing
7. HVAC
8. Plumbing
9. Electrical
10. Insulation
11. Drywall
12. Exterior
13. Finishes + Indoor Air Quality
14. Landscaping
15. End of project

It is important to note, however, that considering all elements of a project together at the beginning of design is key to capturing opportunities and identifying challenges (see BUILT GREEN Remodel and Integrated Design, below). Use the Handbook organization to prioritize and map the project flow.

## The BUILT GREEN environmental categories

In order to help a builder communicate to a client the conceptual categories related to green building (most of which span the project phase categories above), this Handbook also contains information broken into the classic BUILT GREEN categories, which are reflective of the categories often used to organize thinking around green building. They are Site and Water; Energy Efficiency; Health and Indoor Air Quality; and Materials Efficiency.

### Site and Water

The Site and Water category contains Action Items that protect or enhance a home’s landscape, including water quality, soil and plant health, hydrological function (drainage), and water conservation. BUILT GREEN offers a variety of common-sense site protection, water protection, and development techniques to create a “fish-friendly” home. The Puget Sound region is renowned for its natural beauty, especially its forests, rivers, lakes and the Puget Sound fjord itself. Since the 1970s, however, the region has lost a large percentage of its forest cover, primarily due to development activities. In addition, signature wildlife species such as Chinook Salmon and the Puget Sound Orca are facing alarming population declines. Site development activities, such as clearing and grading, as well as less obvious actions including roof material selection and soil amendment, have direct impact on the health of local water resources.

BUILT GREEN Action Items specifically address these issues, and result in homeowner benefits including healthier soils and plants, and reduced or eliminated need for the use of fertilizers and pesticides (thereby reducing ongoing maintenance costs). Additionally, residential water use (both indoors and outside) diminishes the amount of water left in streams for recreation and wildlife. While the popular conception of our region is one of soggy, the Puget Sound region is drier than Tucson, Arizona during the late summer months. Water-wise landscaping and efficient fixtures and appliances within the home help reduce demand on regional water resources. Water efficiency also provides direct homeowner benefits, in the form of reduced water and wastewater utility bills. The Action Items related to Site and Water help manage the natural resources on a project, both during construction and to help protect natural features, prevent erosion, sedimentation and water pollution due to storm water runoff, conserve water, and protect water quality. Also included in this category are sustainable design alternatives that make better use

of the land, promote safety, and optimize use of the building and site as well as the neighborhood.

### Energy Efficiency

This category promotes energy efficiency and improved comfort with Action Items intended to push your project beyond Energy Code minimums.

According to the US Department of Energy’s Energy Information Agency, buildings are responsible for 40% of the country’s energy use, as well as 40% of our greenhouse gas emissions. Climate change related to atmospheric carbon loading is expected to result in a wide array of negative effects, including sea level rise, ocean acidification, the expansion of invasive species and disease, and other effects. In the Pacific West, the expanding range of the Pine Bark Beetle, for example, is causing massive losses of pine forest. Beyond the general impacts of global climate change, residential energy use is a direct, ongoing cost to the homeowner. The US EPA’s ENERGY STAR program estimates that existing home heating systems lose 30% of their heat via the ductwork and distribution system. In order to ensure a Built Green Remodel excels in energy performance (setting it apart from its competition in the marketplace), it is required that each remodel aiming for 3 Star Certification or above undergo an energy retrofit equivalent to current energy code. (Exterior walls are exempted from the requirement, but must achieve an equivalency of R-13 for energy performance. In addition to environmental benefits, energy efficiency can significantly improve comfort levels in the home—a proven selling point. The Washington State Energy Code (WSEC) is a minimum; a base. These Action Items represent achievable goals that go beyond code.

Energy Efficiency Action Items accomplish one or more of the following objectives:

- Reduce overall heating/cooling load.
- Use energy more effectively.
- Take advantage of natural resources and site features, such as window placement to increase solar gain, or landscaping to provide wind shielding.

### Health and Indoor Air Quality

Action Items in this category include selected practices to improve indoor air quality and reduce health risks from toxins, irritants and allergens for occupants and installers. According to the US EPA, Americans

spend 90% of their time indoors, and three out of five buildings suffer from unhealthy levels of air pollutants. Indoor environmental quality is connected to acute health issues such as toxic exposures, as well as long-term effects including asthma and increased risk of cancer and other illnesses. Built Green Health and Indoor Air Quality Action Items include credits related to reducing and eliminating indoor toxics, proper ventilation, and moisture management—all of which help protect occupant health.

Note that the practices described in the Health and Indoor Air Quality Action Items are not intended to represent the comprehensive approach required for an occupant with unusual chemical sensitivities or allergies. For such a client, it will be important to test individual products and practices on a case-by-case basis and develop a specialized remodel plan based on the particular needs of the client.

### Materials Efficiency

Numerous options help reduce job-site waste, saving money for both the homeowner and the contractor. In addition to using materials efficiently, this section offers recognition for using a variety of “green” building materials that reduce resource extraction and waste creation. For example, in the City of Seattle alone, approximately 300,000 tons of construction and demolition waste was delivered to private and city transfer stations in 2007, much of which could be either reused or recycled if properly managed. Globally, natural resource extraction is responsible for massive energy expenditures, deforestation, habitat loss, damage to land and water supplies, and air pollution.

Materials efficiency measures can help benefit the homeowner’s bottom line by reducing the cost of waste disposal during construction, using materials more wisely, and keeping materials out of the landfill.

In a biannual survey of owner occupants, nearly 50% had undertaken a remodeling project in the last two years with an average of 1.5 projects per household during these two years. Remodeling activities include various maintenance and repair (e.g., re-roofing or re-siding) and improvement (e.g., additions, kitchen remodel, etc.) projects.

Remodeling typically generates more waste per square foot than new construction due to the added demolition common in remodeling projects. Remodeling waste can comprise of all types of construction and demolition debris including

household fixtures and finished building materials (e.g., sinks or countertops), leftover building supplies (e.g., lumber), or demolition waste (e.g., painted drywall). The Materials Efficiency Action Items increase the efficiency of jobsite operations through use of the “Three R’s:” Reduce, Reuse, Recycle, as well as make design and material selection more resource efficient.

### Assembling the pieces

Action Item process categories are cross-referenced with the relevant BUILT GREEN category/categories using an icon system. The icons take the shape of puzzle pieces, to represent the interrelated nature of green building. (See the section below on BUILT GREEN and integrated design for more on the concept of a holistic green building approach.) If an Action Item applies to more than one conceptual category, more than one puzzle piece will be shown. For example, a low-flow showerhead saves water, but it also saves energy by reducing demand for water heating; this Action Item would show both Site and Water and Energy Efficiency icons. For more on the interconnected nature of green building strategies, see the section below, BUILT GREEN and Integrated Design.



### The BUILT GREEN Action Items

To make increasing the environmental and health performance of a home easier for both the remodeling professional and the homeowner, BUILT GREEN breaks strategies into bite-sized pieces called Action Items, the titles of which are listed on the BUILT GREEN Checklist. Each Action Item is broken into components for ease of reference.

The *Action Item Number* is a unique identifier to help organize the credits within the BUILT GREEN Remodel program. The number is hyphenated (e.g., 12-4), with the prefix number representing the section to which the credit belongs; i.e., in the above example, the Action Item will be found in Section 12, Exterior.

*Points* provides the specific number of points available, or the point spread, available when an Action Item is implemented on a project. The number of points available for an Action Item represents a combination of the relative environmental and health impact of the measure, and/or the difficulty in attaining the credit—Action Items with a larger environmental/health benefit, and those that are more difficult to implement, are worth more points. The rationale for this is to provide both incentive for maximizing the performance of the home, and to encourage remodeling professionals and homeowners to try newer and more challenging green building measures.

*Responsible Party* identifies the key decision makers and executors of the Action Item. There may be one or multiple responsible parties. Note that these are the primary parties responsible for success of implementation for the Action Item; other players often perform important supporting roles and should be included in planning as well.

*Intent* provides the broad objective of the Action Item, describing the goal of implementation. This helps the homeowner and the remodeling professional better understand why an Action Item is included in the Checklist, and helps ensure the objective is met.

*Homeowner Benefit* is a statement to help better translate the Action Item feature into the benefits that accrue to occupants. For example, the feature of an ENERGY STAR clothes washer provides the homeowner with the benefit of lowered utility bills due to water and energy savings. This section is useful both for homeowners using the Remodel Handbook as a research and reference tool, and to the remodeling professional to help communicate green building benefits to the client.

*What* describes in more detail the Action Item, including definitions and descriptions of referenced processes, products, or technologies.

*Why* gives the rationale for the Action Item, beyond the specific benefits described in the Homeowner Benefit section.

*How* provides information on executing the Action Item, including where materials or products may be sourced, and tips for the remodeling professional.

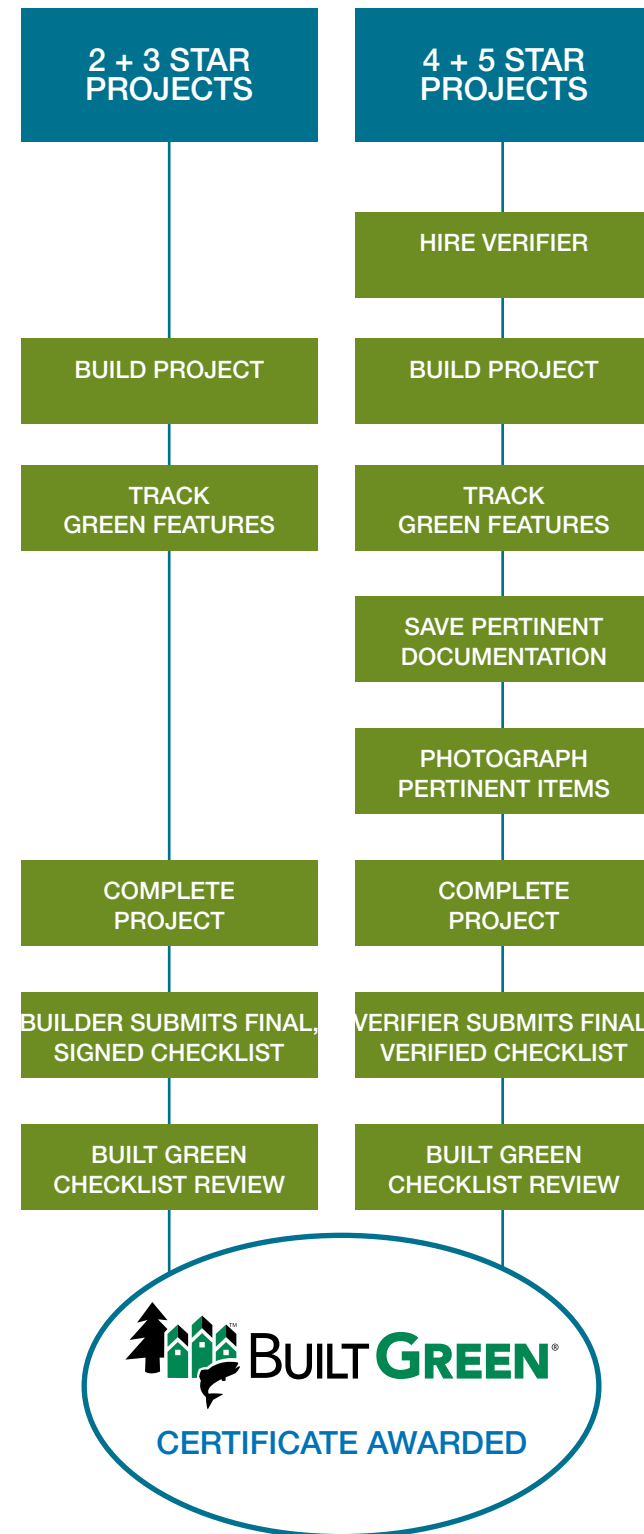
*Considerations* lists, where applicable, there are challenges or opportunities between the listed Action Item and others, and when the goal of the Action Item may be at odds with other green building goals. For example, air sealing a home for energy efficiency without simultaneously considering ventilation levels or materials selection can result in compromised indoor air quality and moisture problems. Adding insulation without considering air leakage and bulk water problems (e.g., poorly installed flashing) can result in rot and mold. Or reusing old water-using fixtures may thwart conservation goals, even if it reduces material waste. Identifying these opportunities and tradeoffs can help better integrate the specific strategies being considered for a particular remodel.

*Resources* provides the top recommended sources of additional information for learning more about and implementing the Action Item. Some resources referenced are written for homeowners as the primary audiences, while others are written primarily for design and construction professionals. However, all resources are considered useful for both audiences, as the homeowner-focused resources help explain the value proposition (the why of specific strategies), while the professional resources are more oriented toward the technical execution of the strategy (the how). Inquisitive homeowners will be interested in reviewing the technical aspects of a strategy, and remodeling professionals will be interested in the value proposition content in order to communicate more effectively with clients.

## The BUILT GREEN certification process

The BUILT GREEN Remodel certification process entails a series of important steps. The following is a synopsis:

1. Join BUILT GREEN. Visit [www.builtgreen.net](http://www.builtgreen.net) to download the “Join BUILT GREEN Form” and the “BUILT GREEN Membership Info and Benefits.” These two documents describe the membership process and benefits.
2. Enroll project. Visit [www.builtgreen.net](http://www.builtgreen.net) for the project enrollment form. Project enrollment starts the clock on the 5-year window for remodel project completion (see Certification Time Frame, below).
3. Complete a preliminary checklist. After enrolling a project, a preliminary Remodel Checklist is completed. This is a valuable step in the process leading up to certification, and an opportunity to have a comprehensive discussion between remodeling professional and homeowner in terms of project goals. The Remodel Checklist is also available at [www.builtgreen.net](http://www.builtgreen.net).



## Certification time frame

BUILT GREEN recognizes that remodels can be a long-term process, especially when actions are strategically sequenced to take advantage of opportunities for upgrades over time. For example, re-siding a home is an excellent opportunity to upgrade a home’s thermal envelope with exterior rigid insulation. Or perhaps the decision to upgrade a furnace or install solar electric panels is postponed for a couple of years in order to take advantage of an exciting new breakthrough technology or the implementation of a tax credit or other financial incentive. Or perhaps finances or the desire on the part of the homeowner to contribute a substantial amount of sweat equity draw out a project over several years. For these and other reasons, the BUILT GREEN Remodel program has created a 5-year window for project completion. The project inception date is determined by the registration date of the project.

### Verification

BUILT GREEN Remodels striving for the top levels (4- and 5-Star) are required to be independently verified. Verification provides several benefits. For projects that are remodeling for immediate or eventual sale, verification provides an added level of authority to the BUILT GREEN certification, by providing prospective buyers with an independent voice confirming that the strategies identified were indeed performed on the home. It also allows a home to be listed on the Northwest Multiple Listing Service as independently verified. Beyond the potential marketing benefits, verification provides a quality control function, by bringing in a technical expert to provide evaluation of the execution of green building strategies on the project, and creating an opportunity to identify and correct errors that may have occurred. (Note that beginning approximately January 2010, all BUILT GREEN Remodel certification levels will require independent verification.)

BUILT GREEN project verification entails identifying a BUILT GREEN Verifier (a Verifier list is maintained on the BUILT GREEN website). Verification is accomplished via a series of site visits, performance tests, and photographic and other documentation. A remodeling professional works with the identified Verifier to establish an inspection schedule and review the Verification Checklist to identify items for verification relevant to the project.

## Energy Retrofit

Projects aiming for 2-Star BUILT GREEN certification must conduct a basic energy retrofit. The Retrofit Checklist is part of the BUILT GREEN Checklist, available at [www.builtgreen.net](http://www.builtgreen.net). The purpose of the basic energy retrofit is to ensure a level of energy efficiency performance on a home. Measures in the Retrofit Checklist are identified for rapid payback and benefit to both the homeowner and the environment.

The details of an Energy Retrofit are described in detail on page 14, under “2-Star Certification requirements.”

Find a more detailed and interactive version of the BUILT GREEN certification process, including verification and a list of BUILT GREEN Verifiers, at [www.builtgreen.net](http://www.builtgreen.net).

### Homeowner’s Operations and Maintenance Manual

Promoting responsible homeowner operation and maintenance, equips homeowners with the tools to continue the good work started with the BUILT GREEN Remodel. Studies show that most individuals care about the environment and are willing to take certain actions to protect it, as long as those actions are not expensive, time-consuming, or inconvenient. A Homeowner’s Manual may simply include information or it may also include environmentally friendly gifts, and is a chance to be creative. In addition to the Manual’s educational value, the remodeling professional benefits by providing enhanced customer service, reinforcing the firm’s reputation as a “Green Builder” serving the community. The Homeowner Operations and Maintenance Manual is a required element of a BUILT GREEN Remodel. For more information, see Action Item 15-3.



## BUILT GREEN Star levels and requirements

BUILT GREEN certification is defined by star levels that represent the depth of green strategies used in a project, serving as shorthand for the home's overall environmental performance. Similar to hotels and restaurants, a higher Star level indicates a higher level of performance: more green choices were made, a higher score was achieved, and therefore the level of green is higher. In addition to higher minimum point scores, the various Star levels also have specific requirements that must be achieved in order to be eligible for that Star level. The intent of this page is to clarify the requirements and point minimums associated with each level, and to help explain page 1 of the BUILT GREEN Remodel Checklist.

The Remodel Checklist is available for download from [www.builtgreen.net](http://www.builtgreen.net).

### 2-Star Certification requirements

The 2-Star level is BUILT GREEN's entry level for certification. It is intended to be achievable for a majority of remodel projects, but because of the energy retrofit minimums, it is substantial and may be difficult for some projects to achieve depending on project scope. If certifying at the 2-Star level, disregard all requirements for 3, 4, and 5-Star certification, but take notice of the 'Codes and Regulations' section that precedes the beginning of the checklist. The requirements to certify at the 2-Star level are as follows:

- Attend the BUILT GREEN orientation. This is a class offered by BUILT GREEN that is intended to help new participants to the program understand green building and the certification process.
- Achieve all items under the 'Codes and Regulations' section of the Checklist. This section follows the star level requirements and is on page 2 of the checklist. Each of these items is denoted by a star in the points field of the checklist.
- Achieve a minimum of 80 points for the project, or 100 points if the project includes an addition.
- Achieve a minimum of 15 points in each environmental category. In the checklist, environmental categories are noted by color. The four BUILT GREEN environmental categories are Site and Water, Energy Efficiency, Materials Efficiency, and Health and Indoor Air Quality (the categories are explained in more detail on page 9, above). The environmental categories are color-coded on the Remodel Checklist for ease of cross-reference. Green signifies the Site and Water category, Yellow

represents Energy Efficiency, Blue corresponds with Indoor Air Quality, and Purple identifies Materials Efficiency. Use the Remodel Checklist spreadsheet to tally project points to make sure they meet requirements for the targeted certification level.

- Perform a BUILT GREEN Energy Retrofit.\* In order to certify the remodel of an existing home, the scope of the project must include some basic energy improvements. In order to make a project eligible for certification, fill out the Energy Retrofit worksheet which requires the following:
  1. Air Seal Home to achieve a 30% improvement or a minimum of 10 ACH@50 Pascals (blower door test required).
  2. If home is air sealed to 7ACH@50 Pascals—the house must meet current Washington State ventilation code requirements.
  3. Insulate entire accessible attic to R-44 or better.
  4. Score a total of 15 points on the Energy Retrofit Worksheet.

\*If remodeling a newer home that performs equivalently to current Washington State Energy Code, the Energy Retrofit requirement may be waived at the discretion of the BUILT GREEN Program Director.

### 3-Star Certification requirements

Certification at the 3-Star level requires meeting all 2-Star requirements plus increasing the home's energy performance to the levels outlined in the current Washington State Energy Code for new construction excluding exterior walls, which must perform at a minimum of R-13 in terms of energy level. For 3-Star Certification, the following requirements must be met:

- Meet all 2-Star requirements.
- Achieve 150 points, or 180 points if the project includes an addition.
- Achieve a minimum of 20 points in each environmental category.
- Perform an energy retrofit resulting in whole building energy performance equal to current Washington State Energy Code (exception: exterior walls must be R-13 or better). This requirement can be met in one of two ways. Code equivalency can be demonstrated using approved energy modeling software, or an approved performance scoring tool such as EPS or HERS, or requirements of the current single-family new construction code can be followed prescriptively, with the exception of exterior walls being required only to achieve R 13.

### 4-Star Certification requirements

Certification at the 4-Star level requires meeting all requirements for the 2-Star and 3-Star levels, in addition to the following:

- Meet all 2-Star and 3-Star Requirements.
- Achieve 250 points, or 280 points if the project includes an addition.
- 3rd Party Verification Required (see reference)
- Achieve all strategy specific requirements outlined on page 1 of the checklist under 4-Star requirements.
- Final project must perform 15% above current Washington State residential new construction Energy Code or achieve equivalent score through an approved performance scoring tool.
- Choose 1 of 5 Indoor Air Quality (IAQ) measures outlined under 4-Star requirements on page 1 of the checklist. Note that you must only choose 1 of the final 5 IAQ items outlined under 4-Star Requirements (under "Choose one of the following" heading).

### 5-Star Certification requirements

Certification at the 5-Star level requires meeting all of the requirements for 2, 3, and 4-Star levels, in addition to the following:

- Meet all 2, 3, and 4-Star Requirements.
- Achieve 400 points, or 430 if the project includes an addition.
- Achieve a minimum of 40 points in each category
- Achieve all strategy specific requirements outlined on pages 1 and 2 of the checklist under 5-Star requirements.
- As an alternate to the prescriptive strategy specific energy requirements, the home may be modeled to perform 30% above current Washington State residential new construction Energy Code or achieve equivalent score through an approved performance scoring tool.

## BUILT GREEN and Integrated Design

A key concept in green building is integrated design, or the idea that the building design and construction process must consider the various goals for a project and their design implications at the earliest possible stage, accounting for occupant needs, environmental and health goals, community and social concerns, and up-front and lifecycle costs and benefits. The conventional design and construction process often uses what is essentially “dis-integrated” design, with decisions regarding product selection, heating and ventilation, building orientation and fenestration et cetera being made in isolation. The latter approach makes it easy to miss opportunities for capturing synergies between design and product selection choices, resulting in a home that fails to reach its full potential. More problematically, the dis-integrated approach can result in serious problems, including compromised indoor air quality and reduced building durability. The integrated design approach helps identify and resolve these issues during the design phase, when they’re much cheaper to fix.

An integrated design approach specifically looks for both the opportunities and challenges that present themselves on any remodel project, but that can be even more numerous on a home that is aiming for advanced levels of environmental and human health performance. Common opportunities include:

- Advanced air sealing and insulation allowing the downsizing (or elimination) of heating systems.
- Water conservation strategies reducing the size of water heating equipment, or making solar hot water systems more viable.
- Advanced energy conservation approaches resulting in a smaller photovoltaic system, in turn reducing project costs.
- Low Impact Development site strategies reducing or the need for stormwater pipes and pumps.
- Enhanced insulation and shading eliminating the need for mechanical cooling.
- Green materials selection protecting indoor air quality.
- Reusing materials reducing waste, conserving resources and lowering project costs.
- Limiting project square footage reducing materials use, energy use and total project costs.

Challenges on green building projects include:

- Materials reuse goals conflicting with energy efficiency, water conservation or health and safety objectives (e.g., reusing inefficient equipment, windows, doors, or water fixtures; reusing trim painted with lead based paint).
- Air sealing and insulating conducted without regard to proper ventilation and moisture management approaches.
- Partial approaches to passive solar design resulting in uncomfortable spaces and increased summer cooling loads.

The Additional Considerations component of each Action Item in Section 2 of the BUILT GREEN Remodel Handbook attempts to identify these opportunities and challenges; however, a comprehensive evaluation and identification process will require careful evaluation and creative thought by both the homeowner and remodeling professional.

Note that consultants tend to focus on a subset of green building, such as energy efficiency, passive solar design, health or materials selection. If hiring specialists, be sure they are apprised of the integrated goals of the project, and select specialists based on their understanding of larger green building concepts. If integrated design is a common theme on a project, the odds are increased that the home can reach its full potential. This is facilitated by employing a hallmark of the integrated design process, the design charrette.

Design charrettes are essentially orchestrated design brainstorming, conducted at the earliest possible stage in a project, involving key players including design and construction professionals and future occupants. On large commercial projects, charrettes can involve dozens of players and take many hours. On a remodel, a charrette can be a much simpler affair, but it is critical to assemble an inclusive team. The BUILT GREEN Action Items calling for systematic assessments of a home’s site, water and energy contexts are intimately related to the integrated design approach. Only by knowing a home’s current context can a project effectively evaluate and plan to optimize the property through smart design decisions. A truly integrated approach takes the information gathered during this assessment phase and assembles it for analysis and action in a charrette or other setting that allows for communication and strategy setting among the project team.

## General resources

Green building is a broad, quickly evolving field. Keeping pace of the changes can be challenging. To help with this, BUILT GREEN suggests a series of print and online resources. The following is a streamlined list, aimed at helping remodeling professionals stay up-to-date. For resources related to specific BUILT GREEN Remodel Action Items, refer to the specific Action Item.

### Online

- **BUILT GREEN:**  
[www.builtgreen.net](http://www.builtgreen.net)  
The BUILT GREEN website includes information on certification, verifiers, and case study projects, and the BUILT GREEN checklists. Sign up for the monthly BUILT GREEN News as well.
- **Environmental Building News:**  
[www.buildinggreen.com](http://www.buildinggreen.com)  
A monthly periodical exploring all facets of green building. Subscribers can search back issues and access the Building Green Suite, which includes the Greenspec directory of green building products.
- **Green Building Advisor:**  
[www.greenbuildingadvisor.com](http://www.greenbuildingadvisor.com)  
From the publishers of Environmental Building News and others, this online resource is targeted specifically at residential green building.
- **ToolBase:**  
[www.toolbase.org](http://www.toolbase.org)  
From the National Association of Home Builders and the Partnership for Advanced Technology in Housing, ToolBase is a compendium of design and technology strategies for homebuilding, focusing on efficiency and durability.
- **Building Science Corporation:**  
[www.buildingscience.com](http://www.buildingscience.com)  
Articles, construction details, and builder’s guides on issues related to energy efficiency, indoor air quality, and building durability.
- **King County GreenTools:**  
[www.greentools.us](http://www.greentools.us)  
King County’s green building resource, with a focus on waste reduction and recycling.

### Print

- *Green Remodeling* by David Johnston and Kim Master
- *The Northwest Green Home Primer* by Kathleen O’Brien and Kathleen Smith
- *Builder’s Guide to Mixed-Humid Climates* by Joseph Lstiburek
- *Your Green Home* by Alex Wilson
- *Green Building Products: The GreenSpec Guide to Residential Building Materials* by Alex Wilson and Mark Piepkorn, eds.
- *The Philosophy of Sustainable Design* by Jason F. McLennan
- *Green Building for Dummies* by Eric Corey Freed

Many more resources, both online and print, exist to help builders and homeowners understand and implement green building strategies. Action Items within this Handbook provide resources specific to the topic covered. Explore these resources for additional information.

## DESIGN

The design phase is a key focus of green building and remodeling: early design decisions can determine the feasibility of subsequent strategies, and early design allows for big ideas to emerge and be tested for feasibility. Additionally, it is early in design that a full accounting of a project's opportunities and challenges should be made, to better inform the overall green strategy for the home.

## Action Item 1-1

Develop comprehensive site assessment and plan (submitted to BUILT GREEN)

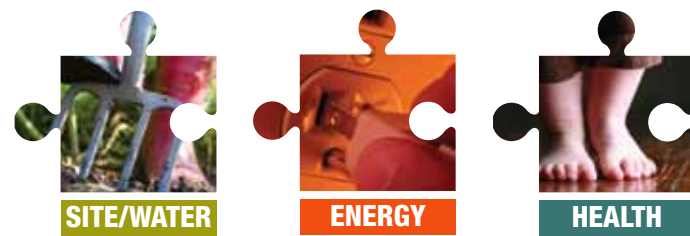
### Points: 5

#### Responsible party:

Architect, Landscape Architect

#### Intent:

Develop a full understanding of current site functions challenges and opportunities to better inform strategic design decisions.



**what:** A comprehensive site assessment entails conducting a detailed analysis of site attributes, from soil quality to drainage patterns to presence of invasive plant species. A site plan emerges from the site assessment by coupling the homeowner's priorities for the project with the context of existing challenges and opportunities revealed by the assessment.

**why:** Understanding a home's site characteristics is key to capturing opportunities related to landscaping, building durability, and passive solar design, and to avoiding and minimizing potential problems such as hazard trees and flooding. By assembling a comprehensive picture of what a site has to offer, a project team can better capture opportunities and anticipate challenges.

**how:** There are three elements to this Action Item: assessment, plan, and meeting plan.

The site assessment is a written survey of the property's existing conditions in terms of tree and plant placement and health (including identification of invasive species), soil quality and type, signs of soil compaction and/or contamination, topography and drainage patterns, and existing maintenance practices (including use of fertilizers and pesticides). It also examines the current use patterns of outdoor space by people and pets.

The plan takes the information identified in the assessment and incorporates owner environmental and health priorities to develop strategies for protecting or improving the site. Strategies can be drawn from other BUILT GREEN Action Items, or be drawn from

other sources. For example, the site assessment may reveal that a portion of the home's foundation is at risk of water damage. The plan could include Action Item 3-12, which directs a project to re-grade to drain water away from the foundation. The plan would identify the area in need of grading and incorporate the process into the project schedule.

After the plan is complete, a meeting is held to communicate the elements of the plan to relevant parties including the architect, landscape architect, contractor and relevant subs prior to the start of design and construction.

A comprehensive site assessment provides a valuable starting point for pursuing many Built Green Action Items in the Site and Water category. Review the Site and Water section both before and after conducting the site assessment to generate ideas and identify areas of focus in the assessment.

**considerations:** Factors relevant in the comprehensive site assessment are also relevant to the comprehensive water assessment (see Action Item 1-2) and having a home's energy performance evaluated prior to construction (Action Item 1-16). Consider offering all services to a client, to capture synergies between the assessments.

**resources:** The Saving Water Partnership maintains resources to help locate landscape professionals familiar with water-wise irrigation:  
[www.savingwater.org/outside\\_professional.htm](http://www.savingwater.org/outside_professional.htm)

Building Soil:  
[www.buildingsoil.org](http://www.buildingsoil.org)



**what:** A comprehensive water assessment evaluates current water use, identifying opportunities on the property for water savings. The water use plan emerges from that analysis to capture opportunities revealed by the water assessment.

**why:** Without a thorough analysis of the water use patterns in a home, it is difficult to make strategic decisions to create a water-wise household. A water assessment and plan helps identify synergies and potential tradeoffs related to pursuing different water conservation strategies on a home.

**how:** There are three elements to this Action Item: assessment, plan, and meeting plan.

The water assessment is a written survey of the property's existing conditions in terms of water use in the landscape and in the home. A landscape water assessment evaluates plant choices, soil quality, and irrigation techniques, as well as identifies land and hardscape drainage patterns to pinpoint potential problem and opportunity areas. The home water use assessment utilizes standard techniques such as flow rate tests to prioritize fixture upgrades, and examines the plumbing layout for complexity and pipe diameter. It can also include an assessment to determine the potential for rainwater harvest.

The plan takes the information gathered from the assessment and incorporates homeowner health and environmental priorities to develop strategies for improving a home's water use. These plan elements can be drawn from other Built Green Action Items, or other sources. For example, the water assessment may reveal a leaky flapper

valve in an older toilet. The plan could identify several steps, including the incremental upgrade of fixing the valve, or the more substantial fix of upgrading to a dual-flush toilet (Action Item 2-8).

Finally, a planning meeting should be held early in the remodel process to review the water assessment and plan and to bring the right players to the table to generate additional creative ideas for achieving water conservation goals.

A comprehensive water assessment provides a valuable starting point for pursuing many BUILT GREEN Action Items in the Site and Water category. Review the Site and Water section both before and after conducting the site assessment to generate ideas and identify areas of focus in the assessment.

**considerations:** Conducting a water assessment simultaneously with site and home energy performance evaluation (Action Items 1-2 and 1-16) can save money and identify even larger synergies. Consider coordinating these assessments.

**resources:** Living Water Smart British Columbia has a Home Water Assessment to help a homeowner evaluate water use:  
[www.livingwatersmart.ca/get\\_involved/home-assessment.html](http://www.livingwatersmart.ca/get_involved/home-assessment.html)

The regional Saving Water Partnership provides a variety of tools for assembling a water use assessment, including finding and fixing leaks and flow rates of existing fixtures:  
[www.savingwater.org](http://www.savingwater.org)

Use the "Home Tour" function at H2Ouse to identify household water use and savings opportunities:  
[www.h2ouse.org](http://www.h2ouse.org)

## Action Item 1-2

Develop comprehensive water assessment and plan (submitted to Built Green)

### Points: 5

#### Responsible party:

Architect, Landscape Architect

#### Intent:

Develop a full understanding of existing water use patterns, opportunities and challenges to better inform strategic design decisions.



#### Homeowner Benefit:

A comprehensive site assessment and plan helps ensure a strategic, integrated and well-sequenced approach to identifying site assets and challenges, and using that information to inform decisions.



#### Homeowner Benefit:

A comprehensive water assessment and plan evaluates opportunities related to water use in and around a home, reducing a home's water consumption and accompanying water (and wastewater) bills.

## Action Item 1-3

No increase to the existing building footprint

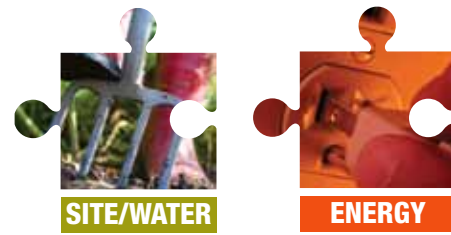
### Points: 5

#### Responsible party:

Architect

#### Intent:

Avoid creation of additional impervious surface to protect site hydrology and water quality.



SITE/WATER

ENERGY

**what:** Not increasing the building footprint means that the remodel project does not add to the home's exterior dimensions in terms of length and width. (In the terminology of permitting agencies, it means no increase in lot coverage.)

**why:** According to the National Association of Home Builders, the average American home has grown from just under 1000 square feet in 1950 to over 2,400 square feet in 2005. Adding to the building footprint increases the total impervious surface onsite, contributing to stormwater problems. It also substantially increases a home's energy and materials use.

**how:** Maintaining a home's existing footprint is relatively straightforward but may involve extensive upfront planning to consider space needs and the best use of existing space. See Resources for recommended texts on efficient space planning.

Building up, rather than out, can also maintain the existing footprint while adding to square footage if needed. Other potential benefits of vertical additions include better access to sunlight for passive solar design, and reducing a home's exterior surface area compared to a horizontal addition, which can benefit energy efficiency.

**considerations:** Consider hiring a space planning or home organization consultant as part of the project to help homeowners understand the value of well-organized space. The cost of this activity will be a fraction of the cost of adding square footage to the project.

#### resources:

Sarah Susanka's Not so Big series of books, including *Not So Big Remodeling*, *The Not So Big House* and *Creating the Not So Big House* feature ideas for more elegant and efficient use of space. Visit [www.notsobighouse.com](http://www.notsobighouse.com) for details.

*How to Live in Small Spaces* by Terence Conran (Firefly Books, 2007) provides practical information on designing, furnishing and living in not so big spaces.

The Small House Style website includes a blog with case studies, information on trainings, and other resources related to smaller houses: [www.smallhousestyle.com](http://www.smallhousestyle.com)



SITE/WATER

ENERGY

**what:** Existing homes often come with the benefit of mature trees and other valuable landscape elements. Examining the existing landscape for plant and soil health, location of trees in relation to the existing home and any planned additions is part of an integrated approach to remodeling. A professional arborist can best determine tree health.

**why:** Trees help moderate surface temperatures, thereby reducing building heating and cooling requirements by providing shade in summer and wind protection in winter. Trees also store carbon, reduce stormwater runoff, stabilize soils, and help cleanse the air of pollution, especially particulate matter. Additionally, trees provide habitat for birds and other wildlife. Studies show that a single mature tree can provide nearly \$300 annually in energy and resource value to the homeowner and the general public in terms of cooling, erosion and pollution control, and wildlife shelter. Trees may also protect some of a site's critical features like stream buffer zones. According to a 1998 study by American Forests (the most recent report available), the Puget Sound region has lost more than 50% of its heavily vegetated areas, while areas of very low tree coverage (20% or less) has increased nearly three-fold. This tree loss has resulted in a 35% increase in stormwater runoff.

Trees represent a financial asset as well: according a survey of real estate agents by Bank America Mortgage, more than 50% believe trees have a positive impact on potential buyers' impressions of homes and neighborhoods. A National Association of Home Builders survey

reported that 43% of home buyers paid up to \$3,000 more, and 27% spent over \$5,000 extra for wooded lots. Studies in some regions of the country have found trees add as much as 30% to property values.

**how:** The best way to determine the health of existing trees is to hire a certified arborist. See Action Item 3-6 for information on hiring a consulting arborist to evaluate trees and develop a tree protection plan. See Action Item 3-5 for details on protecting trees.

**considerations:** Trees affect solar access for passive solar design as well as photovoltaic (solar electric) arrays, solar hot water systems and gardens, both on the project property and adjoining properties. Mature tree size should be evaluated when deciding whether or remove or retain trees near power lines or sewer lines. To maximize the benefits of trees, preserve existing deciduous trees that protect the home from unwanted heat gain during the warm months and those that provide fruit and nuts to the homeowner. Evergreen conifer species are far superior at retaining rainwater on site than deciduous trees, providing a major stormwater management benefit.

#### resources:

The International Society of Arboriculture certifies arborists: [www.isa-arbor.com](http://www.isa-arbor.com).

American Forests info on ecosystem benefits and policy resources, including a Puget Sound Regional Ecosystem Analysis: [www.americanforests.org](http://www.americanforests.org).

Plant Amnesty's arborist referral, pruning information and classes: [www.plantamnesty.org](http://www.plantamnesty.org).

## Action Item 1-4

Retain 100% of existing healthy trees on site

### Points: 4

#### Responsible party:

Arborist, Landscape Architect

#### Intent:

Protect site hydrology; provide air and water quality benefits; create carbon sink.



#### Homeowner Benefit:

Keeping the building footprint to a minimum helps a site manage its stormwater naturally through infiltration, and possibly helping reduce the risk of flooding onsite or downstream. It also avoids triggering remedial action that may be required by local jurisdictions to manage stormwater related to added impervious surface—reducing project design and construction costs.



#### Homeowner Benefit:

Healthy trees provide a variety of "ecosystem services" to a property and the larger community. Trees protect a site from erosion and flooding, and reduce heating and cooling-related energy use by providing shade and wind protection. In addition, a treed lot increases a home's value.

## Action Item 1-5

If building near wetlands, shorelines, bluffs, and other critical areas, preserve and protect beyond code

### Points: 2

#### Responsible party:

Architect, Landscape Architect

#### Intent:

Protect sensitive ecosystems and reduce the risk of erosion and landslide.



**what:** A wide variety of strategies can help preserve and protect critical areas on a site, including minimizing site disturbance beyond limits established by code, preserving trees and existing soils, and removing invasive species and those competing with native vegetation.

**why:** Code minimums for setbacks and critical areas protection are just that: minimums. Performing beyond code is a common theme in green building. By going beyond code to preserve and protect environmentally critical areas, a project builds in added protection.

**how:** Numerous federal, state and local laws affect the use and protection of wetlands and other critical areas. There is variation in local regulations; contact the building department to determine code requirements applicable to the project. Strategies to protect beyond code should be informed by the nature of the critical area and existing site conditions. Protection beyond code can be both construction-phase activities and permanent landscape and building features.

**considerations:** On properties that include areas prone to landslide or erosion such as bluffs, be certain to consult with a hydrologist and/or civil engineer prior to using any Low Impact Development strategies aimed at allowing the groundwater to recharge (see Action Item 1-9). Instead, systems that detain water on site but do not add to groundwater may be preferable, such as stormwater planters. Simply avoiding building near the critical area (Action Item 1-6) and not adding to the building footprint (Action Item 1-3) helps.

**resources:** The Municipal Services and Research Center of Washington maintains a list of links to Critical Areas ordinances throughout the state: [www.mrsc.org/Subjects/Environment/criticalpg.aspx](http://www.mrsc.org/Subjects/Environment/criticalpg.aspx)

Seattle Department of Planning and Development's Green Shorelines manual provides low-impact strategies for reducing shoreline armoring, reestablishing habitat and restoring lake frontage: [www.seattle.gov/dpd/Planning/Green\\_Shorelines/Overview/](http://www.seattle.gov/dpd/Planning/Green_Shorelines/Overview/)

King County's Northwest Native Plant Guide for landscape design examples for steep slopes and marine properties, among others: [www.green.kingcounty.gov/Go-Native/Index.aspx](http://www.green.kingcounty.gov/Go-Native/Index.aspx)



**what:** Environmentally Critical Areas (ECAs) commonly include steep slope areas, geologic hazard areas (e.g., landslide and liquefaction areas), flood-prone areas, wetlands and fish and wildlife protection areas, among others.

**why:** Multiple reasons exist for avoiding development in ECAs including damage to property in the event of a flood, earthquake, or landslide. More generally, protecting ECAs often helps preserves sensitive ecosystems, including wetlands, stream banks, and waterfronts.

**how:** To achieve this Action Item, a project must avoid disturbance of land at a distance twice (2x) the required minimum buffer.

For example, the City of Seattle requires a buffer of 50 feet for a Category IV wetland of over 1000 square feet. To gain points for this Action Item, a project with these attributes in this jurisdiction must avoid disturbing land within 100 feet of the wetland border. For ECAs with no buffer minimum, the minimum buffer required for this Action Item is 50 feet.

**considerations:** Building form and massing decisions should be made based on multiple variables, including proximity to critical areas, presence of trees and other landscape elements, passive solar design, and photovoltaic and solar hot water system design. Balance all of these factors when determining the optimal building form and orientation.

**resources:** See Action Item 1-5 for resources related to critical areas.

## Action Item 1-6

If building in an Environmentally Critical Area, build away from the protected area

### Points: 2

#### Responsible party:

Architect, Contractor, Landscape Architect

#### Intent:

Protect sensitive ecosystems and reduce the risk of erosion and landslide.



#### Homeowner Benefit:

Protecting beyond code provides added certainty to a homeowner's goal of environmental stewardship and can also reduce the risk of property damage due to erosion and landslide events.



#### Homeowner Benefit:

Locating any addition to the existing home away from critical areas adds a level of protection to both the critical area and the home—reducing the likelihood of damage to the home related to erosion or landslide.

## Action Item 1-7

Use low impact foundation system, such as PIN systems or post and pier, for at least 50% of the foundation

### Points: 3-10

#### Responsible party:

Architect

#### Intent:

Minimize impact on site hydrology; reduce resource use and associated embodied energy impacts.



**what:** Low impact foundation systems are alternatives to typical perimeter or slab-on grade foundation. For example, PIN Foundation Systems do not require traditional site excavation; instead, the company's Diamond Pier® system involves minimally excavating to place a series of pre-cast concrete piers, then driving "pins" (galvanized steel pipe) diagonally through four sides of the pier to anchor it securely to the ground.

**why:** Site disturbance related to foundation work can be substantial, altering site topography and hydrology and adding to construction-phase problems including erosion and sedimentation.

Low impact foundation systems provide the following benefits:

- Preserves site topsoil.
- Avoids expensive and time-consuming erosion prevention measures and drainage controls.
- Maintains natural site stormwater flows and topography.
- Affords an opportunity to help preserve salmon streams.

Post and Pier foundations also offer the environmental benefit of minimizing excavation. Large beams run under the home's floor joists and are held up by posts. Each post rests on a separate concrete footing or pier.

Low Impact Foundation systems also reduce the amount of concrete needed for foundation work, saving materials and substantial amounts of embodied energy (cement production is estimated to be responsible for about 7% of global carbon dioxide emissions).

**how:** This Action Item is worth 3-10 points.

Use any combination of low impact foundation systems for:

- 50%-75% of foundation: 3 points
- 75%-99% of foundation: 7 points
- 100% of foundation: 10 points

Work with an engineer to determine whether Low Impact Foundation Systems are advisable for your project. PIN Foundation Systems require a soils analysis to determine the load capacity of native soils, which in turn determines the length of the pins used to create the support structure for the foundation's stem wall. Additionally, such systems may be challenging to tie into the foundation of an existing house. In a remodel scenario, these foundations may be best employed on outbuildings, e.g., a detached accessory dwelling unit.

**considerations:** Carefully examine all options prior to increasing a building's footprint (Action Item 1-3), including better utilization of existing space. Encourage clients to invest more up front in design and craftsmanship needed to refit existing space instead of simply adding more square footage.

PIN Foundations may cost up to 10% more than conventional excavated foundations. However, if incorporated early in the planning stage, the strategy can result in a reduction of site development costs coupled with an increase in environmental compliance.

When using Low Impact Foundation Systems, it is important to protect the site soils from compaction by construction equipment traffic, so that they can maintain hydrologic function. Methods to prevent compaction include keeping vehicles and equipment on defined rock haul roads or existing driveways, using tracked equipment that spreads loads, minimizing material storage and lay down areas, and where some traffic is unavoidable protecting soil with metal plates or 6" of coarse wood chip (hog fuel).

#### resources:

The Puget Sound Partnership's *Low Impact Development Technical Guidance Manual for Puget Sound* includes a section on "Minimal Excavation Foundation Systems" (Section 6.5). The entire manual is available for free download at [www.psparchives.com/our\\_work/stormwater/stormwater\\_resources.htm](http://www.psparchives.com/our_work/stormwater/stormwater_resources.htm) (click on *Low Impact Development—Technical Guidance*).

PIN Foundations:  
[www.pinfoundations.com](http://www.pinfoundations.com)  
(Gig Harbor, WA)



*Low impact foundation systems require minimal excavation, reducing site impact and maintaining a site's natural hydrology. They also reduce the amount of concrete needed for foundation work, and can virtually eliminate the need for formwork—reducing materials use and associated resource extraction and energy impacts.*

*Image: PIN Foundations, Inc.*

## Action Item 1-7



### Homeowner Benefit:

Low impact foundation systems allow a site to maintain existing hydrological function, which in turn can reduce moisture levels in crawl spaces—reducing the risk of moisture-related structural damage or poor indoor air quality. Additionally, these systems require less excavation of the existing site, meaning less disruption during construction.

## Action Item 1-8

Design to effectively infiltrate all stormwater on site with zero runoff

### Points: 10

#### Responsible party:

Architect, Landscape Architect

#### Intent:

Reestablish, protect and enhance site hydrology, protect downstream aquatic habitat; allow for groundwater recharge.



**what:** Effective infiltration involves capturing storm water from all impervious surfaces (roof, conventional sidewalks, driveways, etc.) and designing landscape elements that allow that water to seep into the soil without entering the storm or combined sewer systems, or surface flow off the property. The array of strategies to reduce imperviousness, from the watershed scale down to single lots, is known as “Low Impact Development.” These strategies are increasingly promoted and/or required by local jurisdictions to reduce impacts of development on streams, lakes, estuaries and marine waters.

**why:** Infiltrating stormwater onsite has a variety of ecological benefits, including recharging the local aquifer and restoring pre-development hydrological conditions, slowing and cleansing stormwater, and reducing stream scouring and burdens on stormwater management systems. Well-designed systems can remedy existing drainage problems, including basement or crawl space flooding or landscape health issues.

**how:** It is critical to first evaluate a site for its suitability for infiltration, especially properties that are located near environmentally critical areas or those with unstable soils. Not doing so can result in flooding of the property or adjacent properties, erosion and even landslides.

On suitable sites, design so that runoff is effectively spread over large vegetated areas. Strategies to reduce effective imperviousness:

- Preserving healthy soil and vegetation, or restoring soil by correcting compaction and



- amending with compost and re-establishing dense vegetation.
- Restoring trees and forest coverage (especially native evergreen tree species).
  - Installing rain gardens, drainage swales, dry wells, and/or a green roof.
  - Choosing permeable pavement systems for hardscapes.

Reducing the amount of impervious surfaces onsite also helps, including decommissioning impervious walkways, patios and driveways, and reducing or eliminating expansion of the home’s footprint. (See Action Items 1-10 and 1-11.)

There are a variety of driveway designs that minimize the amount of impervious paving. For example, a “Hollywood” driveway consists of two long strips of pavement for the car wheels. The area between is vegetated (preferably with low-growing, drought-tolerant or native plants) or filled with gravel. Vegetated strips provide runoff infiltration, sediment filtering, and pollutant removal. Strategies installed to reduce runoff should be protected with a covenant so that future property owners do not unwittingly increase impervious surfaces.

Draining one impervious surface onto another magnifies stormwater runoff problems. A paved driveway, for example, should not drain onto a paved street. Try to separate impervious surfaces with areas of turf, other vegetation, or gravel. Where feasible, eliminate curbs and design paved surfaces to be even with the vegetated filter strip. Filter strips should slope (no more than 5%) downhill away from the paved surfaces. Ground cover

should be planted dense enough to discourage erosion if these strips are to be used as part of the stormwater conveyance system,

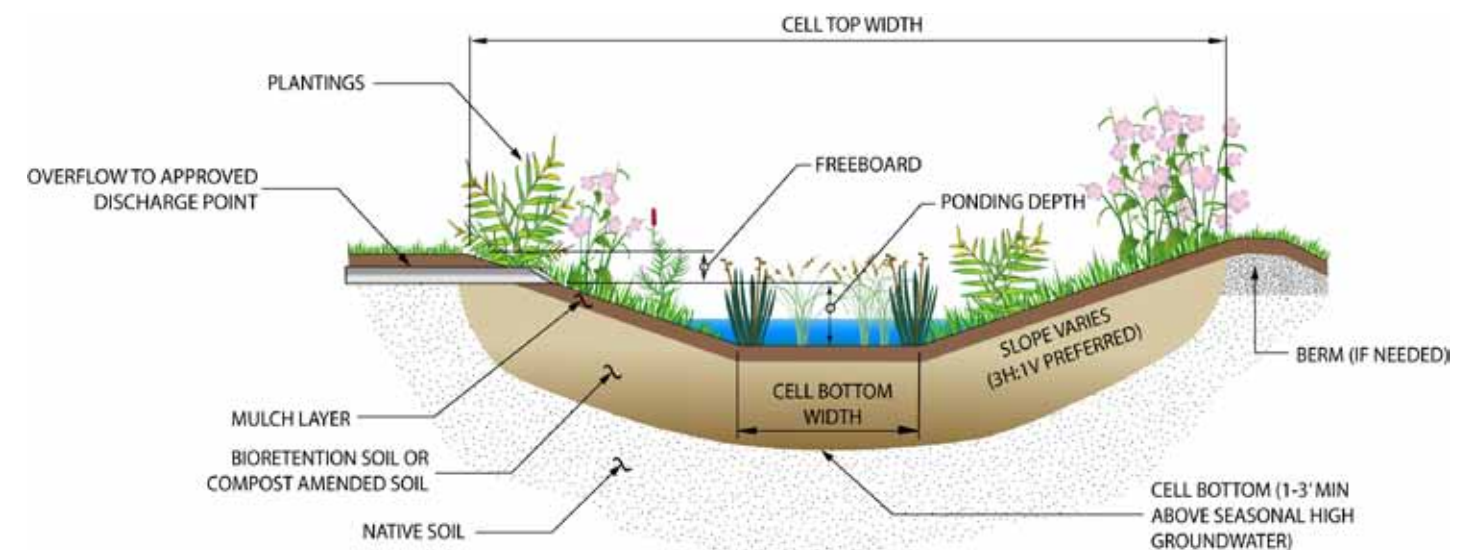
**considerations:** A more compact building footprint (including garage) limits roof runoff area and will generally limit the disturbance to the building site, resulting in less damage to wildlife and natural vegetation. (See Action Item 1-3 for information on not adding to a home’s footprint.)

For projects unable to infiltrate 100% of storm water, consider partial infiltration using strategies outlined in Action Item 1-9. Harvesting rainwater from roof surfaces to be used inside the home (See Action Item 3-12) reduces the amount of stormwater that will require infiltration onsite.

#### resources:

The Puget Sound Partnership’s *Low Impact Development Technical Guidance Manual for Puget Sound* features strategies for infiltrating stormwater on site, as well as information on hydrologic analysis: [www.psparchives.com/our\\_work/stormwater/stormwater\\_resources.htm](http://www.psparchives.com/our_work/stormwater/stormwater_resources.htm) (click on *Low Impact Development—Technical Guidance*).

Seattle Public Utilities’ Natural Drainage Systems website contains a variety of resources, including specifications, presentations, and descriptions of cutting-edge area projects, including Seattle’s High Point redevelopment: [www.seattle.gov/util/naturalsystems](http://www.seattle.gov/util/naturalsystems)



Designing for zero runoff entails landform engineering that allows for temporary capture and detention of stormwater for gradual release into the soil. Drainage swales are one Low Impact Development technique for stormwater detention.

Image: SvR Design, courtesy of City of Seattle.

## Action Item 1-8



## Action Item 1-9

Install a water management system that allows ground-water to recharge

### Points: 5

#### Responsible party:

Architect, Landscape Architect

#### Intent:

Reestablish, protect and enhance site hydrology, protect downstream aquatic habitat; allow for groundwater recharge.



**what:** Landform engineering is the act of using the natural movement of water while manipulating and enhancing existing topographic conditions to improve a site's ability to catch, hold, and absorb water, mimicking natural drainage features.

**why:** Using a site's topsoil and subsoil for infiltration naturally filters stormwater, reducing the amount of toxins and sediments that enter waterways—protecting fish populations and the general health of our lakes, rivers and Puget Sound.

Groundwater is a resource that may have little direct impact on a particular site, but its purity is an important issue down slope where it feeds streams and lakes or is pumped out of the ground as potable water. Groundwater is “recharged” from surface waters infiltrating into natural recharge areas. It is important to understand the hydrology of a site so as not to interfere with these areas. In addition to preserving groundwater recharge zones, landform engineering can help reestablish proper water functions that may have been disrupted during site development.

Water storage and stormwater cleansing processes contribute to forming a healthier ecological community within the landscape. This process allows water to infiltrate into the ground and enrich the life of the soil ecology.

**how:** Designing and installing a water management system aimed at groundwater recharge requires deep technical knowledge. Civil engineers and landscape architects with experience in Low Impact Development strategies is key.

Examples of landform engineering that can contribute to a water management system include mulching, contour trenches, swales and terraces, “rain gardens” (shallow depressed landscape features with deep amended soils and plants adapted to seasonal wetness), check dams, dry wells and sand traps, retention basins, and diversion ponds. Other alternative strategies include roof infiltration systems, level spreaders and other methods to disperse roof or pavement runoff into the landscape, and rainwater detention vaults or cisterns (which serve as detention vaults in winter, but can hold late spring rainfall for summer use).

These systems can be used alone or in combination to put runoff back in the ground via infiltration or dispersion through natural vegetation. Avoid directing unfiltered runoff directly to a natural or constructed drainage system and keep runoff and sediment on site.

See Resources for reference to the Washington State Surface Water Design Manual, and review local stormwater code for approved Best Management Practices (BMPs).

**considerations:** The methods outlined elsewhere in the BUILT GREEN Remodel Checklist, including preserving native vegetation and soils where possible (Action Items 1-4, 3-4, and 3-10), preventing or correcting soil compaction, and restoring disturbed soils with compost amendment (Action Item 14-5) are the first steps to ensuring the whole site can infiltrate, filter and clean stormwater, and recharge groundwater.

**resources:** The Puget Sound Partnership's *Low Impact Development Technical Guidance Manual for Puget Sound* includes information on permeable paving, bioretention areas (rain gardens) and other groundwater recharge strategies. The entire manual is available for free download at [www.psparchives.com/our\\_work/stormwater/stormwater\\_resources.htm](http://www.psparchives.com/our_work/stormwater/stormwater_resources.htm) (click on *Low Impact Development—Technical Guidance*).

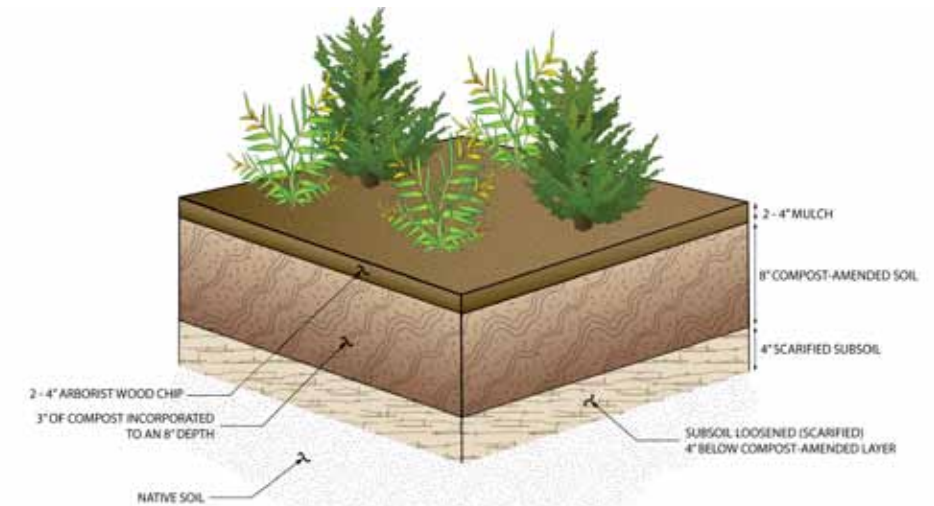
Washington State University Pierce County Extension's *Rain Garden Handbook for Western Washington Homeowners* (2007) offers step-by-step advice on creating rain gardens, from design to maintenance, including flow control modeling information: [www.pierce.wsu.edu/Water\\_Quality/LID/](http://www.pierce.wsu.edu/Water_Quality/LID/)

Snohomish County's Sustainable Development Task Force offers a resource page on rain gardens: [www.sustainable Snohomish County.org/resources/re\\_raingarden.html](http://www.sustainable Snohomish County.org/resources/re_raingarden.html)

Design guidelines, stormwater manual, and examples at Seattle Public Utilities' Natural Drainage Systems site: [www.seattle.gov/util/naturalsystems](http://www.seattle.gov/util/naturalsystems)

The Building Soil manual and other science background and design resources: [www.buildingsoil.org](http://www.buildingsoil.org)

## Action Item 1-9



*Minimizing impervious surfaces and amending soils with compost allows stormwater to percolate into the soils and assist in aquifer recharge. A variety of strategies within the BUILT GREEN checklist facilitate groundwater recharge.*

*Image: SvR Design, courtesy of City of Seattle.*



*Pervious paving options also allow for surface water to be infiltrated on site. Pervious paving takes a variety of forms, including modular pavers (above), pervious concrete and asphalt.*

*Image: Jon Alexander, Sunshine Construction.*



### Homeowner Benefit:

Water management systems that allow for groundwater recharge can help reduce flooding and erosion hazards on site while protecting water quality and habitat downstream.

## Action Item 1-10

Reduce existing impervious hardscape surfaces by 50% or more

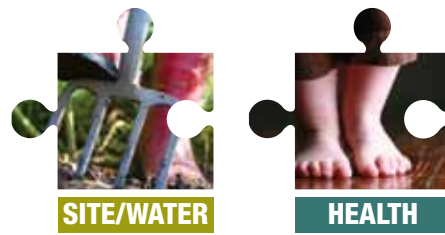
### Points: 3

#### Responsible party:

Architect, Landscape Architect

#### Intent:

Cleanse, slow and infiltrate stormwater runoff; protect downstream habitat; allow for groundwater recharge.



**what:** Impervious surfaces are materials that interrupt the natural hydrology of a site by not allowing stormwater to infiltrate into the subsoil. This includes building structures, such as the roofs of homes and garages. This credit specifically focuses on “hardscape surfaces,” i.e., landscape elements, including patios, driveways and walkways.

**why:** Impervious hardscape surfaces increase the property’s stormwater runoff both in quantity and velocity, as well as increasing the temperature of runoff. Depending on hardscape design, this can result in erosion and water damage to structures on the property, or ill effects offsite, including damage to local streams and water bodies or the increased incidence of sewer overflows.

**how:** Reducing impervious hardscape surfaces can occur in two ways: by removing the hardscape element either in part or altogether, or by replacing it with a pervious alternative.

Examples of permeable paving options include:

- Open or porous paving blocks.
- Pervious concrete.
- Pervious asphalt.
- Crushed stone.\*
- Uncompacted gravel (porous gravel mats).\*

\*Conventional gravel or crushed stone is not considered pervious for driveways or parking areas, as these materials will generally compact under vehicle traffic. Using an engineered product that allows the gravel to remain porous (such

as Gravelpave®) is acceptable. Use gravel and crushed stone for walkways and other light traffic areas.

Pervious concrete and asphalt is considered a proven technology and is becoming more readily available.

Pervious paving materials may cost more than conventional paving materials (such as asphalt), but pavement replacement is simplified, and expensive measures such as asphalt cutting for underground repairs are eliminated.

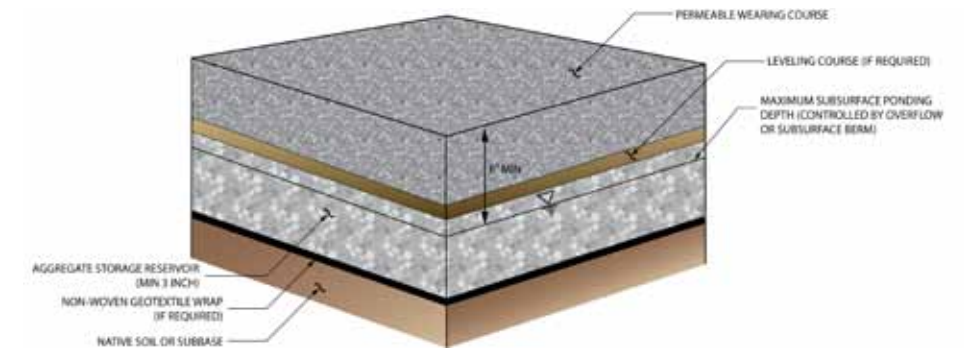
A pervious hardscape element is part of a system, relying on proper preparation of sub-base and skilled installation to work properly. Hire qualified professionals to both design and install these systems, or train staff and crews in-house to add to your firm’s service offerings.

Another way to reduce impervious hardscape surfaces is by reducing the total square footage of surface. This can be accomplished a variety of ways, including by simply removing the hardscape area, or using design alternatives, such as “Hollywood drives” instead of fully paved driveways.

**resources:** The Puget Sound Partnership’s *Low Impact Development Technical Guidance Manual for Puget Sound* includes a section on pervious pavement options. The entire manual is available for free download at [www.psparchives.com/our\\_work/stormwater/stormwater\\_resources.htm](http://www.psparchives.com/our_work/stormwater/stormwater_resources.htm) (click on *Low Impact Development—Technical Guidance*).

Seattle Public Utilities’ *High Point Community: Site Technical Drainage Standards* includes section drawings of various pervious surface treatments, including porous gravel mats, pervious concrete, pavers on a porous base, and others, available from SvR Design: [www.svrdesign.com/high\\_pt.html](http://www.svrdesign.com/high_pt.html) (scroll down to *Additional High Point Resources*).

## Action Item 1-10



Impervious surfaces can be removed completely, minimized, or replaced with pervious alternatives, such as permeable concrete. Permeable concrete is a special concrete mix with the fines removed, which allows water to pass through the small voids that make up the resulting material. This eliminates runoff and allows for groundwater recharge.

Image: SvR Design, courtesy of City of Seattle.



Designing with alternatives to impervious surfaces, such as these driveway and walkway pavers, provide aesthetic as well as stormwater management benefits.

Image: Nelse Design + Build.



### Homeowner Benefit:

Reducing impervious hardscape surfaces helps return a property to healthy hydrological function by allowing water to soak into the ground. Depending on the location of the hardscape surface, it can also help protect a home from bulk water and moisture damage related to improperly draining impervious surfaces.

## Action Item 1-11

Eliminate all impervious surfaces outside building footprint

### Points: 7

#### Responsible party:

Architect, Landscape Architect

#### Intent:

Cleanse, slow and infiltrate stormwater runoff; protect downstream habitat; allow for groundwater recharge.



SITE/WATER

**what:** Use pervious materials for all surfaces outside the house footprint. See Action Item 1-10 for examples of materials that can be used to create pervious paved areas.

**why:** See Action Item 1-10.

**how:** See Action Item 1-10 This Action Item differs from Action



#### Homeowner Benefit:

Eliminating impervious surfaces outside the building footprint reduces the risk of property damage caused by runoff.

Item 1-8 by specifying that hard-scape surfaces (e.g., driveways, walkways etc) must use pervious paving technology, as opposed to coupling impervious surfaces with infiltration systems.

**resources:** See Action Item 1-10 for resources related to eliminating impervious surfaces.

Stormwater detention reduces stresses placed on combined sewer and stormwater systems after a rainfall that can result in the release of raw sewage into local water bodies. Heat absorbed by conventional roofing surfaces can amplify urban ambient temperatures, increasing energy use related to cooling buildings, and/or decreasing occupant comfort.

**how:** Green roofs require special architectural detailing and engineering to ensure durability and structural support. Extensive green roofs can represent additional roof loads of about 15 pounds per square foot, and must be engineered accordingly. Retrofitting an existing roof for a green roof application will likely require structural reinforcement for both roof load and building shear strength.

Green roof systems are best suited for low-slope roofs (a slope of 1:12 minimum slope; 4:12 maximum). Green roof systems are thicker than conventional roofs, often with the roofing insulation being applied above the roof deck.

This Action Item is worth 5-15 points.

- Existing roofs: 200-500sf earns 5 points, 5 points for each additional 250sf, max. 15 points.
- Green roof on addition: 200-750sf earns 5 points; 750sf or more earns 10 points.

Residential green roof design and installation is still relatively new in the Pacific Northwest, and requires structural engineering input to accommodate the load of a green roof, landscaping expertise for plant and growing medium selection, and roofing expertise

to specify and install the membrane. Look for roofing contractors with demonstrated experience in residential green roof installation. Accessing materials for a residential scale project may be a challenge; many green roof manufacturers warranty their products only for commercial projects.

**considerations:** Given the Puget Sound's dry late summer months, it may be necessary to irrigate a green roof even when extremely water-wise plants have been selected. Be aware of this potential water demand working at odds with the project's water conservation goals. According to a recent study by the Portland Bureau of Environmental Services, the economic benefit of green roofs is only realized over an extended time period (20-40 years, i.e., over the lifetime of the installation)—not accounting for public and environmental benefits.



Green roofs consist of multiple layers of material, each fulfilling specific functions. Existing roofs may require additional structural support to accommodate the added load. Benefits of green roofs include storm runoff reduction, extended roofing membrane lifespan, and cooler summertime roof temperatures.

Image: SvR Design, courtesy of City of Seattle.

## Action Item 1-12

**resources:** Greenroofs.com provides green roof information and resources, including a directory of green roof professionals and suppliers: [www.greenroofs.com](http://www.greenroofs.com)

Seattle Department of Planning and Development's Green Building Program maintains a green roof resource page: [www.seattle.gov/DPD/GreenBuilding/OurProgram/Resources/TechnicalBriefs/DPDS\\_009485.asp](http://www.seattle.gov/DPD/GreenBuilding/OurProgram/Resources/TechnicalBriefs/DPDS_009485.asp)

Portland, Oregon's Bureau of Environmental Services' *Ecoroof Handbook* and list of green roof resources: [www.portlandonline.com/bes/index.cfm?c=44422](http://www.portlandonline.com/bes/index.cfm?c=44422)

*Planting Green Roofs and Living Walls* by Nigel Dunnett and Noel Kingsbury (Timber Press: 2008).

## Action Item 1-12

Install a vegetated roof system of at least 200 sq. feet to reduce impervious surface (e.g. green roof)

### Points: 5-15

#### Responsible party:

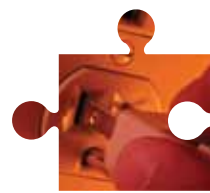
Architect, Structural Engineer, Landscape Architect

#### Intent:

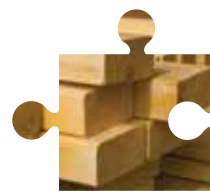
Reduce erosion and aquatic habitat damage associated with stormwater runoff; reduce Urban Heat Island effect and unwanted solar heat gain from roofing materials.



SITE/WATER



ENERGY



MATERIALS

**what:** More commonly used in Europe and on commercial buildings, green roofs are making headway in the US residential market due to their multiple environmental and aesthetic benefits. A green roof is an assemblage of elements: a synthetic waterproof membrane protecting the roof structure, a drainage layer, filter fabric and/

or a root barrier, a thin soil layer (usually 2-6") with specific plant species adapted to the extremes of a rooftop environment. Residential projects almost always utilize thinner soil depths (these are called "extensive" green roofs). Green roofs may be integral to the roof, or installed as modules.

**why:** Stormwater runoff can scour local creeks and waterways, damaging fish spawning habitat.



#### Homeowner Benefit:

Planted roofs capture and cleanse stormwater, reducing on-site and downstream damage related to runoff. In a recent study commissioned by the City of Seattle, a six inch deep green roof was able to capture well over 90% of the rainfall hitting it, on an annualized basis. Vegetated roof can also double the life expectancy of roofing membrane material.

## Action Item 1-13

Install strategies to move rainwater effectively away from foundation

### Points: 3

#### Responsible party:

Architect

#### Intent:

Enhance building durability and protect occupant health.



**what:** Keeping a foundation dry is a key element of healthy and durable building design. Proper drainage away from the foundation incorporates a mix of strategies, including grading, splash blocks, terraced conveyance furrows, and level spreaders.

**why:** Improperly graded sites can direct water toward a home's foundation, leading to flooding and moisture issues in basements, crawl spaces, or the interior of the home itself. Problems associated with improper grading and drainage include damage to the foundation, reduced durability of the home's structural elements, and indoor air quality issues related to mold.

**how:** The following requirements for discharging roof water are from the High Point Community Site Drainage Technical Manual, and serve as best practice for this credit:

- The ground shall have a minimum of 1% positive slope away from building foundations.
- An impervious surface or splash block sloped away from the building shall be installed at the base of each downspout.
- Water shall not flow or puddle adjacent to a building.
- Water shall flow for a minimum of 8 feet on private property on a porous surface prior to reaching the right-of-way.

- Erosion reduction strategies, such as a terraced conveyance furrow, shall be provided for slopes of more than 4:1 (25%).
- If runoff flows across a sidewalk, alley or right-of-way, it shall sheet flow and be spread at least two feet wide to avoid concentrated flows. Slopes of 8% or greater shall have a level spreader installed.

Descriptions and schematics of splash blocks, porous surfaces, conveyance furrows and level spreaders are included in the High Point Community Site Drainage Technical Manual (see Resources).

**considerations:** Proper drainage away from the foundation is part of a suite of strategies that help increase the durability of a structure and protect indoor air quality by reducing the likelihood of mold growth.

**resources:** High Point Community Site Drainage Technical Standards, by SvR Design Company for High Point Community includes information on site grading and drainage: [www.svrdesign.com/high\\_pt.html](http://www.svrdesign.com/high_pt.html) (scroll down to Additional High Point Resources).

Building Science Corporation Info Sheet 101: Groundwater Control: [www.buildingscience.com](http://www.buildingscience.com) (search for Info-101).



**what:** A roof's pitch has an impact on its ability to shed water, with steeper slopes quickly moving water off a structure to where it can be safely managed.

**why:** Properly pitched roofs allow for quick removal of water from the roof—a key element in extending roofing material durability and durability of the structure overall. Low-sloped roofs are notorious for leaks and high maintenance costs. Leaks often go unnoticed until significant damage has been done, resulting in costly fixes.

**how:** To achieve this credit, roofs must be pitched at least 3:12.

**considerations:** If considering a green roof, the slope recommendations in this credit do not apply. Additionally, steeply sloped roofs can present a maintenance and safety challenge. Consider installing stanchions for safety harnesses on steeply pitched roofs. Roof slopes should also be integrated with other strategies, such as proper flashing of all roof penetrations and eaves of sufficient depth to keep windows and walls dry (24" is a commonly referenced ideal eave depth). Deep eaves allow for proper shading of south-facing windows in homes that incorporate passive solar design as well.

If considering a new roof system, consider incorporating energy heels (Action Item 4-1), or using Structural Insulated Panels (Action Item 6-2). When designing a roof, consider the size of overhangs for both durability (Action Item 1-35) and passive solar design (Action Item 1-23).

**resources:** Building Science Corporation Digest 115: "Wood Pitched Roof Construction:" [www.buildingscience.com](http://www.buildingscience.com) (search for *BSD-115*).

## Action Item 1-14

New roofs are pitched properly

### Points: 1

#### Responsible party:

Architect

#### Intent:

Enhance building durability and protect occupant health.



#### Homeowner Benefit:

Effectively conveying stormwater away from the home's foundation helps reduce the risk of structural damage related to wet basements and crawl spaces, and protects indoor air quality by reducing the likelihood of mold and rot in the home.



#### Homeowner Benefit:

Proper pitching of roofs allows for quick drainage of rain away from the building, enhancing durability of roofing material, the roof structure, and the home itself. It also reduces the likelihood of leaks, which protects the durability of the structure and indoor air quality, by reducing unwanted moisture in the home.

## Action Item 1-15

No copper on external structure of building

### Points: 1

**Responsible party:**  
Architect

**Intent:**

Protect water quality and aquatic species.



SITE/WATER

**what:** Copper architectural elements include gutter systems, flashing, and decorative embellishments. Additionally, asphalt composite roofing can contain copper for moss and algae prevention.

**why:** Copper is extremely toxic to aquatic life. Some jurisdictions adjacent to water bodies have

banned the use of architectural copper altogether.

**how:** Eliminating copper elements can actually reduce a project's budget. Look for alternatives that are benign to aquatic life, including steel with baked-on (powder coated) finishes, aluminum, and stainless steel. Note that zinc, used in galvanized metal products, is also toxic to marine life.



### Homeowner Benefit:

Avoiding copper on the exterior of a building or in the landscape helps protect water quality both on and offsite.

## Action Item 1-16

Home performance test prior to initiation of construction

### Points: 5

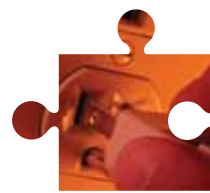
**Responsible party:**  
Architect, Contractor

**Intent:**

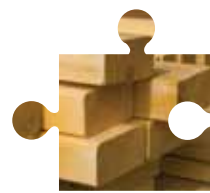
Establish baseline performance; identify areas of focus for energy efficiency improvements.



SITE/WATER



ENERGY



MATERIALS

**what:** A home performance test evaluates the current energy performance of a home in terms of insulation value, airtightness, and other factors related to a home's energy efficiency. Home performance tests usually employ a series of diagnostic tools, including blower door tests (see Action Item 10-11), duct leakage tests

(see Action Item 3-7) and visual inspection of attics, crawl spaces and walls to determine insulation quantity and quality.

**why:** Performance testing helps establish a baseline of the home's energy use, providing a reference point for additional energy improvements. It is also invaluable in identifying major areas for energy improvement that are not evident from a cursory look at the



### Homeowner Benefit:

A home performance test helps identify and prioritize energy efficiency actions most relevant for a home, helping create a strategic plan for improvements that will have the most impact.

home, such as unusual sources of air leakage, leaky or poorly sealed ductwork, or improperly installed or missing insulation.

**how:** Home performance tests are usually conducted by a party external to the remodeling company performing the rest of the work on the home. Look for home performance contractors with applied experience in the field and accreditation in the area of energy performance, e.g., HERS (Home Energy Rating System) qualified staff. Also inquire about a home performance contractor's familiarity with building science concepts to ensure they understand the interaction of energy loss, moisture issues and ventilation. Look for home performance contractors through associations such as Home Performance Washington or the Northwest EcoBuilding Guild, via the home's natural gas or electric utility's conservation services, BUILT GREEN verifiers, or academic programs like Washington State University Energy Extension.

**considerations:** Information from a home performance test should be cross-referenced with information from the comprehensive site audit (Action Item 1-1) and the comprehensive water audit (Action Item 1-2). Considering site, water and energy issues together can help ensure opportunities are captured and obstacles identified and removed.

**resources:** See Action Item 10-11 for information on performing an additional blower door test during construction to verify airtightness strategies have been correctly employed.

## Action Item 1-16

Home Performance Washington provides a list of home performance service providers:  
[www.homeperformancewashington.org](http://www.homeperformancewashington.org)

WSU Energy Extension:  
[www.energy.wsu.edu/code/](http://www.energy.wsu.edu/code/)

Northwest EcoBuilding Guild:  
[www.ecobuilding.org](http://www.ecobuilding.org)



*Blower door tests are a key component of a home performance test. A blower door creates a specified pressure differential between the home and outside, creating a determination of the home's leakiness (described in air changes per hour). Blower door tests also help identify specific leaks that likely would go unnoticed with a visual inspection.*

*Image: Jon Alexander, Sunshine Construction.*

## Action Item 1-17

Model energy improvements beyond code and a reduction in space conditioning energy using approved modeling software

**Points: 10-40**

**Responsible party:**

Architect

**Intent:**

Demonstrate compliance with stated energy conservation goals.



**what:** Residential energy modeling software estimates the energy use of a home design, allowing the user to observe the energy use effect of different designs and efficiency strategies. Depending on the software, the models can include factors such as passive solar gain, renewable energy systems, e.g., photovoltaics, and landscape shading. By comparing the proposed design changes to a reference home (or the existing home), an energy modeling software can estimate energy efficiency improvements.

**why:** Modeling software can be a powerful tool to strategize energy improvements on a home. By giving quick feedback on the energy efficiency effect of different design and system choices, software can help winnow down the universe of design options to the most effective approaches. Additionally, modeling software gives a common yardstick against which to measure design alternatives. For projects that are using advanced passive solar design approaches that require large amounts of glazing, for example, energy modeling provides an alternative to the component-based code compliance pathway, providing more design flexibility.

**how:** Residential energy modeling can be done in-house by an architect or builder, or subcontracted to a firm specializing in energy modeling. Often designers specializing in passive solar design are well versed in energy modeling software. Many home performance contractors (see Resources) utilize energy modeling software to generate a home's energy performance score. Some BUILT GREEN Verifiers also can provide energy modeling.

This Action Item is worth 10-40 points.

Improvement	Points
• 10-19%	10
• 20-29%	15
• 30-39%	20
• 40-49%	25
• 50-59%	30
• 60-69%	35
• 70%+	40

To achieve credit, document the home's percent improvement over baseline using approved energy efficiency software such as ENERGY-10, REM/Rate, EnergyGauge, or TREAT. See Action Item 1-24 for a list of energy modeling software.

When evaluating the baseline case for comparison, the size and complexity of a remodel will dictate the appropriate code-minimum values that apply. For older homes that do not meet current energy codes, energy efficiency upgrades may require extensive envelope improvements to achieve insulation values. Taking time to research and evaluate energy efficiency upgrades most appropriate for each remodel project (i.e. added insulation, higher efficiency windows or heating system, or passive solar design features) will likely result in the highest return on investment.

**resources:**

Home Performance Washington: [www.homeperformancewashington.org](http://www.homeperformancewashington.org)

Find the BUILT GREEN Verifier list at [www.builtgreen.net](http://www.builtgreen.net).

See Action Item 1-24 for links to sources of energy modeling software.



**what:** A variety of airtight building methods exist, including Structural Insulated Panels (SIPs), Insulated Concrete Forms (ICFs), and straw bale construction.

SIPs consist of expanded polystyrene sandwiched between two sheets of OSB or plywood. SIPs are manufactured to specification offsite, and the panels are delivered to the site for assembly. The panels are caulked or glued and fastened together. Along with achieving high levels of airtightness, SIPs also exhibit superior shear strength and have very uniform insulation value, in contrast to insulation approaches such as batt insulation.

Insulated concrete forms (ICFs) fall into two major categories. One version uses an expanded polystyrene outer component that acts as a form during the pour stage. The other form uses insulating materials mixed into a cement binder to create the blocks. Examples of the latter include Durisol and Rastra. Like the polystyrene versions, the blocks act as the form to hold concrete. With training, a standard construction crew can install ICFs.

Straw bale construction uses continuous layers of stucco or plaster on the bales to create an airtight barrier. Straw bale falls into the subcategory of green building often called "natural building." It uses natural, low-cost, low embodied energy materials.

**why:** Airtight building methods help increase occupant comfort and satisfaction by lowering energy bills, reducing drafts and air quality complaints, and reducing contractor callbacks related to moisture issues.

Each airtight building method has its own set of best practices and construction details. If subcontracting out the work, identify contractors with experience in the specific approach selected; many contractors focus on one specific building method and may not have expertise in others. See Resources for information on specific airtight construction techniques.

**considerations:** See Action Item 11-1 for an alternative to the structurally based airtight building methods. When tightening up homes, install mechanical ventilation to ensure good indoor air quality. Experts recommend the provision of make-up air (Action Item 7-22) if a home achieves 7 air changes per hour (ACH) or less using a blower door test (see Action Item 10-11), or a Heat Recovery Ventilator (Action Item 7-14) for homes achieving 3 ACH or less.

**resources:**

ToolBase technical information on SIPs: [www.toolbase.org](http://www.toolbase.org) (click on *Building Systems*, then *Whole-House Systems*).

Structural Insulated Panel Association: [www.sips.org](http://www.sips.org)

ToolBase technical information on ICFs: [www.toolbase.org](http://www.toolbase.org) (click on *Building Systems*, then *Exterior Walls*).

Insulating Concrete Form Association: [www.forms.org](http://www.forms.org)

ToolBase technical information on straw bale construction: [www.toolbase.org](http://www.toolbase.org) (click on *Building Systems*, then *Whole-House Systems*).

*The Straw Bale House* by Steen, Bainbridge and Eisenberg (Chelsea Green Publishers, 1996).

## Action Item 1-18

Use airtight building method, such as SIP, ICF, or straw bale

**Points: 3**

**Responsible party:**

Architect

**Intent:**

Reduce energy loss and indoor air quality issues related to air leaks and unwanted air infiltration



**Homeowner Benefit:**

Energy modeling helps confirm design decisions and provide an estimation of total building energy savings based on energy conservation measures selected. This can result in more certainty around strategic decisions, and a higher likelihood that energy conservation goals are met—reducing energy bills.



**Homeowner Benefit:**

Reduced air infiltration provided by airtight building methods helps conserve energy by keeping heat (or cooling) in the home. It also helps protect indoor air quality by reducing the entry of moisture or stale, moldy air from crawl spaces, attics, and other unheated spaces outside the building envelope.

## Action Item 1-19

Do not install skylights

### Points: 2

#### Responsible party:

Architect

#### Intent:

Reduce building energy loss by increasing the insulating value of the home's thermal envelope.



**what:** Conventional skylights are essentially windows on the roof; while they admit light (which is beneficial for reducing daytime lighting demand) they also compromise the energy efficiency of the home's thermal envelope. A typical skylight has a U-value of 0.4 (or an R-value of 2.5). A roof insulated to BUILT GREEN standards has an R-value of 40.

**why:** Maximizing the efficiency of a home's thermal envelope is probably the single most important step in reducing a home's energy bills and carbon footprint. Even ENERGY STAR skylights are substantially less efficient than an equivalent amount of insulated roof, and represent far more energy used in terms of heat loss than energy gained from offsetting electric lighting needs. Additionally, any penetrations in a home's exterior increase the likelihood of air infiltration (energy loss) and leaks.

**how:** Discuss alternatives to skylights with the homeowner and determine if other, more energy-efficient daylighting methods will work. Strategically placed windows, light shelves, opening interior spaces, using relites (interior windows), and even light-colored interior paint, flooring and finish choices are options to explore.

#### considerations:

Evaluate hiring a lighting designer experienced in daylighting design to identify the ideal lighting scenario for the home. Always keep in mind potential tradeoffs in energy efficiency and daylighting strategies, while also recognizing the health and wellbeing benefits of access to natural light.

If daylight is desired in windowless interior spaces, such as hallways, consider using light tubes (Action Item 1-22) instead.



**what:** On a remodel project, the location of the HVAC system is usually dictated by the existing design, especially duct layout. Centrally locating the system entails identifying the spot in the home where the ductwork or other distribution elements will be shortest and straightest.

**why:** Heating and cooling distribution energy losses can be significant, and are related to the length and complexity of the distribution system, as well as whether the system is well sealed and located within the home's thermal envelope.

**how:** Locate the HVAC equipment such that ductwork, piping, or other distribution lines are minimized both in length and complexity. For forced air systems, short, straight runs deliver conditioned air to spaces most efficiently and with the least amount of energy lost during distribution. Smooth ductwork (see Action Item 2-4) delivers air more efficiently than textured or flexible, accordion-style ductwork. For ductless heating systems such as hydronic systems, locate water heating equipment to minimize piping runs.

**considerations:** In the Pacific Northwest, homes designed for sun tempering and natural cooling in the summer can avoid mechanical cooling altogether (see Action Item 7-6), resulting in significant up-front cost savings. Non-ducted heating and cooling systems substantially reduce distribution-related energy losses.

Increasing insulation levels on existing ductwork (Action Item 7-19) and performing advanced sealing of ductwork (Action Item 7-20), or installing ductwork within the home's thermal envelope (Action Item 7-1) all help increase the distribution efficiency of a heating/cooling system.

#### resources:

US Department of Energy Technology Fact Sheet: "Air Distribution System Design: Good Duct Design Increases Efficiency:" [www.toolbase.org](http://www.toolbase.org) (click on *Design and Construction Guides*, then *Heating, Ventilating and Air Conditioning*).

## Action Item 1-20

Centrally locate heating / cooling system to reduce the size of the distribution system

### Points: 1

#### Responsible party:

HVAC, Architect

#### Intent:

Reduce system energy losses; create a more efficient home; reduce home's carbon footprint.



#### Homeowner Benefit:

Eliminating skylights from the remodel design can help reduce energy bills related to heating and cooling. Additionally, eliminating skylights greatly reduces the likelihood of roof leaks and associated moisture issues and potential structural damage.



#### Homeowner Benefit:

An efficiently designed heating/cooling system means less energy wasted in the distribution process, saving money on utility bills and reducing the home's carbon footprint. Efficiently designed, well-insulated heating distribution systems can save up to 30% of the energy used by a heating/cooling system.

## Action Item 1-21

Use clerestory for natural lighting in addition/remodel

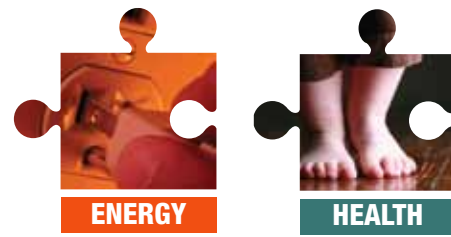
### Points: 2

#### Responsible party:

Architect

#### Intent:

Reduce electric lighting load; enhance indoor environmental quality.



**what:** A clerestory is a long band of (usually short) windows placed high in a space, designed to admit natural light without compromising privacy.

**why:** Access to natural light has human health and comfort benefits, as well as reducing the need for daytime artificial lighting. Also in closely situated urban sites, clerestories help preserve privacy while still providing connection to the outdoors. If properly designed, a clerestory can be part of a home's natural ventilation strategy.

**how:** Including a clerestory in an existing home can be a challenge as it often entails changing the roofline. If a home is considering a second-story addition, green roof, or other roofing modification, however, a clerestory component may be added for minimal cost.

As with any window, select for energy efficiency. North-facing clerestory windows admit even, natural light throughout the day without creating unwanted heat gain and glare. East- and west-facing clerestories will be difficult to shade to avoid heat gain without exterior vertical shading devices. Southern clerestories can be designed with

overhangs that block summer sun but admit winter warmth.

**considerations:** Design also for passive ventilation, taking advantage of the “stack effect” (natural air movement created by warm air rising), and placing other operable windows in locations that capture prevailing breezes (see Action Item 1-43). See Action Item 5-1 for details on selecting energy efficient, orientation-appropriate windows.

Clerestories may be beneficial for admitting natural light into a space, but may not be the ideal solution for passive solar designs (see Action Item 1-23) that require sunlight striking a thermal mass for heat storage. Consult with a passive solar design expert to make the most of fenestration choices if passive solar design is a project goal.

**resources:** The Efficient Windows Collaborative provides window selection information: [www.efficientwindows.org](http://www.efficientwindows.org)

*The Lighting Pattern Book for Homes* by Russell Leslie and Kathryn Conway: [www.lrc.rpi.edu/patternBook.asp?id=13306](http://www.lrc.rpi.edu/patternBook.asp?id=13306)



Clerestory windows allow for natural light without compromising privacy.

Image: Nelse Design + Build.

## Action Item 1-22

Use light tubes for natural lighting and to reduce electric lighting

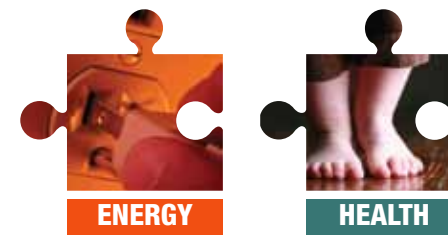
### Points: 2

#### Responsible party:

Architect

#### Intent:

Reduce electric lighting load; enhance indoor environmental quality.



**what:** A light tube (also called a tubular skylight) is an alternative to a conventional skylight. Basic components include a clear plastic dome on the roof that admits sunlight; a reflective tube that carries light down into the home; and a ceiling mounted diffuser that distributes light into the space. Also available are light tube options with a vent (for bathrooms) or recessed can (for illumination at night).

**why:** Light tubes are effective at transmitting light, generally do not suffer condensation problems, and when compared to conventional skylights, allow less heat loss during winter and less unwanted heat gain in summer. They also provide significant location flexibility and are fairly easy to install.

**how:** Light tubes are commonly available from building materials retailers, although some models may require special ordering. Light tubes must be insulated and air sealed to avoid substantial heating energy losses. Light tubes are available with supplemental compact fluorescent lighting, allowing the fixture to provide artificial light when natural light is unavailable. In rooms where it's important to have the ability to control daylight (entertainment rooms, bedrooms), light tubes are available with integrated shading devices.

Light tubes must be properly flashed, air sealed and insulated. Like skylights, light tubes are prone to air leaks, water leaks, and energy losses. Most light tubes are made of metal and come without insulation; in order to qualify for this Action Item, the light tubes must be insulated (minimum R-8 duct insulation works well), and wrapped with an air barrier.

**considerations:** While offering energy benefits over standard skylights, light tubes are still penetrations in the roof, meaning the chance of leaks down the road, and offer less insulation value than solid roof. See Action Item 1-19, for more information on avoiding skylights altogether.

#### resources:

The ToolBase Technology Inventory includes tubular skylights: [www.toolbase.org](http://www.toolbase.org) (click on *Technology Inventory*)

The ENERGY STAR program lists qualified light tubes (ENERGY STAR uses the terminology “tubular daylighting device”): [www.energystar.gov](http://www.energystar.gov) (click on *Products*, then *Windows, Doors, and Skylights*).



#### Homeowner Benefit:

Light tubes provide natural light with a smaller energy penalty than standard skylights, resulting in reduced energy bills compared to the same home with skylights. Additionally, light tubes can be installed between existing roof joists, often without structural modification--meaning reduced installation cost and more design flexibility.



## Action Item 1-23

Include passive solar design features

### Points: 5

#### Responsible party:

Architect

#### Intent:

Reduce overall energy demand and carbon footprint of home; capture on-site resources.



**what:** Passive solar design harnesses a site's incident solar energy to reduce heating loads during the winter without adding to cooling needs during the summer months. Passive solar design employs a diverse mix of strategies, including strategic window placement, thermal mass, and devices to capture and hold heat during the heating season, and shade during the summer months.

**why:** Passive solar design is a critical component of designing low energy use buildings. By harnessing existing site solar resources, a design can reduce heating and cooling needs in the Pacific Northwest by up to 30%.

Additionally, understanding the mechanics of passive solar design avoids creating spaces that are uncomfortable for occupants—either seasonally too cold or hot. Communicating to a client that large west-facing windows will create an uncomfortably hot home in the summer, for example, will help manage client expectations and avoid complaints down the road.

**how:** For remodelers new to passive solar design, consider hiring a building designer or architect with demonstrated experience designing passive solar homes in the Pacific Northwest. Passive solar design software may also be employed to assist with design; see Action Item 1-24.

This Action Item is worth 6 or 12 points.

- 3-5 strategies employed: 6 points
- 6+ strategies employed: 12 points

Projects must select strategies from the list below, and provide a written description of the measures and their expected energy benefit.

Passive solar design strategies:

- Orient the majority of the building's glazing within 22 degrees of due south and provide it with unobstructed sun access during the heating months. Due south can be located with a compass, correcting for magnetic north, which is 21 to 22 degrees East in the Puget Sound area.
- On southern exposure windows, select glazing with a high Solar Heat Gain Coefficient (SHGC), to admit maximum heat. To prevent overheating, window glass on the south side of the building should not exceed 8% of the floor area. However, window area can be increased significantly (and solar performance enhanced) if there is accessible thermal mass in the space to absorb excess heat, and if windows are properly shaded. On a remodel, this may mean expanding existing south facing windows.
- On eastern and western exposure windows, select low SHGC windows. Windows with specially coated or tinted glazing reduce the window's solar heat gain coefficient (SHGC). They block the heat gain without rejecting too much visible light. For comparison, standard clear glass has a SHGC of 0.85. Special coatings/tinting can produce windows with SHGC down to 0.38, depending upon the treatment. These can be especially useful if the home has an attractive view to the West. On east and west windows, use

glazing with SHGC less than 0.40 and/or provide natural shading with landscaping.

- Install minimal windows to the north. A passive solar design home should have no more than 10% of total window area on the north side of the home. Purchase the most energy efficient windows practicable as well, to reduce energy loss. On a remodel, this may mean decommissioning or downsizing north facing windows, and insulating the resulting solid wall area.
- Provide overhangs for summer shading on south windows. Building components that add mass to the home include concrete floors, tile, extra dry-wall, and to some extent, wood flooring. Passive solar design experts and energy modeling software can help inform massing decisions.
- Install exterior vertical and landscape shading for east and west facing windows. East and west shading strategies help protect against overheating the home—exterior vertical shading devices, such as rollup exterior blinds, are the most effective, along with deciduous trees and other landscaping.
- Using thermal mass for heat storage. When employing more than 8% (with respect to floor area) south facing glazing area, it is imperative to include thermal mass to avoid creating excessive temperature swings. Size thermal mass based on passive solar design software (see below).
- Use solar design modeling software. Residential energy modeling software is key to determining optimal window

placement and sizing, shading, and thermal mass approaches. See Resources for software that helps optimize passive solar design strategies. See Action Item 1-24 for more information on solar design modeling software.

**considerations:** Passive solar design involves careful consideration of elements both inside and outside the home and a variety of Action Items within BUILT GREEN, including tree planting and preservation, landscaping, skylights, clerestory windows, and access to natural light.

Employing advanced passive solar techniques on a home requires detailed understanding of passive solar design concepts. If performed correctly, however, the strategies can realize major energy use reductions. Possessing the skill set to employ these strategies is a substantial service to offer clients, both in terms of design expertise and technical knowledge. Properly executed, an advanced passive solar design will result in satisfied clients and positive word-of-mouth.

Good passive solar design requires a substantial skill set and applied experience. Seek input from a solar design consultant, and review literature on the subject (see Resources) and in-person training opportunities.

Advanced passive solar design features may include specifically sizing windows to maximize solar benefit, designing thermal mass correctly to correlate with window design, and providing exterior horizontal shading to the south and vertical shading to the east and west.

## Action Item 1-23

Beyond design knowledge, passive solar design is best achieved by using energy modeling software to refine and identify optimal designs (see Action Item 1-24). It is best to document a reduction in total space conditioning for heating and cooling. Then, demonstrate how the home will stay within reasonable temperature range.

**resources:** The Department of Energy Technology Fact Sheet "Passive Solar Design" provides the basic concepts underpinning passive solar: [www.toolbase.org](http://www.toolbase.org) (click on *Home Building Topics*, then *Energy Efficiency*, then *Passive Solar Design* under *Design and Construction Guides*)

The Department of Energy Energy Savers program provides good general information for consumers on passive solar design: [www.energysavers.gov](http://www.energysavers.gov) (click on *Designing and Remodeling*, then *Passive Solar Homes*).

Solar Washington: [www.solarwashington.org](http://www.solarwashington.org)

Sustainable by Design maintains a shareware tool for calculating overhang sizes for passive solar applications: [www.susdesign.com/sunangle/](http://www.susdesign.com/sunangle/)

*The Solar House: Passive Heating and Cooling* by Daniel Chiras (Chelsea Green Publishing: 2002).

*The Passive Solar Design and Construction Handbook* by Steven Winter Associates (Wiley: 1997).



### Homeowner Benefit:

Proper use of passive solar design strategies means free energy for the home, reducing heating bills—all without mechanical systems.

## Action Item 1-24

Model solar design features using approved modeling software

### Points: 3

#### Responsible party:

Architect

#### Intent:

Enhance certainty of design success; help a designer identify effective solar design features for a project, thereby reducing a home's energy use.



ENERGY

SITE/WATER

**what:** Energy modeling software uses input data on building size, form, orientation and other factors to produce an estimate of the home's energy use intensity.

Available from a variety of sources, modeling programs incorporate region-specific solar data to further refine the model's outputs.

**why:** Energy modeling software helps determine the effectiveness of incorporating various strategies on a project. Consider hiring a design or consulting firm with expertise in performing energy modeling on residential structures if the skill set does not exist in-house.

**how:** See the Resources Section for a list of approved modeling software or consult the BUILT GREEN Program Director if the project wishes to use software not included on the list.

**considerations:** See Action Item 1-23 for passive solar design strategies.

#### resources:

Residential Energy Modeling Software

ENERGY-10. Evaluates residential energy conservation measures, and analyzes energy savings by design element and installed measures. The software has the ability to model daylighting, passive solar design, and photovoltaic system energy impacts. Available from the Sustainable Buildings Industry Council:

[www.sbicouncil.org](http://www.sbicouncil.org) (click on Energy-10).

REM/Rate. Residential energy analysis developed specifically for HERS Raters. From Architectural Energy Corporation: [www.archenergy.com](http://www.archenergy.com) (click on Products).

EnergyGauge USA. Analysis using DOE 2.1E as a base, with enhancements to simulate duct leakage and other factors. Developed by the University of Central Florida: [www.energygauge.com/usares/default.htm](http://www.energygauge.com/usares/default.htm)

TREAT. Allows for hourly energy use simulation; used in weatherization programs and other home energy improvement activities. From Performance Systems Development Consulting: [www.treatsoftware.psdconsulting.com/](http://www.treatsoftware.psdconsulting.com/)

The Department of Energy maintains a building energy software tools directory: [www.apps1.eere.energy.gov/buildings/tools\\_directory/](http://www.apps1.eere.energy.gov/buildings/tools_directory/)



ENERGY

SITE/WATER

**what:** Landscape design aimed to reduce a home's energy load includes a series of strategies related to blocking unwanted solar gain and channeling summer breezes while blocking winter winds. Additionally, it includes hardscaping choices that reduce the accumulation of summertime heat and capture winter warmth.

**why:** Energy-conscious landscaping and building design can result in reduced operational costs for the homeowner, greater comfort, and less energy use.

According to the U.S. Forest Service, a single mature tree provides more than \$70 worth of air conditioning annually. Meanwhile, a well-placed windbreak of evergreens can reduce a building's heating bill by up to 20%.

**how:** Work closely with the landscape architect (if applicable) to ensure that landscape plans mesh with passive solar design objectives for the home. A comprehensive site assessment (Action Item 1-1) is a good way to ensure all site elements are considered together to avoid unintended tradeoffs.

Examples of energy saving design:

- Plantings on the east and northeast to filter the sun without blocking the light.
- Deciduous plantings on the south to create shade and channel breezes in summer without obstructing sun in winter.

- Mid-range colored materials for driveways, walkways, and parking spaces to reflect sun in summer and to absorb and re-radiate heat in winter.
- Paved areas located away from south windows and shaded with plantings.

**considerations:** Some energy modeling software (see Action Item 1-24) programs incorporate landscape shading into the modeling analysis, allowing a designer to see the effect of building and landscape elements on home energy performance. Natural vegetation can also provide aesthetic benefit, erosion and stormwater control, shelter for wildlife, and sound absorption. See Action Items 3-4 for more on preserving existing vegetation, and 1-4 for more on retaining trees on site. Make sure trees and other foliage are kept clear of the home (12-24") to avoid moisture and pest problems, and that the site is graded to drain water away from the home (Action Item 3-12).

**resources:** The Department of Energy Energy Savers website includes information on landscaping for energy efficiency: [www.energysavers.gov](http://www.energysavers.gov) (click on *Landscaping*).

## Action Item 1-25

Use building and landscaping plans that reduce heating/cooling loads naturally

### Points: 3

#### Responsible party:

Architect, Landscape Architect

#### Intent:

Reduce overall energy demand of home; capture on-site resources by employing climate-responsive design strategies to the home and landscape.



#### Homeowner Benefit:

Energy modeling software can speed the design process, quickly winnowing down design alternatives and identifying best approaches. Outputs from modeling software can help the homeowner see the benefits and tradeoffs of different design scenarios, assisting in decision making.



#### Homeowner Benefit:

Strategically placed and selected landscape elements can reduce both heating and cooling requirements for a home, saving on utility bills, enhancing indoor and outdoor comfort, and providing visual appeal. If selected with other environmental functions in mind, the same landscape elements can protect local aquatic habitats and reduce the risk of moisture damage and flooding, both on- and off-site.

## Action Item 1-26

Solar water heating system sized to provide a minimum of 40% hot water designed energy use

### Points: 10

#### Responsible party:

Architect

#### Intent:

Capture onsite energy resources; reduce overall energy demand of home; reduce home's carbon footprint.



#### Homeowner Benefit:

Solar water heaters capture free energy delivered to your home and put it to productive use. Well-designed systems can halve a home's energy use related to water heating. With a moderate time frame for payback (7-10 years), solar water heating is one of the most cost-effective site specific renewable energy strategies.



ENERGY

**what:** Solar water heating systems harness the sun's energy and convert it to hot water for domestic uses. Depending on the system, uses include domestic hot water, space heating, or both. Several types of systems exist including batch heaters, flat plate collectors, and evacuated tube collectors.

Batch heaters were among the earliest designs for solar water heaters, and consist essentially of a dark-colored drum filled with water housed in a glazed box. Sunlight warms the drum and its contents, which is circulated into the home for use.

Flat-plate collectors are more efficient than batch collectors; these systems consist of a thin-profile glazed box containing tubing welded to heat-transferring metal fins. Water or a heat transfer fluid is run through the tubing, and as sunlight strikes the surface of the tubing and fins, the fluid is heated.

In evacuated-tube collectors, tubes and fins are placed in a vacuum-sealed tube, eliminating convective heat loss and increasing the efficiency of the system once again. In all systems the heated fluid is pumped or convectively circulated to a storage tank for direct use in the home or transferred to water via a heat exchanger.

**why:** Solar water heating systems can meet a good portion of a home's domestic hot water needs—particularly in the sunny months. Geographic location, system design, collector orientation, and collector size will determine how much energy can be provided for domestic water heating. A solar

water heating system may result in immediate positive cash flow if the monthly cost of financing the system is less than the net savings. Limitations include the need for regular maintenance, a relatively high initial cost, and a long payback period (although this payback is substantially shorter than solar electric, even with current financial incentives). Lastly, there is potential for freezing with systems that directly heat potable water in the collector (most common in batch heaters, but also in some flat plate collectors).

**how:** To receive points for this Action Item, the solar water heating system must be sized to provide a minimum of 40% of the home's designed hot water use.

A solar water heating contractor can provide the expertise needed to correctly estimate the system size needed for a specific property. Estimate hot water use after the installation of water saving technologies and products, and cross-reference this with the annual average provided by the proposed system. Solar hot water systems can provide 100% of a home's hot water needs during the summer, but substantially less in winter due to the Pacific Northwest's short, cloudy winter days. A backup conventional water heater is still necessary to supply hot water to the home when the solar heating system is unable to meet the demand.

Check local building codes to determine requirements related to the installation of solar water heaters. Specify systems certified by the Solar Ratings and Certification Corporation (see Resources).

**considerations:** To maximize the investment in solar water heating, reducing hot water demand within the home is an important first step. See Action Items 8-9, 8-10 and 8-11 for low-flow kitchen and lavatory faucets and showerheads. Additionally, consider the hot water system's distribution efficiency, including pipe diameter (Action Item 8-26) and water heater location (Action Item 8-14).

When considering solar hot water for space heating, be sure to design the system holistically. Systems sized for winter demand can be grossly oversized for summer hot water demands.

#### resources:

ToolBase maintains a useful fact sheet on solar water heating, including rules of thumb for sizing systems:  
[www.toolbase.org](http://www.toolbase.org)  
 (click on *Design and Construction Guides*, then *Solar Water Heating*)

Solar Washington maintains a list of professionals that design and install solar electric and solar hot water systems:  
[www.solarwashington.org](http://www.solarwashington.org)

The Solar Ratings and Certification Corporation establishes performance standards for solar water and pool heating systems:  
[www.solar-rating.org](http://www.solar-rating.org)

*A Homebuilder's Guide to Going Solar* by the US Dept. of Energy's Office of Energy Efficiency and Renewable Energy (2008). Available as a free PDF download from [www.eere.energy.gov](http://www.eere.energy.gov) (click on Find Publications and Products). This guide provides an

## Action Item 1-26

overview of the design, construction and marketing considerations when adding solar electric and solar hot water features to a home.



Evacuated tube solar collectors.

Image: George Ostrow, VELOCIPEDA architects inc



Flat plate solar collectors.

Image: Jim Burton, blip designlab.

## Action Item 1-27

House powered  
by photovoltaics

**Points: 5-25**

**Responsible party:**

Architect

**Intent:**

Capture onsite energy resources; reduce overall energy demand of home; reduce home's carbon footprint.



**what:** Photovoltaic (PV) modules convert sunlight directly into electricity. PV modules can be integrated into roofing materials (called Building Integrated PV), or mounted as arrays on rooftop racks or on poles in areas with unobstructed solar access.

PV systems can be either grid tied, where the municipal electric grid receives the power generated by the system and the power meter spins backward when the system produces more power than is being consumed by the home, or they can be “off-grid” where energy produced is used to charge a battery bank. In Washington, renewable energy production incentives are available only for grid tied systems. Additionally, grid tied systems obviate the need for expensive battery storage.

Solar cells, components of a PV array, come in three major varieties: monocrystalline, polycrystalline, and thin-film. Monocrystalline solar cells are manufactured from a single crystal of silicon. Polycrystalline cells are constructed from multiple crystals. Thin-film cells use nano-scale photoreactive materials applied to a substrate. Each type varies in cost and efficiency of power production.

**why:** Producing power with a PV array benefits the homeowner by providing onsite power, and benefits the environment by reducing society's reliance on fossil, carbon-intensive fuels. In the Pacific Northwest, photovoltaic power has an additional benefit: with much of our power supply coming from hydroelectric sources, PV-based power represents a complementary power source that is most produc-

tive when our hydro sources are stretched thinnest during the dry sunny months.

**how:** For the remodeling professional, installation of PV systems represents a specialized service offering that can help round out a firm's skill set, and show prospective clients that the firm possesses specific knowledge related to green building.

This Action Item is worth 5-25 points.

- 0.5-1kW 5 points
- 1kW-.9kW 10 points
- 2kW-2.9kW 15 points
- 3kW-3.9kW 20 points
- 4kW + 25 points

The cost for PV installations is dropping as demand for residential solar systems increases and new technologies emerge. For homes not in proximity of existing electric power lines, PV systems may be less costly than extending power lines to the home. Unlike fossil-fuel generators, PV systems operate silently and require little maintenance.

A variety of financial incentives are available for PV systems. Be sure to account for federal tax credits, the Washington State sales tax exemption, and the Washington State renewable energy incentive program when determining the costs and paybacks of a PV system on a house.

Examine a site's suitability for PV in terms of available roof space, roof orientation, and potential shading caused by existing or future neighboring buildings or trees. Even modest shading of a PV panel can dramatically reduce output.

A common theme in green building is “reduce, then produce.” This refers to the fact that conservation activities almost always equate to a cheaper and faster payback than technologies that generate resources (in this case, energy). PV tends to be a highly visible, and therefore sexy, component of green building. PV systems only make sense where extensive effort has been made to reduce a home's energy demand. Educate clients about the benefits of starting with energy conservation activities, such as upgrades to insulation, windows, and appliances and air sealing activities prior to embarking on the quest for renewable energy.

**considerations:** All of the energy conserving Action Items in the BUILT GREEN checklist (and many of the water conservation and landscape-related items as well) help reduce a home's energy use intensity, which in turn results in a smaller (and less costly) PV system.

**resources:**

Solar Washington is the Washington State chapter of the American Solar Energy Society:  
[www.solarwashington.org](http://www.solarwashington.org)  
The Solar Washington membership includes virtually all photovoltaic and solar contractors in Washington.

The Department of Energy's Energy Savers provides consumer information on PV:

[www.energysavers.gov](http://www.energysavers.gov)  
(click on *Electricity*, then *Make Your Own Clean Electricity*).

*A Homebuilder's Guide to Going Solar* by the US Dept. of Energy's Office of Energy Efficiency and Renewable Energy (2008). This guide provides an overview of the design, construction and marketing considerations when adding solar electric and solar hot water features to a home:  
[www.eere.energy.gov](http://www.eere.energy.gov)  
(click on *Find Publications and Products*)



*Well-designed photovoltaic systems become part of the home's overall aesthetic. In this remodel, the photovoltaic array is prominently displayed on the roof to signal the owners' commitment to sustainability, while also optimizing solar access for the panels.*

*Image: Benjamin Benschneider, courtesy of Jim Burton, blip designlab.*

## Action Item 1-27



### Homeowner Benefit:

Onsite power production helps reduce a home's carbon footprint by turning the home into a mini power plant. While the payback on a photovoltaic system is quite long even when regional and federal incentives are taken into account, lowered monthly electric bills and (with systems tied to the electric grid) the personal satisfaction of watching one's electric meter spin backwards strong benefits.

## Action Item 1-28

Install innovative non-solar renewable power systems that produce a minimum of 15%, 30%, or 50% of the house's total annual energy

**Points: 5-25**

**Responsible party:**

Architect

**Intent:**

Capture onsite energy resources; reduce overall energy demand of home; reduce home's carbon footprint.



ENERGY

SITE/WATER

**what:** Non-solar renewable power systems that could add to the houses' total energy production include wind power and small-scale hydropower. However, small-scale hydropower systems are not yet practical. Geothermal systems are not part of this Action Item.

There are two major types of residential wind power systems: horizontal axis and vertical axis.

Horizontal axis systems are the more traditional propeller-type systems where the axis of rotation is parallel to the ground. These systems can require relatively high wind speeds to be effective, and their blades spin at high speeds.

Vertical axis systems feature "egg beater" or helical shapes with sculptural qualities. These machines can capture lower velocity winds and rotate at slower speeds.

**why:** See Action Item 1-27, above, for information on the benefits of onsite renewables.

The amount of money a small wind turbine saves a homeowner in the long run will depend upon its cost, the amount of electricity used and produced, the average wind speed at the site, and other factors. Optimally, wind turbines are mounted high in the air to maximize efficiency.

**how:** This Action Item is worth 5-25 points

- 15% 5 points
- 30% 10 points
- 50% 25 points

Residential scale wind systems are now becoming more available, although code barriers still are likely

due to height restrictions, potential noise issues, and the lack of UL listing for meeting electrical safety standards.

When considering a wind energy system for a property, it is critically important to understand the site's wind resource. Trees, the home and neighboring structures, and larger geographic aspects all play into a site's suitability for wind energy.

It is advisable to gather as much as a year's worth of site-specific wind data prior to designing a wind system. Alternatively, look for the closest source of wind data—often a school weather station. However, wind conditions can vary dramatically over even short distances.

For best results, hire a firm that specializes in designing and installing residential wind power systems.

**considerations:** Geothermal (ground-source heat pump) systems receive credit under Action Item 7-4.

**resources:**

ToolBase provides information to builders on wind power generators: [www.toolbase.org](http://www.toolbase.org) (click on *Technology Inventory*, then browse for *Wind Power Generators*).

The National Renewable Energy Laboratory establishes wind turbine certification criteria: [www.wind.nrel.gov/cert\\_stds/Certification/certification/index.html](http://www.wind.nrel.gov/cert_stds/Certification/certification/index.html)

The Department of Energy's Energy Savers consumer information on on-site renewable energy: [www.energysavers.gov](http://www.energysavers.gov) (click on *Electricity*, then *Make Your Own Clean Electricity*)



SITE/WATER

ENERGY

**what:** Various definitions of net zero annual energy use are available, but for the purposes of this Action Item, an all-electric home that can show energy data proving that the annual power created by on-site renewable sources meets or exceeds the annual energy use qualifies for zero energy status.

**why:** Built examples of next-generation homes, such as net zero energy dwellings, will be a critical part of society's ability to develop a more sustainable relationship with the planet. More specifically to homeowners, a net-zero home represents true energy independence.

**how:** Achieving zero net energy status requires careful attention to all energy-related elements of a home and correcting many existing deficiencies. It means employing a vast array of Action Items and bringing them together in a way that creates an extremely low energy use building. Improvements to the building structure and envelope to maximize on passive heating and cooling will likely be a first step in the design process. Using home energy modeling software (see Action Item 1-24) is invaluable in helping make strategic decisions about energy conservation and renewable energy measures.

Once strategies are identified, an energy budget can be derived for the home and the renewable energy resource needs determined. Engaging home performance, passive solar and renewable energy specialists as early as possible in the design phase will help identify opportunities and avoid pitfalls.

Finally, zero net energy status hinges on homeowner behavior. Work closely with the homeowner to understand occupant energy use habits and inform design and equipment decisions. Provide information in the Homeowner Operations and Maintenance Manual to encourage behaviors and maintenance activities that optimize efficiency.

Note: achieving this Action Item requires an all-electric home, as use of natural gas, propane or heating oil cannot meet the intent of zero use of fossil fuel.

**considerations:** The advanced insulation, air sealing and other initiatives likely needed to achieve this Action Item should be approached in an integrated fashion, with special focus on human health and building durability. Carefully review the health and indoor air quality Action Items simultaneously with energy items to avoid unintended tradeoffs. Apply a "building science" approach to the project, carefully considering the physics of energy transfer, moisture and ventilation.

**resources:**

US Department of Energy's *A Homebuilder's Guide to Going Solar*: [www.eere.energy.gov](http://www.eere.energy.gov) (click on *Find Publications and Products*).

ToolBase has a variety of resources on zero energy homes: [www.toolbase.org](http://www.toolbase.org) (click on *Home Building Topics*, then *Zero Energy Homes*).

Energy Savers information for consumers: [www.energysavers.gov](http://www.energysavers.gov) (click on *Designing & Remodeling*, then *Zero Energy Homes*).

## Action Item 1-29

Build a zero net energy home that draws zero outside power or fuel on a net annual basis

**Points: 50**

**Responsible party:**

Architect

**Intent:**

Capture onsite energy resources; reduce overall energy demand of home; reduce home's carbon footprint; eliminate the use of fossil fuels.



### Homeowner Benefit:

Onsite power production helps reduce a home's carbon footprint by turning the home into a mini power plant. While the payback on a photovoltaic system is quite long even when regional and federal incentives are taken into account, lowered monthly electric bills and (with systems tied to the electric grid) the personal satisfaction of watching one's electric meter spin backwards strong benefits.



### Homeowner Benefit:

Attaining zero net energy status on a home means insurance against energy price increases in the future, and a dramatic reduction in a home's carbon footprint. While net zero status is a challenge to attain (and requires attention and dedication to maintain), such status is a rare distinction and can be expected to add substantial value to a home.

## Action Item 1-30

Assist homeowners with chemical sensitivities to identify preferred IAQ measures and finishes

### Points: 5

#### Responsible party:

Architect

#### Intent:

Protect the health and comfort of occupants, especially those with known chemical sensitivities.



**what:** Multiple Chemical Sensitivity (MCS) is a complex syndrome that can incapacitate its sufferers. Its primary symptom is extreme reaction to any number (or a particular subset) of chemical compounds. Some sensitive individuals exhibit less extreme but still irritating and uncomfortable reactions to chemicals in newer construction materials. While primarily related to synthetic compounds, those afflicted with MCS can also show sensitivity to natural materials that emit volatile compounds, such as pine resin, citrus residues and linseed oil.

**why:** Chemically sensitive individuals may be forced to evacuate a space that contains materials that trigger their condition. While it will take special attention to ensure such a client's needs are met, the alternative—removing and replacing the offending materials—is costly and time consuming, not to mention disrupting for the homeowner. Being attuned to such a client's needs helps mitigate these reactions and ensure success.

**how:** This Action Item is only available to projects with chemically sensitive clients; therefore, speculative projects are not eligible. If a client suspects they have chemical sensitivities, recommend that they receive an assessment from a medical professional with training in diagnosing chemical sensitivities. If they are chemically sensitive, allergic, or asthmatic they will likely require special measures. Pay close attention to information provided to the client about their medical conditions/sensitivities, and work closely with them and their medical professional to identify required measures.

- Considerations should include:
- Specific building materials and constituents to avoid.
- Setting thresholds for moisture level control (below 50% is best to minimize molds and dust mites).
- Optimizing the ventilation system.
- Optimum filtration for heating and/or ventilation systems.
- Excluding outdoor pollutants at entries with walk off mats (Action Item 15-2) and convenient places at entries to remove and store shoes (Action Item 1-44).

If the project team does not include individuals that specialize in building for chemically sensitive clients, recommend including one. The specialist may require samples of prospective building materials for tests.

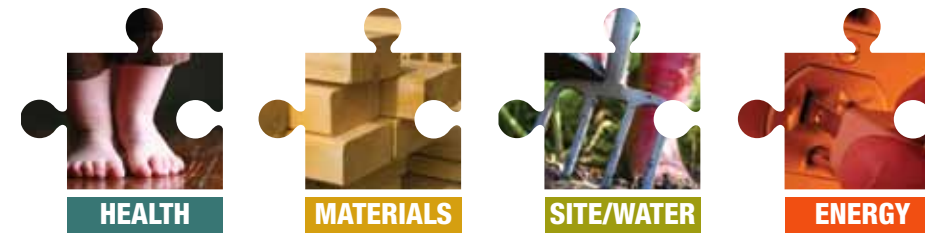
**considerations:** Many of the BUILT GREEN Action Items help to improve indoor air quality, a key concern of MCS sufferers. Carefully review all Action Items for ideas to help with sensitive clients.

#### resources:

American Academy of Family Physicians article regarding MCS: [www.aafp.org/afp/980901ap/magill.html](http://www.aafp.org/afp/980901ap/magill.html)

*Home Safe Home* by Debra Lynn Dadd (Tarcher Publications, 1997)

*Prescriptions for a Healthy House: A Practical Guide for Architects, Builders and Homeowners* by Paula Baker-Laporte (New Society Publishers, 2001).



**what:** Specialized training in indoor air quality issues as it relates to home design and construction exists through BUILT GREEN, via the Healthy Home Builder Training.

**why:** Protecting indoor air quality is a central component of green building, and involves a nuanced understanding of the interaction of a wide variety of design and construction strategies. Immersion in the concepts in a classroom setting allows a professional to tie the often seemingly disparate elements of green building and indoor air quality together and provide a complete program of integrated strategies to the homeowner.

**how:** Courses in indoor air quality for residential design and construction professionals are offered on an occasional basis via a variety of channels. Look to the Master Builders Association (MBA) website (see Resources) to find out when the next Healthy Home Builder class is offered.

Alternatively, research other classes for availability, such as the Sustainable Building Advisor Certificate program (see Resources), offered through various community and technical colleges around the country.

Alternative educational programs require pre-approval by the BUILT GREEN Director.

**considerations:** Classes in energy efficiency, low impact development, universal design and other green building concepts help round out a Built Green builder's education and are occasionally offered through MBAU, the Northwest EcoBuilding Guild, and other sources (see Resources).

#### resources:

Master Builders Association of King and Snohomish Counties: [www.mba-ks.com](http://www.mba-ks.com)

Northwest EcoBuilding Guild: [www.ecobuilding.org](http://www.ecobuilding.org)

American Lung Association Health House program: [www.healthhouse.org](http://www.healthhouse.org)

National Sustainable Building Advisor Program: [www.nasbap.org](http://www.nasbap.org)

## Action Item 1-31

Project team member to have taken BUILT GREEN/ALA of Washington "Healthy Homes Training for Building Professionals" course, or other approved IAQ class with 8 hours of curriculum minimum

### Points: 5

#### Responsible party:

Architect, Contractor

#### Intent:

Protect the health of occupants, workers, and the general public.



#### Homeowner Benefit:

For homeowners with Multiple Chemical Sensitivity or sensitization to any particular chemical, the benefit of avoiding those compounds is self-evident. For all occupants, a keen eye on selecting low-toxic, hypoallergenic materials will create a healthier, more comfortable indoor environment.



#### Homeowner Benefit:

In-depth training in healthy home practices translates into design and construction skill, and a level of awareness of health issues that helps ensure an integrated approach to healthy building and, ultimately, a healthier home.

## Action Item 1-32

Optimize air quality in bedrooms to basic or advanced level

**Points: 2-6**

**Responsible party:**

Architect

**Intent:**

Protect the health and wellbeing of occupants by providing good air quality in bedroom spaces.



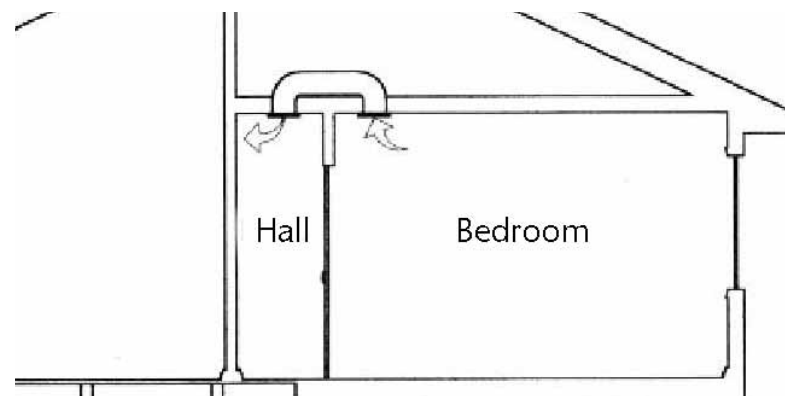
**what:** Optimizing air quality in bedrooms entails providing proper ventilation and moisture control and reducing exposure to irritants and toxins through design and materials selection.

**why:** We spend a third of our lives (and often a substantial majority of our time at home) in our bedrooms. At the same time, bedrooms often suffer from poor indoor air quality due to inadequate ventilation and the presence of hazardous gases, particulates, and VOC emitting materials (e.g., paints, draperies and composite wood products) and carpeting that is a sink for toxins.

**how:** This Action Item is worth 2 or 6 points.

- Basic: 2 points
- Advanced: 6 points

To achieve points for this Action Item, all of the following actions must be taken in all bedrooms.



Ducting between bedrooms and hallways can reduce pressure differentials common in bedrooms due to lack of returns or insufficiently undercut doors. Note that ducting through unheated space introduces an energy penalty; through-wall ducts can avoid this problem.

Image: Washington State Energy Code Builder's Field Guide, courtesy of Washington State University Energy Extension.

Basic:

- No carpets.
- Low VOC/low toxic paints, finishes, caulks and sealants.
- Low toxicity cleaners (during construction).

Advanced:

- Install operable windows for cross ventilation where possible (e.g., corner bedrooms).
- Install hygrometer (moisture sensor) and thermometer.
- Reduce chances of exposure to EM fields (electronic panels, timers, generators, PV inverters, refrigerators, large wire chases located away from sleeping areas).
- Install damp-proof ledges or alcoves.
- Provide return ducts or air communication vents to hallways.
- No materials with added urea formaldehyde.

**resources:** See Action Item 1-31 for resources related to healthy home training.



**what:** A detached garage physically separates the garage from the home. Air sealing creates an airtight barrier between an attached garage and occupied space.

**why:** Studies show that carbon monoxide, sometimes produced in significant levels when automobiles are started, can enter the home from the attached garage. Volatile hydrocarbons and other toxins and irritants emitted by automobiles or materials stored in the garage can also enter indoor air if garages are insufficiently sealed from living spaces.

**how:** This Action Item reduces potential sources of indoor air pollution by eliminating the garage altogether or air sealing it from the house and including an automatic exhaust fan in the garage. Air sealing the garage from the house involves:

- Using blocking, caulk and/or foam to seal all holes in walls and the ceiling between the house and garage.
- Making sure that the door between the house and garage is weather-stripped and is fitted with a threshold that creates a tight seal with the door. (An ENERGY STAR qualified exterior door is an ideal choice.)
- If garage walls are unfinished drywall, caulking all cracks and joints, and then mudding and finishing the walls with paint.

Alternatively, using the Airtight Drywall Approach (ADA) in the walls and ceiling shared by house and garage will accomplish good air sealing. ADA is an advanced sealing package that goes beyond basic practice (see Action Item 11-1).

An exhaust fan helps maintain a negative pressure in the garage, reducing the risk of pollutant infiltration. Select an ENERGY STAR exhaust fan (see Action Item 9-11) and wired to the garage opener on a timer. If garage air sealing is not desired by or outside the budget of the homeowner, consider at least installing the exhaust fan in the garage (see Action Item 9-6).

**considerations:** A blower door test (see Action Item 10-11) is valuable in identifying air leaks between the garage and living space.

**resources:** The Canada Mortgage and Housing Corporation publishes "About Your House: Garages and Indoor Air Quality." [www.cmhc.ca](http://www.cmhc.ca) (search using the keyword *Garage*).

The Department of Energy's Energy Savers program provides information for consumers on air sealing: [www.energysavers.gov](http://www.energysavers.gov) (click on *Insulation and Air Sealing*).

## Action Item 1-33

Detached or no garage, or garage air-sealed from house with automatic exhaust fan

**Points: 5**

**Responsible party:**

Architect

**Intent:**

Protect the health of occupants by reducing the likelihood of automobile exhaust and other toxins and irritants stored or present in the garage from entering the living space.



### Homeowner Benefit:

Physically separating the garage from the home, or air sealing an attached garage, helps protect occupant health by creating a barrier between unhealthy automobile combustion byproducts and other hazardous compounds and the household air.



### Homeowner Benefit:

Providing good air quality in bedrooms helps ensure occupant health and comfort.

## Action Item 1-34

Completely condition crawlspace

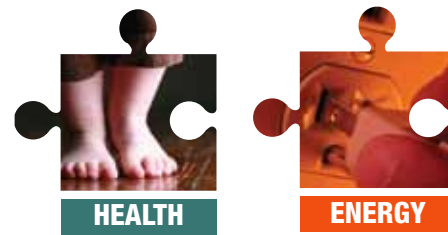
**Points: 7**

**Responsible party:**

Architect

**Intent:**

Increase occupant comfort; reduce energy use and carbon footprint of home.



**what:** A completely conditioned crawl space is essentially a short basement, where the crawl space is brought inside the thermal envelope.

**why:** According to research from Washington State University Energy Extension, conditioned crawl spaces in the Pacific Northwest mainly provide comfort benefits, and not necessarily energy savings.

Warmer floors can reduce the likelihood of condensation on floors which can result in mold and compromised indoor air quality.

**how:** Local code officials may have concerns with conditioned crawl spaces, and with good reason, if the designer or builder does not make clear the fact that the process doesn't simply involve closing off the crawlspace vents. The approach requires careful detailing, sealing and insulation, with particular attention to water and moisture issues.

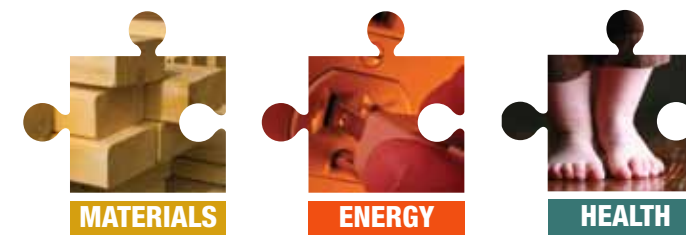
**considerations:** If evaluating this approach, consult with a building science expert to determine its suitability for the project. Conditioning an existing crawl space can be more challenging than designing a crawl space from the outset to be within the home's thermal envelope. The Building Science Corporation (see Resources) has information on creating conditioned crawl spaces. Insulating between floor joists (Action Item 10-2) and conducting a comprehensive crawl space improvement (Action Item 3-21) may be a more suitable approach for a project, depending on the circumstances.

**resources:** Building Science Corporation: "Research Report 0401: Conditioned Crawl Space Construction, Performance and Codes" available at [www.buildingscience.com](http://www.buildingscience.com)



### Homeowner Benefit:

A conditioned crawl space can increase occupant comfort by keeping the floor above the crawl space warmer. If properly detailed, it can also save energy by reducing heat loss through the floor.



**what:** A house's eaves are the home's first line of defense against water damage.

**why:** Appropriately sized and positioned overhangs protect the home from moisture damage caused by precipitation. Roof overhangs can also provide passive solar benefit; see Action Item 1-23.

**how:** Design 24" overhangs or deeper, factoring elements such as wind-driven rain or wall height (see Action Item 1-36).

**resources:** Building Science Corp.: "Rain Control in Buildings" [www.buildingscience.com](http://www.buildingscience.com) (search for *BSD-013*).

ToolBase Tech Set 2: Durable Building Envelope: [www.toolbase.org](http://www.toolbase.org) (click on *Tech Sets*).



### Homeowner Benefit:

Ample overhangs help reduce maintenance and wear on a home by protecting it from the elements. Additionally, a home with properly sized overhangs will stay cooler in summer and reduce heating bills in winter by selectively admitting or rejecting sunlight depending on the time of year.



**what:** See Action Item 1-35.

**why:** See Action Item 1-35. This strategy protects window and door finishes, reducing maintenance.

**how:** This Action Item requires using overhangs greater than 24" when protecting more than two stories of walls.

**considerations:** Overhangs provide a first line of protection; a well-constructed drainage plane (Action Item 4-19), proper gutters, and a maintenance plan give added protection. See Action Item 4-20 for window and door flashing.

**resources:** See Action Item 1-35.



### Homeowner Benefit:

See Action Item 1-35 above for information.

## Action Item 1-35

Roof overhangs are at least 24"

**Points: 2**

**Responsible party:**

Architect

**Intent:**

Enhance building durability and protect occupant health by limiting moisture intrusion.

## Action Item 1-36

Protect windows and doors on tall walls with additional overhang protection

**Points: 2**

**Responsible party:**

Architect

**Intent:**

Enhance building durability and protect occupant health by limiting moisture intrusion.



## Action Item 1-37

Design and install moisture management details for all new or replaced below grade walls beyond code, e.g., dimple drainage mat at exterior face and capillary breaks

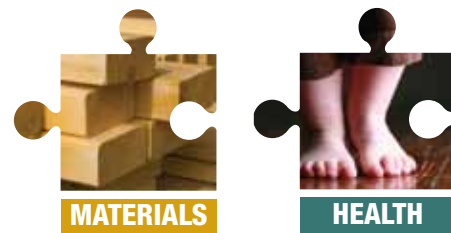
### Points: 3

#### Responsible party:

Architect

#### Intent:

Enhance building durability and protect occupant health by limiting moisture intrusion.



**what:** Moisture management for below grade walls includes a combination of design and construction strategies aimed at minimizing water intrusion and damage.

**why:** Water intrusion through below grade walls can result in mold and rot, compromising a building's durability and the home's indoor air quality. Additionally, bulk water intrusion (flooding) can damage property and render rooms uninhabitable. Designing systems to avoid moisture in below grade walls can reduce callbacks related to moisture issues.

**how:** Detail a moisture management system for below grade walls that goes beyond code.

Best practices indicate that there are six elements of waterproofing below grade walls.

1. Slope surface soil away from the structure (see Action Item 3-12).
2. Install roof water management system that keeps water away from basement walls.
3. Install a waterproof barrier, either roll- or liquid-applied membrane from 6" above final grade down to the base of the footing or grade beam.
4. Install a perforated footing drain around perimeter of foundation, and cover with geotextile filter fabric.
5. Install dimple drainage mat on exterior face of waterproofing membrane to provide protection for the membrane and over top of the footing drain

and drain rock. The dimple drainage mat provides an air channel to carry water by gravity to the footing drain

6. Backfill with soil if dimple board air barrier with a filter fabric has been installed (if using native soil, be sure to determine if it is appropriate for foundation backfill).

Creating capillary breaks also helps avoid moisture migration through a wall. Place a capillary break between the footing and the foundation wall by spraying the footing with an elastomeric asphalt coating or by covering the footing with a polyethylene sheet prior to pouring the foundation wall. Before backfilling, clean the vertical face of the foundation (exterior walls) and fill any cracks or gaps larger than 1/8" wide. Spray on an elastomeric coating starting 4" above the final backfill level, with a continuous application down to the footing.

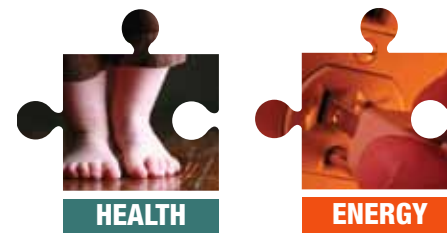
#### considerations:

Larger roof overhangs (Action Item 1-35) also help keep below-grade walls drier.

#### resources:

Building Science Corporation Research Report 0103: "Water Management" provides a general overview of total moisture management for a home: [www.buildingscience.com](http://www.buildingscience.com) (search for 0103).

Building Science Corporation Information Sheet 101: "Groundwater Control" provides details on constructing a freely-draining foundation: [www.buildingscience.com](http://www.buildingscience.com) (search for 101).



**what:** Concrete is excellent at wicking moisture through capillary action, easily conveying water into a home if a sufficient barrier is not installed.

A moisture barrier installed beyond code entails specifying thicker polyethylene sheeting and more careful sealing of all seams and edges to ensure a continuous effective moisture barrier.

**why:** Beyond-code moisture barrier detailing for slabs and crawl spaces provides an added level of moisture protection, helping ensure building durability, indoor air quality, and reduced likelihood of callbacks related to these issues at little added expense. It is also virtually impossible to retrofit this measure; installing a new slab presents an opportunity to build in added protection.

**how:** This Action Item applies to slabs and crawl spaces in additions only.

If a slab is installed, use gravel fill beneath the foundation slab with a polyethylene sheeting (min. thickness of 10 mm) or vapor retarder, placed over the gravel prior to pouring the basement floor. Seal the poly at the edges and seams to prevent moisture migration. The polyethylene sheeting must be in contact with the slab (no sand layer between sheeting and slab). Taped and sealed rigid foam insulation under the entire slab also qualifies for this Action Item (see Action Item 3-17 for insulating under slab on grade).

If the addition uses a crawl space instead of slab on grade, provide at least 12" clearance from the finished crawl space floor. Consider pouring a "rat slab" (2" concrete) to keep out vermin, and place 10 mil minimum poly on the crawl space floor, overlapped at least 12", sealed at the seams, and caulked and sealed to the foundation walls.

Note: The polyethylene barrier also protects against radon and other soil gases. However, radon generally not a problem in western Washington.

**resources:** Building Science Corporation Research Report 0509d: "Crawlspaces" provides information on crawl space sealing: [www.buildingscience.com](http://www.buildingscience.com) (search for 0509d).

Building Science Corporation Research Report 0509e: "Slabs" provides information on slab sealing: [www.buildingscience.com](http://www.buildingscience.com) (search for 0509e).

## Action Item 1-38

If installing new slab on grade, upgrade under slab moisture barrier beyond code to 10 mil minimum; minimum of 10 mil poly in crawl spaces with sealed seams and sealed perimeter

### Points: 2

#### Responsible party:

Architect

#### Intent:

Enhance building durability and protect occupant health by reducing moisture migration into the home from slabs or crawl spaces.



#### Homeowner Benefit:

Keeping below grade walls dry helps protect indoor air quality and enhances a home's durability by limiting moisture intrusion.



#### Homeowner Benefit:

Additional measures to reduce moisture migration from slabs or crawl spaces protects indoor air quality and can enhance the durability of the home, protecting it from moisture damage.

## Action Item 1-39

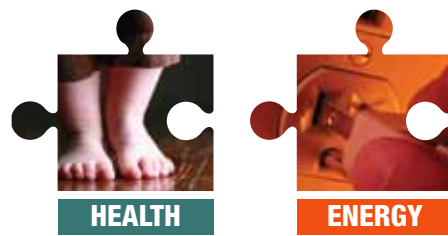
Remove existing wood burning fireplace and do not replace

### Points: 4

**Responsible party:**  
Architect

**Intent:**

Protect the health of occupants and the general public.



**what:** The combustion process for wood creates a variety of toxic gases and particulates, including carbon monoxide and creosote.

**why:** See Action Item 7-12 for statistics on the health and pollution problems associated with wood burning fireplaces.

**how:** Removing a fireplace

means either removing fireplace and chimney (the most energy efficient approach), or sealing off the fireplace. Exercise care when sealing a fireplace; improper sealing can result in moisture problems.

**resources:**

US EPA: [www.epa.gov/woodstoves](http://www.epa.gov/woodstoves)

The Puget Sound Clean Air Agency: [www.pscleanair.org/actions/woodstoves](http://www.pscleanair.org/actions/woodstoves)



### Homeowner Benefit:

Wood burning fireplaces are a major source of particulate air pollution in our region. Removing a wood burning fireplace or stove protects the health of the home's occupants and regional air quality. Additionally, fireplaces often lose more heat than they produce as conditioned air is lost up the chimney.



**what:** Gas burning appliances include ovens, ranges, cooktops, and fireplaces.

**why:** Gas appliances, if improperly vented or due to pressure imbalances in the home, can introduce significant amounts of moisture and combustion byproducts, including carbon monoxide, into the indoor environment.

Of particular concern are unvented gas appliances, which can release substantial amounts of moisture into a home along with a variety of combustion byproducts, including carbon monoxide and nitrogen oxides.

**how:** This Action Item is only available to projects that do not install any gas-burning appliances inside the home. Homes that install gas-burning appliances must include a carbon monoxide detector.

Specify alternatives to gas ovens, ranges, and cooktops, and fireplaces. High-efficiency alternatives for cooking include induction cooktops (Action Item 13-46) and convection ovens.

**resources:** US Consumer Product Safety Commission provides information on combustion safety and gas appliances: [www.cpsc.gov/CPSCPUB/PUBS/452.html](http://www.cpsc.gov/CPSCPUB/PUBS/452.html)

EPA Indoor Air Quality in Homes: Preventing Problems with Combustion Equipment: [www.epa.gov/iaq/homes/hip-combustion.html](http://www.epa.gov/iaq/homes/hip-combustion.html)

## Action Item 1-41

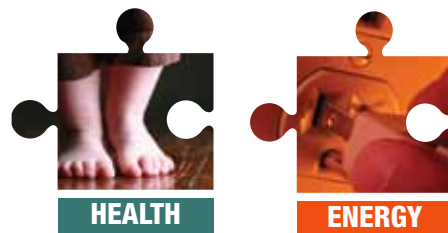
Do not install gas-burning appliances inside of house

### Points: 5-15

**Responsible party:**  
Architect, Owner

**Intent:**

Protect the health and wellbeing of occupants.



**what:** See above.

**why:** See above.

**how:** Discuss with the homeowner the energy and health downsides of installing a wood-

burning appliance. See Resources for Action Item 1-39 for information on the public health impacts of wood burning appliances.

**resources:** See above.



### Homeowner Benefit:

See above.



### Homeowner Benefit:

Avoiding gas-burning appliances in the home reduces the likelihood of excess water vapor and combustion byproducts, including carbon monoxide, being released into the indoor environment. This helps protect indoor air quality and building durability.

## Action Item 1-42

Provide balanced or slightly positive indoor pressure using controlled ventilation

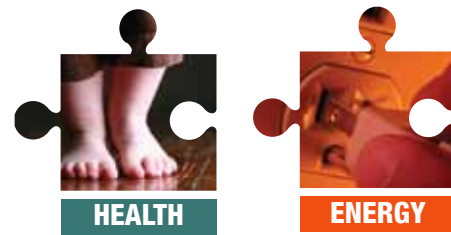
### Points: 5

#### Responsible party:

HVAC

#### Intent:

Enhance building durability and protect occupant health.



**what:** Balancing or achieving slightly positive air pressure in a home requires properly designed and tested mechanical ventilation.

**why:** Greater air tightness creates a need for mechanical ventilation to properly distribute fresh air and avoid potential indoor air quality problems. Balanced or slightly positive ventilation keeps outdoor pollutants from being drawn into the house, prevents backdrafting or spillage from combustion appliances (due to under-pressurization), and prevents moisture migration into structural cavities.

**how:** Indoor air quality experts recommend operating a home at a natural or slightly positive pressure (+1 Pascal difference with respect to outdoors). However, accomplishing this using supply ventilation only may ignore other critical factors involved in making the home energy efficient, comfortable and healthy. These items need to be taken into consideration when installing ventilation. The primary causes of negative pressure in the home are:

- Wind, natural convection or the stack effect.
- Supply duct leaks.
- Supply ducts isolated from return ducts by a closed door, or insufficient door undercuts.
- Excessive exhaust ventilation: Usually a large range hood or the clothes dryer.

The best way to provide natural pressure under normal operating conditions is:

- Air seal the home (see Resources).
- Seal the heating system ducts with mastic (see Action Item 7-20).
- Provide return air to isolated rooms with ductwork or bypass grille (see Action Item 1-32).

**considerations:** A home performance evaluation (see Action Item 1-16) can be invaluable in locating and correcting air leaks and other energy issues on existing homes. Once these items are addressed, a supply ventilation system may be used to balance exhaust ventilation de-pressurization or provide a slight positive pressure with a modest volume of fresh air. Ventilation can be provided by quiet fans with automatic controls or by heat recovery ventilators (see Action Item 7-14). The volume of air supplied should follow specifications in the WA State Ventilation and Indoor Air Quality Code.

**resources:** Building Science Corporation Digest 109: "Pressures in Buildings:" [www.buildingscience.com](http://www.buildingscience.com) (search for *BSD-109*).

The ENERGY STAR consumer guide to air sealing and insulating: [www.energystar.gov](http://www.energystar.gov) (click on *Home Improvement*, then *Seal and Insulate with ENERGY STAR*)

Performance Tested Comfort Systems certifies technicians: [www.ptcsnw.com](http://www.ptcsnw.com)

Home Performance Washington information on performance contracting and a directory of service providers: [www.homeperformancewashington.org](http://www.homeperformancewashington.org)



**what:** Cross ventilation is a natural ventilation strategy that takes advantage of natural air movement around a home and puts it to use for cooling and/or providing fresh air to occupants.

**why:** Open floor plans with a minimum of interior partitions improve a home's air circulation. Strategically placed operable windows promote indoor air quality by providing a means to bring fresh air into the home and exhaust stale air. Building a natural ventilation option into a home provides an alternative to mechanical ventilation, potentially reducing energy use.

**how:** This Action Item applies to areas of the home that are additions or undergoing a down-to-the-studs remodel.

Generally, natural cross ventilation is obtained by locating window openings in opposing walls and in line with each other. Opening these windows uses the air pressure

differential to cause air movement. Use smaller window openings for the inlets (the side with prevailing breezes) and larger openings for the outlet. This increases the air speed and improves the cooling effect.

The success of a natural ventilation strategy relies on a combination of good design and proper use by occupants. Be sure to provide information to the homeowner in the Operations and Maintenance Manual.

**considerations:** Ceiling fans (Action Item 9-12) can assist a natural ventilation strategy on still, hot days, helping avoid the need for mechanical air conditioning.

**resources:** The National Institute of Building Sciences' *Whole Building Design Guide* information on natural ventilation: [www.wbdg.org/resources/naturalventilation.php](http://www.wbdg.org/resources/naturalventilation.php) (note this resource is primarily for commercial buildings, but includes much information relevant to residential buildings)



Operable windows for cross ventilation are part of a larger strategy of natural ventilation which can include open-plan spaces and open stairwells for air movement.

Image: Nelse Design + Build .

## Action Item 1-43

Provide for cross ventilation using operable windows in addition/remodel

### Points: 2

#### Responsible party:

Architect

#### Intent:

Enhance occupant health and wellbeing; reduce or eliminate the need for mechanical cooling; reduce overall building energy use.



#### Homeowner Benefit:

Balanced air pressure in a home keeps unhealthy air and moisture in attics, walls, and crawl spaces from entering living spaces, and reduces the likelihood of moisture problems in the home, protecting indoor air quality and building durability.



#### Homeowner Benefit:

Well-designed natural ventilation provides free ventilation and cooling of a home, enhancing indoor air quality and reducing cooling-related energy expenses.

## Action Item 1-44

Design a shoe removal vestibule at major entrances to house (front, back, garage)

### Points: 3

#### Responsible party:

Architect

#### Intent:

Protect the health of occupants by reducing indoor contaminants.



**what:** A shoe removal vestibule consists of a place for occupants to remove shoes, and a storage system for the shoes themselves. Vestibules can be indoors or outdoors, and are placed at major entrances to the home (front door, garages and mudrooms).

**why:** According to healthy home experts, one of the single most important indoor air quality measures occupants can take is to maintain a shoe-free household. Shoes can track in heavy metals (including lead), pesticides, hydrocarbons, and pollen into the home. Building a shoe removal vestibule at major entrances to the house provides a convenient and tidy place to store shoes, and will help improve indoor air quality. It can provide additional energy efficiency benefits if an exterior vestibule is built in an airlock space.

**how:** Vestibules can be on the exterior, or placed indoors where space permits in the foyer, mudroom, or other convenient and available space.

Shoe removal vestibules should include, at a minimum:

- A bench or seating area close to each major entrance to allow for easy shoe removal.
- Shoe shelves, compartments, or racks, in sufficient capacity for the household.

Shoe storage systems can be designed in a variety of styles and configurations. Built-in units help the vestibules blend into the home's décor. The Japanese concept of the *getabako*, or shoe cupboard, takes this craftsmanship to an impressive level.

**considerations:** Exterior vestibules can be built in an airtight enclosure, to provide the energy benefits of an airlock design (keeping conditioned air in the house). Since this space is outside the thermal envelope of the home, there is added flexibility to use skylights, salvaged windows, and other elements that would otherwise compromise the energy efficiency of a home. Be sure to consider comfort issues with the space, especially unwanted heat gain during the summer; providing operable windows or a venting skylight can help with this.

An exterior shoe removal vestibule can be designed into a front porch (Action Item 1-58).



*Built-ins promote a shoe-free household, protecting indoor air quality.*

*Image: Terry Phelan, Living Shelter Design Architects.*



**what:** A comprehensive waste management plan identifies all existing and potential waste streams from a project and determines the best management strategy for each stream. Concurrently, it identifies strategies for eliminating waste in the first place.

**why:** Beyond the homeowner benefits, a comprehensive waste management plan is simply good business. By keeping close tabs on the waste reduced on a project, a firm is able to anticipate and avoid any surprises in terms of waste creation or disposal. A clean, organized and low-waste jobsite will be more efficient, and safer for workers and occupants.

**how:** The King County *Contractor's Guide* serves as a blueprint for creating a comprehensive waste management plan (see Resources). Use the plan located at the end of that document, or create your own by listing the following:

- Designate a materials coordinator; include contact information.
- Set a total materials diversion goal, in terms of a percentage, by weight, of materials generated.
- Create a set of materials diversion policies to share with workers and subcontractors, and create a checklist of steps needed to inform key parties of policies.

- Create a table of likely materials generated by the project, and the planned method for diverting the materials. (Include for each material the expected quantity, diversion method and destination, and handling procedures).

(The above list is adapted from the King County *Contractor's Guide*, 2008.)

#### resources:

The State of Washington General Administration maintains a construction waste management guidelines page, including guidance on developing a waste management plan:  
[www.ga.wa.gov/Eas/cwm/guideline.html](http://www.ga.wa.gov/Eas/cwm/guideline.html)

King County's GreenTools program maintains a waste management plan template:  
[www.greentools.us](http://www.greentools.us)  
 (click on *Construction Recycling* and then *Design Specifications and Waste Management Plans*). For general information on construction waste management, including the *Contractor's Guide*, visit the GreenTools website.



#### Homeowner Benefit:

A shoe-free household is a central strategy for maintaining good indoor air quality, protecting the family's health and comfort. Exterior front-door vestibules can be designed to provide additional benefit by acting as an airlock space for the home, keeping conditioned air from escaping the building and reducing energy bills.

## Action Item 1-45

Develop a comprehensive waste management plan for demolition and new construction waste

### Points: 5

#### Responsible party:

Contractor

#### Intent:

Create more opportunities for reducing jobsite waste and increase beneficial use of waste.



#### Homeowner Benefit:

A comprehensive waste management plan helps ensure waste reduction and recycling opportunities are captured on the jobsite. This translates into lower waste management fees and a smaller environmental footprint in terms of resource use.

## Action Item 1-46

Develop a written comprehensive reuse plan and/or invite company/contractor to perform a re-use audit

### Points: 3

#### Responsible party:

Contractor, Architect

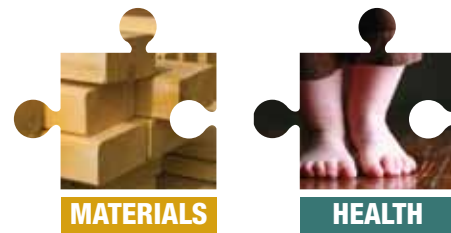
#### Intent:

Reduce impact of construction-related waste and establish context and understanding of existing building conditions and opportunities, to make best use of those resources.



#### Homeowner Benefit:

A materials reuse audit provides a full accounting of reuse opportunities on a project, allowing for maximum waste reduction and savings on disposal fees. Additionally, it can result in tax deductions if the salvaged materials are donated to a nonprofit organization.



**what:** A comprehensive reuse plan establishes an inventory of reusable elements in a home and provides a strategy for maximizing reuse over time.

A comprehensive reuse plan surveys those elements of the building slated for demolition or deconstruction and identifies:

- The method and timing of removal that will maximize salvage and reuse potential.
- The approximate amount of material available for reuse.
- The destination of the material, whether for reuse on the project or to be sold/donated.

**why:** Without a plan, activities often result in hasty decisions and lost opportunities. A comprehensive reuse plan identifies opportunities for maximizing the productive reuse of existing materials—either on site or on other projects. The plan can identify the most cost-effective methods for reuse, and reduce waste recycling and disposal fees. Additionally, it can help avoid the need to purchase new materials by cycling existing materials back into the project. Materials donated to used building materials retailers may result in tax benefits.

Gaining the skill to conduct a building materials reuse audit provides more evidence to prospective clients that the firm has the experience needed to do a comprehensive green remodel.

**how:** For professionals unskilled in creating a materials reuse inventory, there are resources for hire. These include used building materials retailers and green building consultants (see Resources).

A reuse audit determines the estimated percentage salvaged, recycled, and landfilled of:

- Appliances
- Bath fixtures (toilet, tub, shower, faucet)
- Cabinetry (kitchen, bath)
- Dimensional lumber
- Doors
- Exterior: decking
- Exterior: fencing
- Flooring
- Foundation
- Heating/AC equipment
- Kitchen fixtures (sink, faucet, etc.)
- Light fixtures
- Masonry
- Roofing
- Sheathing/sheet goods
- Siding
- Trim/moulding
- Windows

**resources:** King County Green Tools offers information on salvage, including a list of regional reuse and salvage companies: [www.greentools.us](http://www.greentools.us).

WA General Administration guidelines: [www.ga.wa.gov/Eas/cwm/guideline.html](http://www.ga.wa.gov/Eas/cwm/guideline.html)

The Northwest Building Salvage Network provides info on regional used materials retailers and consultants: [www.nbsnonline.org](http://www.nbsnonline.org).

Second Use Building Materials reuse audit document: [www.seconduse.com/greenbuilding](http://www.seconduse.com/greenbuilding)



**what:** Deconstruction is a coordinated process of disassembling a building and salvaging materials. Design for Deconstruction (or Design for Disassembly or DfD) is a suite of design and construction practices that help facilitate the future salvage and reuse of building materials. The Design and Build for Deconstruction concept assimilates design, construction, and demolition, so as to maximize reusability and durability of building components throughout their functional and end-of-use lifetime.

**why:** Deconstruction extends material life, reduces environmental impact on landfills and harvesting of new materials, and saves money in disposal fees. Many design and construction practices make it difficult and time consuming (and therefore expensive) to salvage materials on a home. This results in reduced levels of reuse, and more waste-affecting the project's overall costs and the home's environmental impact.

**how:** This Action Item is worth 5, 7, or 9 points, determined by the percentage of total cost of materials chosen for simplifying deconstruction as a fraction of the total cost of materials in the affected area:

- 50-74%: 5 points
- 75-89%: 7 points
- 90%+: 9 points

To qualify for this credit, demonstrate that the minimum percentage required for each point range represents the amount of chosen building components and design elements that contribute to simplified construction in preparation for future deconstruction.

A variety of strategies facilitate deconstruction and salvage. These include:

- Simplifying the materials palette (more of one material is of higher value than small amounts of different materials)
- Designing on modules (2', 4' or 8' increments, to yield standard sizes) and with prefabricated components
- Minimizing chemical and welded connections (e.g., glues and adhesives; soldering)
- Exposing connections to ease disassembly
- Using a limited number of different size connections
- Installing materials and products such that future removal does not damage adjacent finishes
- Designing centralized and accessible utilities and wiring, and using stacked floor plans (Action Item 1-48).

To gain points for using deconstruction to salvage materials on a project, see Action Item 2-2.

#### resources:

The King County Green Tools *Design for Deconstruction* guide: [www.greentools.us](http://www.greentools.us) (click on *Construction Recycling* and then *Design for Disassembly*).

The EPA Lifecycle Building Challenge provides ideas for deconstruction strategies: [www.lifecyclebuilding.org](http://www.lifecyclebuilding.org)

Northwest Building Salvage Network: [www.nbsnonline.org](http://www.nbsnonline.org)

## Action Item 1-47

Design and build for deconstruction

### Points: 5-9

#### Responsible party:

Architect

#### Intent:

Build components of the home specifically to allow for disassembly, increasing the reuse of building materials.



#### Homeowner Benefit:

Designing for deconstruction facilitates later salvage and reuse of building components, increasing the likelihood of materials reuse and reducing waste in the future.

## Action Item 1-48

Use stacked floor plans

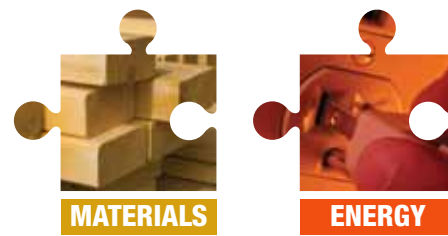
### Points: 1

#### Responsible party:

Architect

#### Intent:

Simplify plumbing, heating, and ventilation system design and layout; capture system efficiencies.



**what:** Stacked floor plans align utilities on successive floors, e.g., stacking bathrooms on top of one another. More residential builders, especially production builders, are becoming interested in the concept of “disentangling utilities.” This involves designing and constructing to make it simpler to replace and upgrade heating, ventilation, plumbing and electrical systems, which are often installed in a way that makes it very difficult to modify one without affecting (or even having to remove) others.

**why:** In a remodel involving a second floor addition or raising a home to construct a new ground floor, stacked floor plans can reduce construction costs by allowing the project to tap into existing waste and water infrastructure. By building up versus out, efficiency of land use preserves open space, and tight floor plans reduce material consumption. Stacked plans also reduce construction costs for site and foundation work.

**how:** Stacked floor plans are most feasible in remodels that involve upstairs additions. Wet spaces can be located over other wet areas and/or mechanical areas, minimizing pipe runs, ductwork, and chases.

**considerations:** Stacked bathrooms and/or a single waste stack for wastewater increases the feasibility of drainwater heat recovery (Action Item 8-27).

**resources:** The Partnership for Advancing Housing Technology (PATH) document “Organizing Residential Utilities: A New Approach to Housing Quality” describes the problem of, and solutions to, entangled utilities: [www.pathnet.org](http://www.pathnet.org) (search for Disentangling).



#### Homeowner Benefit:

Stacked floor plans can simplify construction, reducing construction costs. They can also shorten plumbing and ductwork runs, saving energy and water and reducing utility bills.



**what:** There is a large family of engineered structural products, including laminated veneer lumber (LVL), wood I beams and I joists, and wood roof and floor trusses.

Combining wood veneer and fiber with adhesives produces laminated veneer lumber. Wood I beams and I joists also combine veneer and adhesives.

**why:** Engineered structural products combine efficient raw material use with improved strength and performance capabilities to produce a superior option to traditional materials. Engineered lumber manufacturers use fast-growing, small diameter trees efficiently, which ultimately protects old growth forests.

The LVL manufacturing process allows more of the log (up to 80%) to end up as product. LVL lumber is very consistent and stable.

Wood roof and floor trusses commonly save both time and materials. They can also reduce wood waste because they are manufactured to order, and due to efficiencies in the production process.

**how:** LVL headers and I beams are accepted by all major building codes. They provide more load bearing capacity than solid sawn lumber, and resist shrinking, twisting, splitting, warping, and crowning. They are capable of long spans, thereby increasing design flexibility. They can cost more than dimensional lumber, but in general are considered better products.

For truss manufacturing, supply a detailed building plan, calling out any unusual requirements, e.g., an oddly shaped cathedral ceiling or an opening planned through the roof framing. Store trusses flat to prevent warping.

**considerations:** Be aware of the indoor air quality issues associated with urea formaldehyde resins. Most engineered structural wood products use phenolic or other exterior-grade resins, but confirm this with the supplier. Also ask about the availability of certified wood products.

Couple larger engineered structural products with smaller dimension sustainable harvest wood products (Action Item 4-14).

**resources:** Efficient Wood Use in Residential Construction: A Practical Guide to Saving Wood, Money and Forests by the Natural Resources Defense Council: [www.nrdc.org/cities/building/rwoodus.asp](http://www.nrdc.org/cities/building/rwoodus.asp)

## Action Item 1-49

Use engineered structural products and use no new dimensional 2xs larger than 2x8, and no 4xs larger than 4x8

### Points: 3

#### Responsible party:

Structural Engineer

#### Intent:

Minimize demand on old growth and long-term renewable resources; promote the more efficient use of forest products.



#### Homeowner Benefit:

The strength, stability and uniformity of engineered structural products translate into a higher quality end product, and the ability of engineered products to make use of smaller diameter trees mean reduced resource use.

## Action Item 1-50

Use advanced framing: 24" o.c. for all new walls and 2-stud corners

### Points: 7

#### Responsible party:

Structural Engineer, Architect

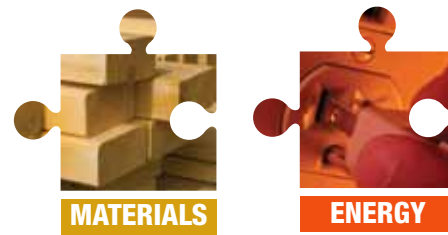
#### Intent:

Enhance energy efficiency of the home; reduce wood material use.



#### Homeowner Benefit:

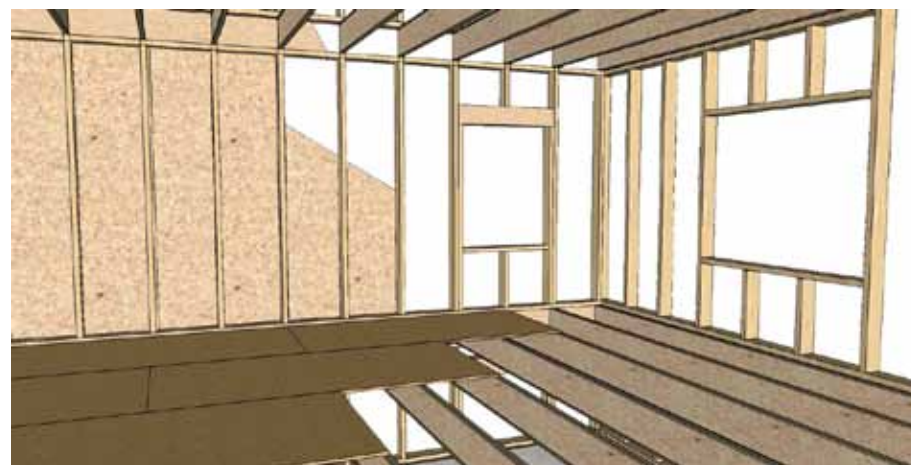
Advanced framing substantially reduces dimensional lumber use, saving on materials costs. It also allows more room in the walls for insulation, creating a more efficient home and reducing heating and cooling bills.



**what:** With advanced framing (also called Optimum Value Engineering), studs are placed at 24-inches on center and include insulated headers, corners, and intersections.

**why:** Although this approach is primarily considered an energy efficiency strategy, it also contributes significantly to materials conservation.

As costs of framing lumber rise and the availability of straight tight lumber decreases, intermediate and advanced framing can add to savings on the bottom line. Because an advanced frame house uses 20-30% less lumber, it can also take less time to construct and be less expensive to build. Recent studies by building scientists also show that this system generates less movement in the wall system resulting in fewer nail pops. Finally,



Advanced framing conserves materials and increases thermal efficiency by reducing the proportion of wood in a wall assembly. .

Image: David Vandervort Architects, courtesy of City Green Building, Seattle Department of Planning and Development .

fewer plumbing and electrical penetrations result in fewer nail or screw holes to seal and sand.

**how:** Advanced framing requires sheathing, siding, and drywall rated for 24" stud spacing. More insulation will be required, but the wider stud spacing results in fewer pieces of insulation and therefore faster installation.

Using two-stud, rather than three-stud corner construction reduces material use. Two studs are sufficient where two walls intersect at corners; however, most builders use at least three studs and spacer blocking as non-structural nailers for interior finishing. With two stud corners, drywall clips spaced two feet apart support interior finish materials and eliminate the need for extra studs. Place the clips where one wall abuts another, or at corners.

**considerations:** To help increase the efficiency of exterior walls, use strategies to fully insulate at interior/exterior wall intersections (see Action Item 10-4). The usual practice of adding extra studs in the exterior wall to provide nailing for drywall creates an inaccessible pocket that can't be insulated after exterior sheathing is installed. Ladder partitions and other approaches can avoid this.

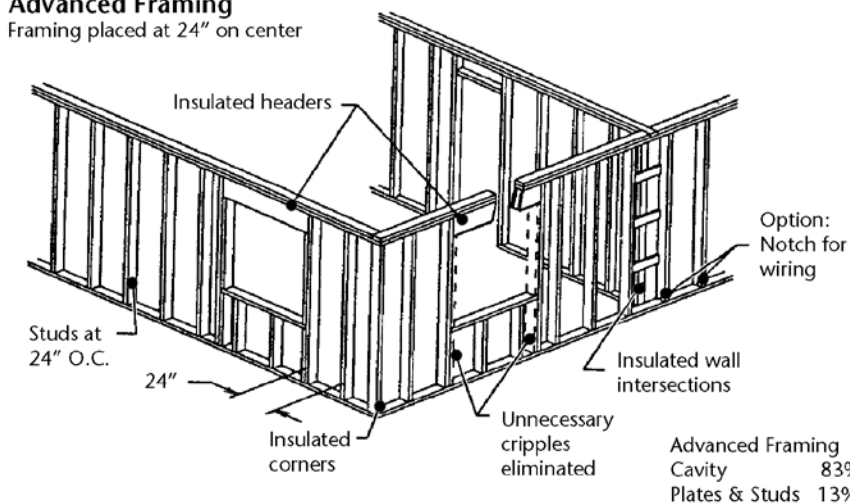
**resources:** ToolBase offers a Technology Fact Sheet: "Advanced Wall Framing:" [www.toolbase.org](http://www.toolbase.org) (click on *Design and Construction Guides* and then *Exterior Walls*). ToolBase also offers a description of drywall clips and stops; search using the term *Drywall Clips*.

The Washington State Energy Code *Builder's Field Guide* includes information on advanced framing: [www.energy.wsu.edu/code/](http://www.energy.wsu.edu/code/) (click on Chapter 3: Framing).

Seattle Department of Planning and Development has developed a Client Assistance Memo (building code assistance) on advanced framing. Client Assistance Memos are available through the department website: [www.seattle.gov/dpd](http://www.seattle.gov/dpd) (click on *Resource Center* and then *Publications*).

*Efficient Wood Use in Residential Construction* by the Natural Resources Defense Council: [www.nrdc.org/cities/building/rwoodus.asp](http://www.nrdc.org/cities/building/rwoodus.asp)

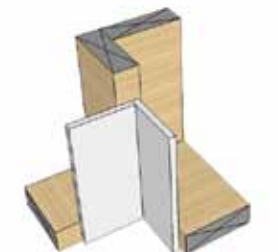
Advanced Framing  
Framing placed at 24" on center



A variety of framing strategies comprise the advanced framing approach beyond the 24" o.c. stud spacing, including two-stud, insulated corners, elimination of unnecessary framing members, and insulated headers.

Image: Washington State Energy Code *Builder's Field Guide*, courtesy of Washington State University Energy Extension.

## Action Item 1-50



Two stud corners allow additional space for insulation, but also require slightly different methods for finishing walls. Drywall clips anchor wallboard to framing when a third stud is not available for backing; similarly, scrap plywood or drywall can act as the securing surface.

Image: David Vandervort Architects, courtesy of City Green Building, Seattle Department of Planning and Development.

## Action Item 1-51

If adding a garage, minimize garage size

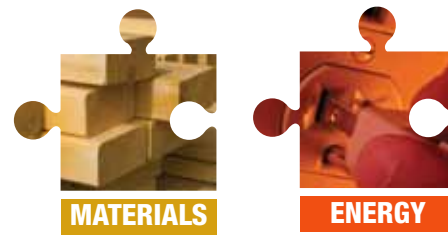
### Points: 2-5

#### Responsible party:

Architect

#### Intent:

Minimize construction material-related resource use; encourage simpler lifestyles.



**what:** For the purposes of this Action Item, minimal garage size means limiting the size to accommodate either two or one car.

**why:** Garages have become de facto storage units, and additions to the home. They result in additional resource use both in construction and operation.

Minimizing garage size may encourage people to consider alternate transportation methods including mass transit, biking, or walking. It also helps to reduce the focus on having multiple cars.

**how:** This Action Item is worth 2 or 5 points.

- 2-car garage: 2 points
- 1-car garage: 5 points

The need for additional garage space may be symptomatic of other design deficiencies within the existing house, including poorly designed spaces for activities and storage. It may also represent a temporary situation, such as a driving-age child. Try to discern the factors behind needing the additional space, and see if it can be accomplished in other, more cost-effective and environmentally friendly ways, such as hiring a professional organizer, or renting a temporary storage space.

Building a smaller garage is a relatively straightforward endeavor, although it may require more design time up front to build a smart space that maximizes its reduced square footage. Design for innovative storage options that make items easy to access in less space, such as pulley storage systems for items such as bicycles keep them safe and out of the way until needed. Consider providing homeowners with a book on simple living (see Resources) in addition to the Homeowner Operation and Maintenance Manual.

**considerations:** Consider physically separating the garage from the living space, or thoroughly air sealing it, to reduce infiltration of exhaust fumes into indoor air (Action Item 1-33). Also consider incorporating easy-access bicycle storage (Action Item 1-56) and installing an outlet for electric car recharging (Action Item 9-21).

#### resources:

The Not So Big Life by architect Sarah Susanka offers help with simplifying one's life: [www.notsobiglife.com](http://www.notsobiglife.com)

*Circle of Simplicity: Return to the Good Life* by Cecile Andrews is a classic of voluntary simplicity: [www.cecileandrews.com](http://www.cecileandrews.com)



**what:** Food waste garbage disposals grind food waste into small bits, allowing the materials to be flushed into the sanitary sewer along with wastewater.

**why:** While garbage disposals are convenient, they load sewer and septic systems with large amounts of organic matter, placing burdens on wastewater treatment. Such systems also increase energy and water use.

**how:** Discuss the need for a food garbage disposal with the homeowner. The common alternative to a disposal is food scrap composting. A remodel is a good time to help the homeowner create a comprehensive food waste management program including dedicated food scrap storage space/receptacles and, potentially, onsite composting ability. Alternatively, many municipalities offer curbside kitchen scrap recycling programs.

For example, the City of Seattle now provides curbside pickup of all food waste, including meats, fats, and food-soiled paper (materials that should not be composted onsite).

**considerations:** Make kitchen composting easier by designing composting amenities into the design, including a kitchen food waste receptacle and cabinet space for temporary kitchen scrap storage, and possibly a worm bin or other onsite composting device (see Resources).

**resources:** The Natural Lawn and Garden *Composting at Home* guide provides information for homeowners on composting food and yard waste: [www.savingwater.org](http://www.savingwater.org) (click on *Conserve Outside*).

Snohomish County Public Works offers brochures on composting: [www1.co.snohomish.wa.us/Departments/Public\\_Works/](http://www1.co.snohomish.wa.us/Departments/Public_Works/) (click on *Solid Waste*, then *Brochures*).



Making kitchen scrap disposal easy can help facilitate the move from using an in-sink garbage disposal to backyard composting or subscribing to a food waste composting service. This built-in kitchen counter waste receptacle holds scraps for later composting.

Image: VELOCIPEDA architects inc

## Action Item 1-52

Do not install food garbage disposal

### Points: 2

#### Responsible party:

Architect, Owner

#### Intent:

Reduce demand on sanitary sewer and related greenhouse gas emissions; encourage food waste composting.



#### Homeowner Benefit:

Kitchens without garbage disposals use less water and energy, saving on utility bills, and are more likely to compost at home, reducing kitchen food waste as well.



#### Homeowner Benefit:

Minimizing the size of a planned garage addition helps control construction costs by saving on labor and materials. In the long run, a smaller structure means less to maintain and operate as well.



## Action Item 1-53

Install materials with at least a 50-year life cycle; minimum of 5 finish applications

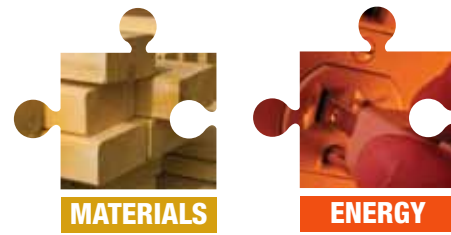
### Points: 1

#### Responsible party:

Architect

#### Intent:

Reduce resource extraction and attendant embodied energy consumption.



**what:** Materials with a 50 year life cycle or longer are identified by either product warranties or by materials service life research.

**why:** Long-lived products yield the financial benefit of reduced replacement frequency; installation costs can often dwarf the materials cost of products.

Additionally, selecting long-lived building materials is one way to improve a building's environmental performance. For example, all else equal, a product that lasts twice as long will have half the embodied energy and extraction, manufacturing, distribution and installation impacts, and half the waste potential as well.

**how:** Whenever possible, choose materials that offer durability and best lifetime value over lowest first cost. One method to evaluate materials with this balance in mind is to use a tool known as life cycle assessment (LCA). Simply put, LCA evaluates a material based on its "cradle-to-grave," or "life cycle," including raw materials extraction and processing, intermediate materials manufacture, material manufacture, distribution, installation, operation and maintenance, and ultimately recycling and waste management following the end of a product's useful life. Life cycle costs prorate the cost over the life of the product. See Resources more on LCA.

Look for 50-year warranty products; alternatively, the Durability by Design guide (Appendix B) from HUD/PATH contains a table listing expected service life for various building materials. Among finish materials, wood flooring and drywall are the only materials on the list. Other finish materials that can be expected to last 50 years or more are porcelain tile, concrete or terrazzo floors, and natural linoleum.

Note: Long-lasting materials are often torn out well before they are worn out. Take special care to select durable materials that will stand the test of time in terms of style and aesthetics as well as service life. Ceramic tile is a particular case in point. Look for classic designs and colors that will look just as good in 25 years as they do today. One tip for longevity of aesthetics is to match the vintage of the existing home. A Craftsman-era tile design in a Craftsman home likely will look better down the road than Italian Modern in the same home.

**resources:** *Durability by Design: A Guide for Residential Builders and Designers* is available through the PATH website: [www.pathnet.org/sp.asp?id=984](http://www.pathnet.org/sp.asp?id=984)

"Life Cycle Assessment for Buildings: Seeking the Holy Grail" (*Environmental Building News*, March 2002) gives a good overview of the potential and current limitations of LCA in evaluating building materials. Available at [www.buildinggreen.com](http://www.buildinggreen.com) (search for Life Cycle Assessment).



**what:** Window reuse includes on-site and off-site salvage, e.g., purchasing from used building materials retailers or other projects.

**how:** Reusing windows can provide the opportunity to retain or reproduce architectural heritage, and reduces the embodied energy of a project.

This credit is available if salvaged windows are purchased from salvage and reuse operations, re-used from the project or other jobsites, or reclaimed in demolition.

Be aware that used windows may not be permissible on an addition by building code authorities, where the windows must show their U-value for code compliance.

**considerations:** Carefully consider the energy trade-offs inherent in reusing windows on a project. New window technologies and designs are dramatically increasing the energy efficiency of fenestration (see Additional Considerations). Often, used building materials retailers will have overstock or improperly specified new windows that still have their NFRC rating stickers intact.

Consider reusing inefficient windows ineligible for this Action Item on the home's interior (as transoms or relites) or for an exterior airlock (see Action Item 1-44) where they will not compromise the integrity of the building envelope.

Also consider specifying new, NFRC certified efficient windows (Action Item 5-1) and the impact of window reuse on passive solar design goals for a project (Action Item 1-23).

**resources:** The Efficient Windows Collaborative provides information on window glazing and frame efficiencies: [www.efficientwindows.org](http://www.efficientwindows.org)

The Northwest Building Salvage Network provides links to regional used building materials retailers: [www.nbsnonline.org](http://www.nbsnonline.org). The site also offers a fact sheet on reusing windows (click on *Downloads*).

The Building Materials Reuse Association provides a directory of used building materials retailers and salvage consultants: [www.bmra.org](http://www.bmra.org)

The Green Home Remodel Salvage and Reuse guide provides general information on building materials salvage and reuse: [www.greentools.us](http://www.greentools.us) (click on *Residential Buildings*, then *Residential Remodeling Guides*).

EPA information on avoiding lead based paint hazards: [www.epa.gov/lead](http://www.epa.gov/lead). Homeowners should read the EPA document: "Renovate Right: Important Lead Hazard Information for Families, Child Care Providers and Schools."

## Action Item 1-54

Reuse windows (excluding single-pane)

### Points: 1

#### Responsible party:

Architect, Owner

#### Intent:

Reduce resource extraction and fabrication and attendant embodied energy consumption.



#### Homeowner Benefit:

Long-lived materials save a homeowner money by reducing replacement frequency. Financial savings can be substantial, when materials costs, installation costs, and disposal costs are all taken into account.



#### Homeowner Benefit:

Reusing windows can save on project costs by avoiding the often-substantial cost of new windows.

## Action Item 1-55

Reduce interior walls through open plan for kitchen, dining, and living areas

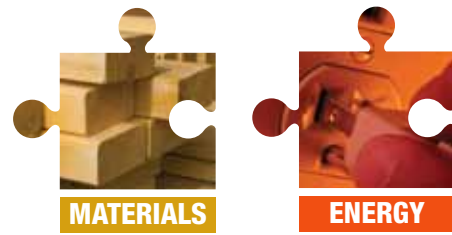
### Points: 2

#### Responsible party:

Architect

#### Intent:

Reduce material use; enhance space flexibility and reduce costs of space reconfiguration; enhance access to daylight and views; enhance air circulation and natural ventilation.



**what:** Open plan design minimizes or removes interior partition walls, creating larger rooms by marrying spaces.

**why:** This strategy reduces material use and cost for walls and creates an adaptable space that allows for optimal daylighting, occupant interaction, and natural ventilation.

**how:** Determine feasibility of opening up existing space by identifying bearing walls. Modifying bearing walls will require engineering and structural beams or headers.

Work with an interior design professional, architect, or lighting designer to determine the optimal configuration for open space.

**considerations:** Consider salvage and reuse for dimensional lumber (Action Item 4-8) and other materials that may be yielded by removing interior partition walls.

In areas where privacy or sound attenuation is needed but natural light desired, consider adding relites (interior windows to allow natural light to penetrate deeper into a space) to existing walls. Consider reusing windows that are not appropriate for exterior use due to their thermal characteristics for relites (see Action Item 1-54).

Proper placement of windows for cross ventilation (Action Item 1-43) can add function to an open plan design.



**what:** A bicycle storage area can take many forms, but essentially consists of a dry, secure, and easily accessible place for bikes when not in use.

**why:** The carbon footprint of the Pacific Northwest is dominated by transportation-related carbon emissions, unlike many other parts of the country, where houses are the primary source of greenhouse gases. Encouraging bicycle ownership and use helps get people out of their cars and onto healthier and more environmentally benign forms of transportation, including bicycling.

**how:** Bicycle storage is a chance to be creative with otherwise underutilized spaces in or near the home. Examine the existing home and proposed modifications to find easy-access, dry and secure spaces that could hold at least two bicycles. Potential existing places are under the front or back stairs, or in the rafters of the garage, where a pulley system could help store bikes out of the way but easily accessed. If planning an addition as part of the remodel, or adding a front porch (Action Item 1-58), consider adding dedicated space for bicycle storage.

## Action Item 1-56

Install a special bike storage area or other design features to encourage bike ownership and use

### Points: 3

#### Responsible party:

Architect, Owner

#### Intent:

Reduce transportation related energy use and pollution; enhance occupant health and wellbeing.



#### Homeowner Benefit:

Reducing interior walls can provide more flexible, usable space for a home, reducing the need to build more space and saving on materials expenses.

Additionally, open plan spaces can reduce energy bills related to lighting and ventilation, and provide occupant benefit by increasing access to natural light, views, and fresh air.



#### Homeowner Benefit:

A dedicated bicycle storage area helps protect a bicycle from damage from the elements or wear and tear; it also encourages the use of bicycles for transportation—saving fuel and promoting exercise and wellbeing.

## Action Item 1-57

Add a permitted accessory dwelling unit or living quarters

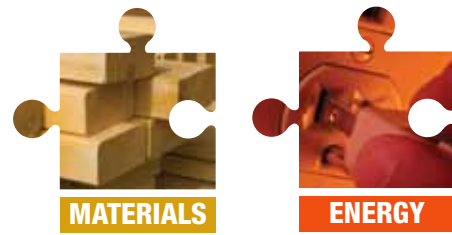
**Points: 10**

**Responsible party:**

Architect

**Intent:**

Promote site density; reduce per-capita energy and material use; promote community, flexibility of living, and housing affordability.



**what:** An ADU is a distinct and separate living space provided on a single-family property. ADUs are often called “Mother-in-Law Units,” or detached ADUs may be called “backyard cottages.” Snohomish County refers to them as accessory apartments. The living space is equipped with all amenities needed to allow rental of the space: kitchen, bath, and living/sleeping space, and includes a separate entry and design features to help retain occupant privacy and maintain the single family aesthetic of the neighborhood. Nearly all jurisdictions with ADU regulations require that the owner must occupy one of the two units in a home with an ADU.

**why:** Urban sprawl is a significant contributor to carbon emissions, by increasing vehicle miles traveled. According to the Washington State Department of Ecology, approximately half of Washington’s carbon footprint is related to transportation. By adding an ADU to a property, a homeowner can help combat this problem.

**how:** Depending on the project’s jurisdiction, different rules apply to ADU development. Check with the project’s building permitting authority to determine the requirements in a particular location. Beyond the permitting implications, the ADU is an opportunity to incorporate green building principles along with the primary structure. By sharing a wall (or multiple walls) with the primary structure, an ADU is more energy efficient than a freestanding structure. However, a detached ADU (backyard cottage) can open up the possibility of employing passive solar design strategies that may be

unavailable given the placement and orientation of the existing house. Consider solar access, privacy and the larger community whenever planning an ADU.

When working with the homeowner to determine the suitability of an ADU, include basic calculations on the anticipated monthly income possible from the unit’s rental, and factor this into the home improvement loan scenario. It may be possible that the loan amount increment needed for the ADU is substantially or totally offset by the income potential (especially with basement conversions) provided by the added unit.

**considerations:** If the ADU plans include conversion of existing unheated basement space, pay special attention to building science implications related to insulating sub-grade areas. Ignoring these issues can result in moisture damage, indoor air quality problems, and unnecessarily large energy bills.

**resources:** A Regional Coalition for Housing (ARCH) provides an overview of ADUs from a Central Puget Sound perspective: [www.archhousing.org/adu2/design.html](http://www.archhousing.org/adu2/design.html)



**what:** Front porches can take many forms, but usually incorporate covered space near the front door. Porches are usually outfitted with seating to facilitate use, and can be free of walls or partially enclosed.

**why:** Front porches help promote community by offering a semi-public place for homeowners to congregate with neighbors and socialize with passers-by. Front porches can also be part of a home’s passive solar design strategy, offering shade in the summertime but allowing solar access during the winter—reducing heating and cooling season energy bills.

**how:** Improperly designed, front porches can appear to be an afterthought or clumsy add-on. Incorporate a front porch early on in the design process, allowing for an aesthetic that complements the existing structure in terms of both form and materials.

**considerations:** A front porch can serve several purposes at once, and these functions should be considered when designing the porch. These include passive solar design (see Action Item 1-23), acting as a vestibule for shoe removal (Action Item 1-44), and as convenient bicycle storage (Action Item 1-56).

## Action Item 1-58

Provide a new covered front porch of at least 50 square feet

**Points: 4**

**Responsible party:**

Architect

**Intent:**

Promote community engagement; promote access to the outdoors.



### Homeowner Benefit:

Including an accessory dwelling unit (ADU) in remodeling plans can provide long-term income to a homeowner in the form of rent, as well as flexibility to future living arrangements.



### Homeowner Benefit:

A front porch provides protected outdoor space to enjoy the Pacific Northwest’s temperate climate regardless of whether it’s raining, and helps promote neighborliness. Front porches can also help a home save energy by providing summer shading.

## OPERATIONS

Jobsite operations offer an opportunity to increase the environmental performance of a project in a variety of ways, including construction waste prevention and recycling, site protection and enhancement, and ensuring a healthy home and jobsite for workers and occupants.

## Action Item 2-1

Prepare a waste reduction and jobsite recycling plan, and post on site

### Required

#### Responsible party:

Contractor, Architect

#### Intent:

Reduce waste and promote a closed-loop resource use paradigm



**what:** A waste reduction and jobsite recycling plan is a comprehensive strategy for dealing with waste generated during the course of construction. Such plans identify the materials likely generated, and provide information on how materials will be handled and recycled. Key to the plan is the act of sharing this information with crew and subs, to increase the effectiveness of plan deployment.

**why:** The US EPA estimates that in 2003 (the most recent data available) the residential construction sector was responsible for generating 10 million tons of construction and demolition debris. For example, in Seattle in 2007 alone, more than 300,000 tons of demolition waste was delivered to private and city transfer stations for landfill disposal. This amount can be dramatically reduced through waste reduction and recycling efforts.

The Pacific Northwest has strong options for construction and demolition debris recycling, as well as salvage and reuse opportunities. Combined, these options can reduce the environmental footprint of a remodeling project.

**how:** This Action Item is required for credit in the program.

Each construction project presents a unique set of circumstances. Some key points to keep in mind when developing a plan:

- Customize the recycling plan to the project's specifics. The King County GreenTools program provides construction recycling information including a sample recycling plan; see Resources.
- Target high-potential materials for recycling and reuse. Phase recycling based on construction activities.
- Decide how and where to collect the targeted materials, e.g., stockpile cardboard in garage, use a roped-off area for metal, and containers for wood and drywall.
- Make recycling on the jobsite at least as convenient as disposal (e.g., place wood collection containers near the central cutting area).
- If commingling recycling, educate subcontractors and employees on how the recycling system works, and what can and cannot be recycled in the commingled waste container. Post guidelines near containers.

- Rely on quality, easily accessible recycling and salvage service providers and facilities.
- “Sell” program benefits: savings, safety, and marketing, to jobsite crews (including subs).
- Designate a lead on site (individual or team) responsible for educating others and keeping things on track.

Provide key field personnel the information they need to participate. This could include:

- A copy of the Jobsite Recycling Plan (see Resources).
- A copy of relevant contract language to subcontractor.
- Regular updates on recycling results at safety or project meetings.
- Recognition to everyone participating in the program.

**considerations:** A waste reduction and recycling plan is the first step to gaining multiple points related to building materials salvage, reuse, and recycling within the BUILT GREEN program. Maximizing the recycling rate for waste materials generated, either via source separated recycling (Action Item 2-9) or commingled recycling (Action Item 2-10) is the necessary next step.

**resources:** King County GreenTools provides a sample waste reduction and recycling plan: [www.greentools.us](http://www.greentools.us) (click on *Construction Recycling*, then *Design Specifications and Waste Management Plans*). Explore the GreenTools site for much more information on jobsite waste reduction and recycling.

## Action Item 2-1



### Homeowner Benefit:

A jobsite waste reduction and recycling plan helps ensure that waste is minimized and materials recycling is efficient and effective, reducing the cost of materials disposal.

## Action Item 2-2

Use deconstruction to dismantle existing building(s) for reuse

### Points: 2-20

#### Responsible party:

Contractor

#### Intent:

Reduce materials-related energy and resource use.



**what:** Deconstruction is the systematic dismantling of a building with the aim of removing materials in reusable condition. “Full deconstruction” entails removing most items with hand tools. “Hybrid deconstruction” uses heavier machinery, including outreach forklifts, to panelize and then pull elements of the home apart, to lay them on the ground for safer and easier dismantling. Depending on the process chosen, deconstruction can take about 2-3 weeks to complete. The cost tends to be slightly higher than traditional demolition and disposal/recycling, but costs can be offset by reduced disposal fees and funds or tax credits generated from the sale or donation of salvaged materials.

**why:** Deconstruction activities help minimize the amount of waste generated by a demolition, and helps maintain materials in reusable condition, either on the current project or off-site. In general, reuse of materials helps conserve both material and energy (“embodied energy”) resources. In addition, salvaging materials often helps generate local economic activity, both with the deconstruction services and with resale of salvaged materials. Finally, donating the materials salvaged from a home can provide a tax benefit to the homeowner.

**how:** This Action Item is worth 2, 10, or 20 points:

- Architectural elements/fixtures: 2 points
- Architectural elements/fixtures, plus large pieces: 10 points
- Salvage is 20%+ of total project waste by weight: 20 points

Architectural elements/fixtures include antique original lighting and hardware, mantels, timbers, tongue and groove paneling, flooring, window trim, faucets, shelving, bricks, and pavers.

Architectural elements/fixtures, plus large pieces includes cabinets, windows, crown molding, sinks, bathtubs, railings, etc.

Everything salvageable includes all the above listed items plus reusing scrap wood to build shelves, shoe removal vestibule (see Action Item 1-44), roof shingles, bricks, slate, broken concrete.

To determine whether or not the project qualifies for the 20% salvage tier, sum the total project waste by adding up disposal receipts from all project waste including waste that was taken to a recycling facility. Then, work with salvage contractors to estimate the weight of the items in the home that were deconstructed for salvage/reuse purposes, either onsite or off. The weight of salvaged materials must be 20% or more of the total waste on the project in order to earn 20 points.

Deconstruction services are available from a variety of firms, both for-profit and nonprofit. The contractor or remodeling professional can perform deconstruc-

tion; however, performing salvage operations on a home requires know-how and experience to be done safely and cost-effectively. Proper deconstruction follows a process of abating any existing hazards (primarily lead and asbestos) prior to the deconstruction process. Deconstruction essentially entails “un-building” a building, in the reverse order of construction. Some jurisdictions, (e.g., Seattle) offer processes that allow for the issuance of a demolition permit in advance of the building permit, in order to allow more time for deconstruction. Be sure to allot time for the deconstruction process in the project schedule. The City of Seattle, for example, has now decoupled its demolition permit from the building permit issuance for projects using deconstruction, to allow for the added time it takes to deconstruct.

**considerations:** Designing additions and alterations on the existing home helps facilitate deconstruction in the future. See Action Item 1-47 for details on this process, or consult King County GreenTools *Design for Deconstruction* manual (see Resources).

A wide variety of Action Items throughout the checklist encourage building materials reuse.

Balance the materials benefits of reuse of materials against the fact that some older products may reduce the efficiency of a home (e.g., exterior doors, windows, lighting and water-using fixtures). Also consider health and safety in terms of the presence of lead based paint or asbestos in salvaged products.

**resources:** The Deconstruction Institute provides resources to better understand and employ deconstruction:  
[www.deconstructioninstitute.com](http://www.deconstructioninstitute.com)

The Northwest Building Salvage Network provides links to used building materials retailers and resources on building salvage and deconstruction:  
[www.nbsnonline.org](http://www.nbsnonline.org)

The Building Materials Reuse Association provides a directory of used building materials retailers and salvage consultants:  
[www.bmra.org](http://www.bmra.org)

King County’s GreenTools program provides information on deconstruction:  
[www.greentools.us](http://www.greentools.us)  
(click on *Construction Recycling*, then *Deconstruction and Salvage*). This site also includes the *Design for Deconstruction* manual.

The Green Home Remodel *Salvage and Reuse* guide provides general information on building materials salvage and reuse:  
[www.greentools.us](http://www.greentools.us)  
(click on *Residential Buildings*, then *Residential Remodeling Guides*).

Homeowners should read the EPA document: “Renovate Right: Important Lead Hazard Information for Families, Child Care Providers and Schools.” This document, and much more information useful for dealing with household lead hazards, is available at:  
[www.epa.gov/lead](http://www.epa.gov/lead)

## Action Item 2-2



### Homeowner Benefit:

Building deconstruction (as opposed to demolition) can dramatically reduce a project’s waste disposal. In addition, deconstruction is a more careful dismantling of a structure, helping reduce incidental damage to materials intended for saving. The result can be both monetary and materials savings.

## Action Item 2-3

Enroll the project in the local utility's renewable energy program

### Points: 3

#### Responsible party:

Owner, Architect

#### Intent:

Promote development of community and regional renewable energy resources; reduce the home's carbon footprint.



**what:** Renewable energy programs vary from utility to utility, but tend to focus on supporting the development of local renewable energy projects by collecting funds to help finance such projects. A small fee is charged on the utility bill, acting as a monthly donation to the cause of renewable energy development. Some utility programs may also offer their customers the ability to purchase carbon offsets for the energy used by their home.

**why:** Utility renewable energy programs help promote the full-cost accounting of energy production, thereby reducing the externalities accrued by energy production activities. By encouraging carbon-offsetting activities ranging from photovoltaic panel installation to tree planting, these programs help lower the environmental impact of energy production and use.

**how:** Review the local electric utility's website or contact utility representatives to learn more about the renewable energy program(s) offered. Work with the homeowner to enroll the home; most often the electricity account holder for the home coordinates this.



#### Homeowner Benefit:

Enrolling in a local renewable energy program provides peace of mind related to knowing a home is reducing its carbon footprint by supporting local renewable energy projects.



**what:** Cardboard, plastic shrink-wrap, kraft paper, wood pallets or frames, and metal bands are just some of the packaging materials that show up on the jobsite along with building materials. In the end, they comprise a significant portion of the typical construction waste stream and in this way add to your project costs.

**why:** Reducing packaging waste not only benefits the environment by conserving landfill space and the resource use and pollution related to waste disposal, it also provides a financial benefit by reducing recycling and tipping/disposal fees. Additionally, it reduces labor costs associated with handling and hauling waste materials.

**how:** Reducing waste in the first place is preferable to recycling. Look for suppliers who provide materials in reusable packaging, such as pallets and moving blankets.

A few manufacturers are beginning to take their own packaging back and reuse it to package new materials. Items that can be reused cost effectively include:

- Pallets
- Some types of corrugated cardboard packaging
- Plastic buckets

In addition, encourage manufacturers to accept and recycle their own packaging and product waste. Some ways to encourage suppliers and manufacturers to take responsibility for their packaging;

- Request minimal packaging when placing a materials order.
- Select brands of building products that are delivered with minimal packaging.
- Select products with reusable packaging.
- Select products with recyclable packaging.
- Purchase materials like fasteners, paints, caulking, and dry-wall mud in bulk containers.
- Request suppliers take back their packaging.

Some packaging will always be necessary to prevent materials damage; find the balance between necessary and excessive packaging. Let suppliers know the economic and environmental reasons for reducing and recycling packaging.

**resources:** The King County GreenTools program has produced a sample letter to vendors to help facilitate waste reduction:  
[www.greentools.us](http://www.greentools.us)  
(click on *Construction Recycling*, then *Prevent Jobsite Waste*).

## Action Item 2-4

Use suppliers who offer reusable/recyclable or no packaging for major materials

### Points: 1

#### Responsible party:

Contractor

#### Intent:

Reduce packaging waste and attendant energy and resource use.



#### Homeowner Benefit:

Reducing packaging waste reduces disposal, recycling, and handling fees that come with materials that are over packaged.

## Action Item 2-5

Use suppliers that operate a “take back” program

### Points: 1-3

#### Responsible party:

Contractor

#### Intent:

Reduce materials-related energy and resource use.



MATERIALS

**what:** Take back programs take two forms: programs that allow contractors to return unused, undamaged materials for restocking, or programs for returning a product or material at the end of its service life.

**why:** Take back programs reduce waste by more effectively using materials, and encourage the closed-loop recycling of building materials.

**how:** This Action Item is worth 1 or 3 points:

- Use suppliers that take back packaging materials: 1 point
- Use suppliers that allow take-back of surplus building materials: 3 points

Ask suppliers and manufacturers about their take back and return policies. Manufacturers usually manage end-of-life take back programs. Suppliers and retailers normally handle take-back programs for unused and surplus materials.

Examples of end-of-life take-back programs include some modular carpet tile manufacturers and suspended acoustical ceiling tile manufacturers.

**considerations:** Design for deconstruction (Action Item 1-47) can facilitate the removal of materials for reuse and/or take back.

**resources:** King County’s GreenTools program includes information on construction waste prevention, including a suggested letter to vendors to request packaging take-back, reusable packaging, and surplus take-back: [www.greentools.us](http://www.greentools.us) (click on Construction Recycling, then Prevent Jobsite Waste).



MATERIALS



SITE/WATER



HEALTH

**what:** Waste reduction is the prevention of waste in the first place, and considered the most environmentally beneficial approach to managing waste. By avoiding the creation of waste, a job can avoid the effort and cost of either recycling or waste disposal. Waste reduction takes a variety of forms, including reducing packaging waste, avoiding construction and jobsite activity waste, and reducing demolition waste. Requiring contractor employees and subs to participate creates the needed follow-through.

**why:** Like all plans, waste reduction efforts are only as successful as the execution. Inserting contract language and providing educational opportunities dramatically increases the likelihood that plans will be implemented, and help convey the message that the contractor is serious about their environmental objectives.

**how:** Successful subcontractor participation in waste reduction efforts requires clearly communicating your intentions to reduce waste on the jobsite. Strategies include:

- Require waste reduction in written contracts with subs (see below).
- Communicate waste reduction goals at a jobsite kickoff meeting and reiterate and give updates on progress during safety meetings.
- Give examples of types of materials that can be reused.
- Clearly indicate materials targeted for recycling on this job and explain how materials are collected for reuse and recycling.

- Provide incentives to encourage sub participation.

Additionally, letting subcontractors know that they will be required to provide documentation of waste management efforts sends a clear signal that follow-through is expected.

Sample contract language:

“Subcontractor will be required to reduce the amount of waste generated on the site and recycle materials per the Contractor’s jobsite recycling plan. Subcontractor will follow source separation recycling requirements for each waste type targeted in the plan and use the appropriate on site containers for each waste type. Subcontractors are required to participate in jobsite meetings during the course of the project as part of the waste reduction program. In addition, subcontractors are to use recycled content products whenever feasible.”

**considerations:** See Action Item 2-1 for information on preparing and posting a jobsite recycling plan.

**resources:** King County’s GreenTools program includes information on construction waste prevention, including a construction waste management specification that serves as a good outline for recycling and waste prevention activities: [www.greentools.us](http://www.greentools.us) (click on *Construction Recycling*, then *Prevent Jobsite Waste*).

## Action Item 2-6

Require subcontractors and contractor’s employees to participate in waste reduction efforts

### Points: 2

#### Responsible party:

Contractor, Architect

#### Intent:

Reduce waste and promote a closed-loop resource use paradigm.



#### Homeowner Benefit:

Waste reduction on the jobsite means no waste created in the first place, and consequently, reduced waste management fees. Keeping the jobsite free of waste also means a safer and cleaner site.



#### Homeowner Benefit:

“Take back” programs can save money on construction costs by allowing the return and refund of unused, surplus materials, and on disposal costs by providing a free or low-cost way of returning materials at end of life back to manufacturers.



## Action Item 2-7

Sell or donate wood scraps

### Points: 1

#### Responsible party:

Contractor

#### Intent:

Reduce waste and promote a closed-loop resource use paradigm.

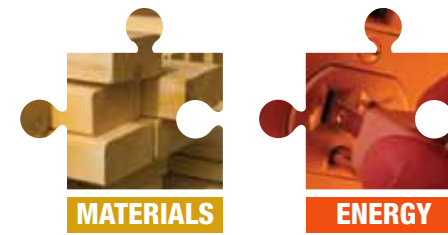


**what:** A “closed loop resource use paradigm” means retooling the way we view and deal with waste, recognizing it as a resource and opportunity to reduce raw material extraction. Redirecting wood scraps entails selling or giving away materials to encourage productive use of the materials.

**why:** According to the National Association of Home Builders, wood waste can make up 40-50% of the residential construction waste stream. Putting this material to active use helps reduce landfilling and burning of this resource. Additionally, placing organic debris, such as wood, in landfills creates methane, a greenhouse gas twenty times more potent than carbon dioxide.

**how:** Sell or give away logs not used as timber, or wood scraps that are less than one foot long since they are unlikely to be reused on the job. Lumber may be desirable for small renovation projects by local homeowners or could be donated to a used building materials store for tax credit. Land clearing debris can be dropped off at local organics recycling centers where they will be composted or mulched into valuable soil amendment products.

**resources:** In King County, the King County Solid Waste Division’s “What do I do with...” database can provide outlets for various building materials and construction and demolition scrap: [www.your.kingcounty.gov/solidwaste/wdidw/index.asp](http://www.your.kingcounty.gov/solidwaste/wdidw/index.asp)



**what:** Used and salvaged materials are available for virtually any application, from structural lumber to finish materials and fixtures.

**why:** Purchasing used building materials (or using them from other jobs or onsite) helps keep useful materials out of the landfill, and conserves increasingly scarce resources and reducing the demand for logging, mining and other natural resource extraction practices. Sourcing and installing salvaged materials can be an added service offering for a remodeler as well; tracking down salvaged materials and employing the craftsmanship to install them properly takes skill and determination.

**how:** Source salvaged materials from local used building materials retailers, via online sources, or from other jobs. Most used building materials retailers have good lists of available materials on their websites, making it easier to locate needed materials. However, sometimes online inventories are not up-to-date; calling ahead and making regular visits can pay off with great finds. Alternatively, the homeowner can serve as the scout for potential materials. This approach can make incorporating salvaged materials more cost-effective for the homeowner, and reduces the risk of bringing something to the jobsite that is not to the client’s liking.

**considerations:** Be sure to consider the operational efficiency of used building materials, especially windows, fixtures such as toilets and faucets. Also be aware that vintage items may be painted with lead-based paints. Low cost lead testing kits are available from home improvement retailers.

**resources:** The Northwest Building Salvage Network provides links to used building materials retailers and resources on building salvage: [www.nbsnonline.org](http://www.nbsnonline.org)

The Building Materials Reuse Association provides a directory of used building materials retailers and salvage consultants: [www.bmra.org](http://www.bmra.org) (click on *Directory*).

The Green Home Remodel *Salvage and Reuse* guide provides general information on building materials salvage and reuse: [www.greentools.us](http://www.greentools.us) (click on *Residential Buildings*, then *Residential Remodeling Guides*).

EPA information on avoiding lead based paint hazards: [www.epa.gov/lead](http://www.epa.gov/lead) Homeowners should read the EPA document: “Renovate Right: Important Lead Hazard Information for Families, Child Care Providers and Schools.”

## Action Item 2-8

Purchase used or salvaged building materials; minimum of 5 applications

### Points: 5

#### Responsible party:

Contractor

#### Intent:

Reduce waste and promote a closed-loop resource use paradigm.



#### Homeowner Benefit:

Redirecting wood scraps reduces total disposal and recycling costs.



#### Homeowner Benefit:

Salvaged materials can add “instant history” to a project, helping tie existing and new elements together. Some salvaged materials (especially wood products) are of a quality unavailable today. And by purchasing used building materials, a homeowner is reducing resource depletion, and, in many cases, supporting local businesses.

## Action Item 2-9

Recycle by source separation with an 85% minimum recycling rate (applies to all demolition waste that is appropriate for recycling and all new construction waste):

### Points: 1-9

#### Responsible party:

Contractor

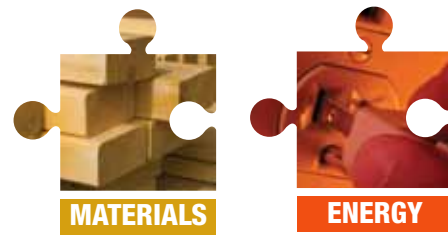
#### Intent:

Divert resources from the landfill and promote a closed-loop resource use paradigm.



#### Homeowner Benefit:

Maximizing recycling rates often results in lower waste management costs on a project, as recycling materials is cheaper sending them to the landfill. Additionally, the homeowner is promoting local recycling industries and reducing waste by encouraging recycling on the project.



**what:** Source separation is the process of separating recyclable materials into specific categories for later delivery to recycling facilities. The alternative to source separation is commingled recycling, where a single receptacle is used to collect and transfer recyclable materials to a materials recovery facility. Source separation reduces the amount of contamination of the potentially recyclable material, leading to higher recycling rates. Cleaner material can usually be recycled into higher quality materials than contaminated mixed materials.

**why:** Source separation of recyclable materials helps ensure materials are put to their highest and best use. Much of the material in commingled recycling is used as landfill cover or burned for fuel—not the best use for the materials. Source separation can also help spur local uses for products, such as recycling asphalt roofing material into road resurfacing material. Additionally, according to the King County GreenTools program, source separation of demolition debris is usually more cost-effective than commingled recycling or disposal.

**how:** This Action Item is worth 1-9 points.

Achieve 85% or better recycling rate for the following materials:

- Asphalt roofing: 4 points
- Carpet padding and upholstery foam: 1 point
- Glass: 2 points
- Landclearing and yard waste, soil and sod: 2 points

Setting up source separation is relatively straightforward; it requires creating dedicated receptacles for the materials the project intends on recycling. Given the larger number of bins, source separation does require more physical space on the jobsite, and clear identification on bins. Additionally, training all workers and subs as to where the recyclables should go is imperative to keeping things on track.

The King County GreenTools Construction Recycling Directory and the online “What do I do with...?” service identifies companies that take a wide variety of source separated materials for recycling (see Resources).

Many companies throughout King and Snohomish Counties collect and process land clearing debris and yard waste. In addition there are companies that offer mobile grinding services in which they will process land clearing debris at the jobsite. This reduces transportation costs and provides you with a material to use on your property for site protection activities.

Chipped woody land clearing debris makes effective mulch for covering soil stockpiles or temporary erosion and sediment control, and can be reused in final landscaping as woody mulch around trees and shrubs (cover with a top layer of arborist mulch or coarse bark mulch if appearance is an issue). Use these un-composted woody materials as mulch, not for soil amendment. Wherever possible, topsoil that can't be protected should be carefully stripped and stored on-site for reuse and subsoil cut and fill should be balanced.

Grading plans can often be adjusted to reuse excess soil, or it can be kept clean and delivered to a topsoil blender or another project nearby. Sod and green waste should go to a composting facility. Potentially, the same trucks that haul these materials away can haul in finished compost for erosion-control blankets and final soil amendment, reducing totally hauling costs and impacts.

**considerations:** Avoiding waste in the first place is better than recycling. Look for ways to avoid waste on the project, including salvaging on site (Action Item 2-2) and reducing packaging waste from suppliers (Action Item 2-4).

**resources:** The King County/Seattle *Construction Recycling Directory* provides contact information for firms offering recycling services for source separated and commingled construction and demolition waste. The Recycling Directory is available through [www.greentools.us](http://www.greentools.us)

Additionally, visit the GreenTools website for information on planning and executing a successful waste reduction and recycling program, as well as information on the cost-effectiveness of different construction waste management approaches (click on *Construction Recycling*).

Earth 911 maintains a handy ZIP Code-based recycling directory for a wide variety of construction recycling debris: [www.earth911.org](http://www.earth911.org) (click on *Construction*).

Snohomish County Public Works maintains a brochure on construction recycling, as well as a list of construction and demolition debris recyclers: [www1.co.snohomish.wa.us/Departments/Public\\_Works/](http://www1.co.snohomish.wa.us/Departments/Public_Works/) (click on *Solid Waste*, then *Brochures*).

## Action Item 2-9

## Action Item 2-10

Send at least 85% of jobsite waste (by weight, excluding concrete) to a commingled recycling facility with a: 50%, 75% or 95%+ recycling rate

### Points: 5-20

#### Responsible party:

Contractor

#### Intent:

Divert resources from the landfill and promote a closed-loop resource use paradigm.



**what:** Commingled recycling places all recyclable waste for a project in a single receptacle, to be later separated and recycled at a materials recovery facility. While the process is simpler to employ on the jobsite, the recycling rate achieved by different facilities can vary dramatically—from less than 10% to over 95%.

**why:** Commingled recycling streamlines the collection process on the jobsite, and requires the placement of a single recycling receptacle. If taken to a facility with a high recycling rate, diversion in terms of percentage can be as good as or better than with source separation.

**how:** This Action Item is worth 5, 10, or 20 points.

85% of construction and demolition waste must be sent to a facility with a minimum recycling rate:

- 50-74% : 5 points
- 75-89% : 10 points
- 90%+ : 20 points

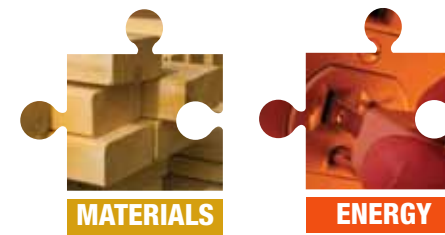
Various commingled recycling services exist throughout the Puget Sound region. In order to achieve the most points for this Action Item, be sure to consult with the King County commingled recycling facility data, updated regularly on the King County website (see Resources). Communicate closely with haulers in order to ensure the material is hauled to the correct facility.

**considerations:** While commingled recycling is cost-effective and streamlined compared to source separation on the jobsite, there are concerns that the end product recyclable materials are of a quality that means they will be “downcycled” into low value products. A goal of recycling is to maintain the value of the materials they represent. Source separation increases the likelihood that this will happen.

**resources:** The King County/Seattle Construction Recycling Directory provides contact information for firms offering recycling services for source separated and commingled construction and demolition waste. The Recycling Directory is available through [www.greentools.us](http://www.greentools.us)

Additionally, visit the GreenTools website for the latest information on commingled recycling facilities’ diversion/recycling rates (click on Construction Recycling).

Snohomish County Public Works maintains a brochure on construction recycling, as well as a list of construction and demolition debris recyclers: [www1.co.snohomish.wa.us/Departments/Public\\_Works/](http://www1.co.snohomish.wa.us/Departments/Public_Works/) (click on Solid Waste, then Brochures).



**what:** Materials with a 50 year life cycle or longer are identified by either product warranties or by materials service life research.

**why:** For the purposes of this Action Item, “longer life cycle products” refers to building materials with a 30-year or longer expected life.

**how:** Whenever possible, choose materials that offer durability and best lifetime value over lowest first cost. One method to evaluate materials with this balance in mind is to use a tool known as life cycle assessment (LCA). Simply put, LCA evaluates a material based on its “cradle-to-grave,” or “life cycle,” including raw materials extraction and processing, intermediate materials manufacture, material manufacture, distribution, installation, operation and maintenance, and ultimately recycling and waste management following the end of a product’s useful life. Life cycle costs prorate the cost over the life of the product. See Action Item 1-53 for more on LCA.

Look for product warranties of 30 years or more. In addition to the materials listed in Action Item 1-53, metal roofing, fiber cement siding, green roofs (Action Item 1-12), metal-clad wood windows, and many other products are designed to be long lasting.

**considerations:** Proper care and maintenance has dramatic impact on product life. Include information in the Homeowner Operations and Maintenance Manual on materials care and maintenance.

Specify finish materials with 50-year life cycles (Action Item 1-53).

When installing long-life materials, consider Design for Deconstruction (Action Item 1-47) to facilitate reuse.

**resources:** See Action Item 1-53 for resources related to materials with longer life cycles.

*Durability by Design: A Guide for Residential Builders and Designers* (US Department of Housing and Urban Development, 2002): [www.huduser.org/publications/destech/durdesign.html](http://www.huduser.org/publications/destech/durdesign.html)

## Action Item 2-11

Install materials with longer life cycles

### Points: 1

#### Responsible party:

Architect, Contractor

#### Intent:

Reduce resource extraction and fabrication and attendant embodied energy consumption.



#### Homeowner Benefit:

Commingled recycling is a simple way of achieving a high recycling rate on a project’s waste stream. By keeping the recycling process simple, commingled recycling helps encourage all workers and subs to participate. Commingled recycling is often slightly less expensive than disposal, which can translate into reduced waste management costs on the project.



#### Homeowner Benefit:

Long-lived materials save a homeowner money by reducing replacement frequency. Financial savings can be substantial, when materials costs, installation costs, and disposal costs are all taken into account.

## Action Item 2-12

Install locally produced and sourced materials; minimum of 5 applications

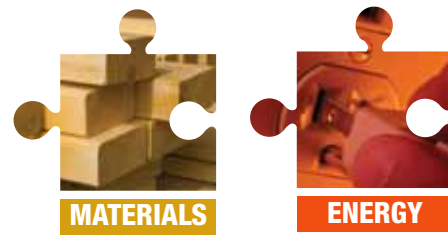
### Points: 2-6

#### Responsible party:

Contractor, Architect, Owner

#### Intent:

Promote the development of local and regional economy; reduce transport-related energy use.



**what:** For the purposes of this Action Item, regionally produced materials are considered to be those materials manufactured within a 500 mile radius of the jobsite (not including Canada), and local materials are produced within King, Snohomish and Pierce Counties.

**why:** Sourcing local materials for a remodel provides the environmental benefit of reducing transportation-related energy use and pollution. Additionally, it helps promote the development of local industries, enhancing the region's economy. Materials sourced from the global supply chain not only carry the environmental burden of transportation; they can be notoriously difficult to verify in terms of the environmental and social practices employed during manufacture.

**how:** This Action Item is worth 2 or 6 points. Use materials in a minimum of 5 applications that meet either the definition of local or regional above:

- Regional: 2 points
- Local: 6 points

In the current era of global supply chains, it can sometimes be difficult to source local materials and products. Appliances, HVAC equipment, and more complex technologies can be difficult, if not impossible, to source on a regional basis. However, regionally produced steel, concrete, wood products and even countertops and ceramic and glass tile are easily identified. Online searches of business listings that cross-reference the region and the product category can yield results.

**considerations:** As with any single environmental attribute, the superiority of a local product is based on all other variables in the product being equal. In other words, simply because a product or material is locally produced does not mean it performs well in terms of indoor air quality, energy use, or other environmental and health characteristics. Be sure to weigh all aspects of a product to derive its total environmental and health profile.



**what:** Pressure treated lumber is created by forcibly injecting anti-rot and anti-pest compounds into wood. Historically, this was done with highly toxic compounds, such as arsenic and chromium. While the most toxic materials have been taken off the market, some alternatives are still questionable in terms of human health.

**why:** By avoiding pressure treated materials, the total burden of toxic materials in a home is reduced. Additionally, for the remodeler, this means less exposure to toxins during product installation.

**how:** Specify naturally rot-resistant species lumber, or 100% recycled content plastic or composite lumber, available from most local lumberyards.

**considerations:** Specify certified responsible harvest lumber (Action Item 4-14).

**resources:** The Washington Toxics Coalition maintains a page on wood preservatives and treated woods and their alternatives: [www.watoxics.org](http://www.watoxics.org) (click on *Healthy Homes and Gardens*, then *Home Repair and Building Materials*).

The Healthy Building Network has created a Guide to Plastic Lumber: [www.healthybuilding.net/plastic\\_lumber.html](http://www.healthybuilding.net/plastic_lumber.html)

The local company Durable Plastic Design produces Orcaboard, a 100% post-consumer HDPE plastic lumber product: [www.orcaboard.com](http://www.orcaboard.com)

## Action Item 2-13

Use no pressure treated lumber

### Points: 4

#### Responsible party:

Contractor, Architect

#### Intent:

Reduce toxics in building materials and in the greater environment; promote the development and use of least-toxic preservatives.



#### Homeowner Benefit:

Sourcing locally produced materials are usually easily verified for performance and environmental characteristics, due to the proximity of manufacture.



#### Homeowner Benefit:

Reducing the volume of toxic and irritating materials in a home means less likelihood that family occupants and pets will be exposed to dangerous materials.

## Action Item 2-14

Provide weather protection for stored materials

### Points: 1

#### Responsible party:

Contractor

#### Intent:

Reduce incidence of materials damage, saving financial and material resources, as well as protecting indoor environmental quality.



MATERIALS



HEALTH



SITE/WATER

**what:** Rain can quickly make valuable materials worthless, or introduce significant moisture that ends up trapped in wall assemblies, in ceilings or under floors. Weather protection can take a variety of forms on a remodel, including designating an existing garage as a temporary storage space, or erecting a temporary tarp or tent structure.

**why:** The minimal up-front investment related to properly storing building materials yields substantial benefits down the road in terms of reduced product damage, and fewer callbacks due to moldy surfaces or indoor air quality complaints. Few homeowners are happy with the idea of receiving a weather-damaged product, let alone paying for a material twice.

**how:** Minimize the amount of materials stored on site in the first place, by opting for “just in time” delivery and carefully scheduling deliveries.

For materials that must be stored on site, store them in a secure, protected place, or by covering them with tarps. Used shipping pallets and other packaging can be put to temporary use storing materials off the ground. Be sure to follow manufacturer’s recommendations for proper storage to prevent structural or finish damage. For example, panelized materials should be kept dry and flat.

Siding and other finish materials should be stored back-to-back and face-to-face, taking measures to prevent marring.

Investing in a portable, weather-tight storage structure may be a good investment for a remodeling company. Alternatively, structures are available for rent on a weekly or monthly basis.

**considerations:** Focusing exterior and site work during the dry months also reduces the likelihood of materials damage. (See Action Item 3-13 for tips on avoiding grading and earthwork during the rainy season.)

For remodeling projects that intend to salvage large portions of the existing home for reuse later on, investing in onsite temporary protection structures for stored materials may be necessary.



HEALTH

**what:** A healthy building jobsite plan is a comprehensive strategy for implementing the healthy building practices. It consists of an evaluation of the home’s current conditions, and a determination of which activities (e.g., disturbing lead- or asbestos-containing materials) will likely impact the jobsite and what activities will be undertaken to minimize or eliminate those risks. Additionally, it performs a comprehensive survey of the specifications for the project, and identifies responsible parties for ensuring the continued health and safety of the jobsite. Finally, the plan lays out the training and communications requirements to ensure healthy best practices are followed. This final element is the intent of this Action Item, but the previous steps are required for successful training.

**why:** A healthy building jobsite plan brings into focus the combination of actions that should occur throughout a project to ensure a home is kept healthy and that health and safety risks are reduced for occupants and workers alike. Establishing a plan makes it simpler to share critical information with workers and subs to ensure all workers implement healthy home building activities.

**how:** It is important to enlist the support and cooperation of your subcontractors, especially painters, floor finishers, cabinet maker, as well as any others that will be applying adhesives and caulks indoors (for example, flooring installers, countertop installers, finish carpenters, framers, plumbers, and HVAC contractors). Before the job begins and during onsite work, coordinate with them about:

- Using low toxic materials (see Action Items 11-2 for low toxic adhesives and joint compound; 13-34 for low toxic grouts and adhesives; and 13-35 for low toxic paints and stains).
- Proper ventilation during construction (Action Item 13-38).
- Preventing moisture (see Action Item 2-18) during construction.
- No unvented heaters during construction (Action Item 2-17).
- Prohibiting smoking in the structure enclosure.
- Coordinating closely with HVAC and electrical contractors for installation of whole house ventilation and quiet spot ventilation in wet areas.
- Making sure any toxic materials such as asbestos or lead are handled and disposed of properly. (See Action Item 3-9 for establishing procedures to prevent illegal discharges.)

Post the healthy building jobsite plan in a visible location and utilize jobsite safety and coordination meetings to communicate its requirements with subcontractors.

**considerations:** Receiving healthy home training (Action Item 1-31) will help provide the knowledge needed to assemble and deploy a comprehensive healthy building jobsite plan.

**resources:** *Prescriptions for a Healthy House: A Practical Guide for Architects, Builders and Homeowners* by Paula Baker-Laporte (New Society Publishers, 2008).

## Action Item 2-15

Train subs in implementing a healthy building job-site plan for the project

### Points: 4

#### Responsible party:

Contractor

#### Intent:

Protect the health of occupants, workers, and the general public.



#### Homeowner Benefit:

The creation and implementation of a healthy building jobsite plan increases the likelihood that best practices will be followed on the jobsite by workers and subs to ensure the home is healthy during and after the remodel. The result is improved indoor environmental quality and better certainty that healthy building plans were closely followed.

## Action Item 2-16

Educate workers and subs in using VOC-safe masks when applying VOC containing wet products and N-95 dust masks when generating dust

### Points: 1

#### Responsible party:

Contractor

#### Intent:

Protect the health of workers on project.



**what:** Educating workers about proper mask selection and use involves knowing and supplying this information to both workers and subs in a format that is likely to be used and understood by them. Making this a part of contracts can also help with mask wearing compliance and reduce the likelihood of worker claims at a later date.

**why:** Proper respiratory protection is a worker health and safety imperative, and reduces the likelihood of worker injury and worker compensation claims down the road.

Volatile organic compounds, or VOCs, are materials that readily convert to gas at room temperature and pressure, making them an inhalation hazard. Many such organic compounds have ill health effects, from respiratory irritation to acute toxicity and cancer.

Hazardous gases and hazardous airborne particulates also have a variety of negative health effects. Even seemingly harmless dust particles can be dangerous. In fact, the Occupational Safety and Health Administration classifies wood dust as a carcinogen (cancer-causing).

**how:** The best method of protection against hazardous gases, hazardous airborne particulates and VOCs is to eliminate or reduce the hazard in the first place by choosing low- or nontoxic alternatives and construction practices and thoroughly ventilating the work area.

It is key to identify the correct mask for the job, and important to keep a sufficient stock of masks at the jobsite. Specify NIOSH (National Institute for Occupa-

tional Health and Safety) approved masks. Make sure workers and subs are properly trained in the use of masks, and that reminders are given at regular safety meetings as to their use.

For small projects with short exposures to VOCs, a gray carbon-impregnated dust mask should suffice. These masks are low cost and available at most lumberyards and home improvement centers.

Whenever workers are exposed to off gassing or fine particulates (for example, from paints, solvents, adhesives, molds or finishes), provide flexible half masks equipped with at least two straps and filter cartridges and require their proper use. Masks are color-coded to identify the contaminant they filter. Cartridges to filter VOCs are black and filled with activated charcoal. To extend the life of the filter, store in a airtight plastic bag.

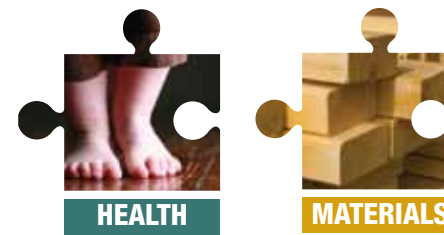
For dust-generating tasks, use NIOSH-approved N95 particulate masks, which filter with electrostatically charged microfibers.

**considerations:** For information on low-toxic, low-VOC materials, see Action Items 13-34 and 13-35. For example, purchasing pre-finished flooring (Action Item 13-8) keeps wood dust and finishes out of the home. For ventilation during construction, see Action Item 13-38. See also Action Item 1-31 for info on healthy home training.

#### resources:

OSHA:  
[www.osha.gov/Publications/OSHA3252/3252.html](http://www.osha.gov/Publications/OSHA3252/3252.html)

NIOSH:  
[www.cdc.gov/niosh/](http://www.cdc.gov/niosh/)



**what:** Unvented combustion heaters are usually propane or kerosene-fired. As with any combustion process, large amounts of water vapor are created as hydrocarbon molecules are broken down into carbon and water. Additionally, combustion byproducts are formed, including toxic carbon monoxide.

**why:** Banning the use of unvented combustion heaters helps ensure a healthier indoor environment down the road, and it also helps ensure that the intent of heating a home (usually to dry out materials or finishes) is actually achieved. Combustion heaters also produce carbon monoxide, which can threaten the health and safety of workers and occupants if the home is occupied during the remodeling process.

**how:** In many cases, standard box fans (see Action Item 13-38) may be sufficient for producing airflow needed to remove water vapor from a space.

Electric portable heaters and dehumidifiers are readily available for use, either for purchase or rent.

Reduce the need for additional drying activities by protecting materials from moisture exposure prior to installation and scheduling interior construction activities during the warmer, drier months.

## Action Item 2-17

No use of unvented combustion heaters during construction

### Points:

#### Responsible party:

Contractor

#### Intent:

Reduce the introduction of moisture into the project during construction; promote healthy indoor air quality.



#### Homeowner Benefit:

Workers properly trained in using masks are more likely to be aware of and responsive to the dangers of inhalation hazards on the jobsite, taking care to minimize hazards in the first place. Especially in a remodel situation where the home may be occupied during construction, this translates into added protection to both workers and the home's occupants.



#### Homeowner Benefit:

Unvented combustion heaters introduce large amounts of water vapor into the home during construction, which can lead to mold and other moisture-related issues later. Keeping a home dry during construction protects indoor air quality and enhances durability.

## Action Item 2-18

Take measures during construction operations to avoid moisture problems later

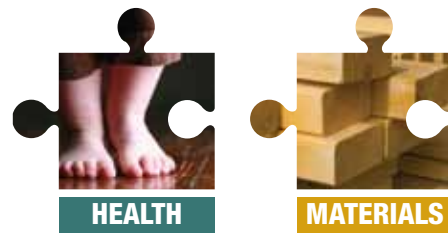
### Points: 3-5

#### Responsible party:

Contractor

#### Intent:

Reduce the introduction of moisture into the project during construction; promote healthy indoor air quality.



**what:** A variety of moisture-related problems, including mold growth and reduced durability of building elements can occur due to actions taken during the construction phase. This Action Item is split into two groups, Basic and Expanded.

**why:** Measures taken during construction operations avoid moisture problems down the road, protecting the home's indoor air quality and providing building durability benefits.

**how:** This Action Item is worth 3 or 5 points.

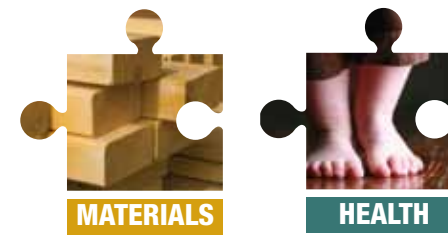
- Follow basic requirements: 3 points
- Follow expanded requirements: 5 points

#### Basic requirements:

- Keep stored materials dry with tarps or in a protected place, or use just in time delivery to avoid problems with stored materials (see Action Item 2-14).
- Moisture content of underlayment, sheathing, and framing materials may not exceed 15%, measured with a moisture meter. If readings exceed 15%, dehumidify or allow sufficient drying time before installing insulation and drywall.
- Protect materials from moisture damage during transit, delivery, and handling.

#### Expanded requirements:

- Perform all basic requirements, above.
- Pump or drain standing water out of the structure after rainstorms.
- Hook up installed rain gutters to temporary pipes to draw water away from foundation.
- Install dimpled drainage mats at foundation walls.
- Use flashing instead of caulking to seal above doors, windows, and other openings.
- Properly counter flash chimneys and build a cricket above chimney to divert water.
- Properly flash all roof-to-wall intersections.
- Avoid flat roofs (even green roofs should have a minimum 1:12 slope).
- Use quiet fans (1.5 sones or less) with a 60-minute timer in bathrooms. Noisy fans discourage use.
- During construction, remove unwanted moisture with a dehumidifier, not unvented combustion heaters (Action Item 2-17), which only introduce additional moisture.



**what:** Measures to protect exterior building components from moisture damage include a suite of materials selection choices and installation details. Moisture damage includes bulk water from rain events, as well as moisture damage due to water vapor.

**why:** Water and moisture damaged exterior building elements can result in major structural damage over time, and create a pathway for moisture to enter the home, causing additional damage to materials and compromising indoor air quality by promoting the growth of mold and mildew. Prevention of such damage is almost always much cheaper and less disruptive than subsequent repair.

**how:** Inspect exterior building components for water or moisture damage and repair problem areas.

#### Measures include the following:

- Check and repair or install flashing around all window frames, especially those showing signs of swelling and water stains.
- Repair rot in decks, ribbon board, belly boards, and doors.
- Tape house wrap to flashing.
- Cut back or remove any vegetation within one foot (12") of the house.
- Caulk all exposed joints. (Note that caulking will invariably fail over time, and should never be used as the only line of defense against water intrusion.)

**considerations:** Airtight construction practices, from airtight wall assemblies (Action Item 1-18) to the Airtight Drywall Approach (Action Item 11-1), as well as providing natural or slightly positive air pressure to a home (Action Item 1-42) also help reduce the likelihood of moisture migrating through wall assemblies.

**resources:** Building Science Corporation Building Science Digest 012: "Moisture Control for New Residential Buildings" provides an overview of common moisture problems and solutions in residential construction: [www.buildingscience.com](http://www.buildingscience.com) (search for *BSD-012*).

## Action Item 2-19

Protect exterior building components from water or moisture damage; address any existing problems

### Points: 2

#### Responsible party:

Architect, Contractor, Expert

#### Intent:

Reduce the introduction of moisture into the project during construction; promote healthy indoor air quality.



#### Homeowner Benefit:

A coordinated plan for reducing moisture problems in a home helps ensure all workers and subs are on board with the goal of protecting the durability and indoor air quality of the home. The end result is a higher likelihood that the home will have good indoor air quality and fewer moisture-related durability issues.



#### Homeowner Benefit:

Many homes have moisture and water damage problems stemming from exterior building components either failing or being incorrectly installed. By addressing these issues, a remodel can help enhance a home's durability and protect indoor air quality.

## Action Item 2-20

Use a non-toxic mold inhibitor to prevent future mold

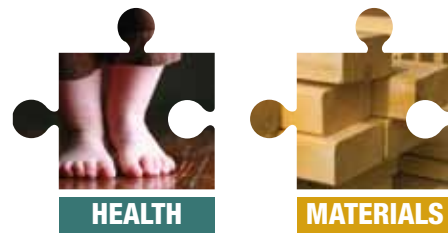
### Points: 2

#### Responsible party:

Contractor, Architect

#### Intent:

Reduce the likelihood of mold growth; protect the health of occupants.



**what:** Low-toxic and nontoxic mold inhibitors, such as boric acid and borax (borates), are an alternative to the toxic wood preservatives currently on the market. These inhibitors can be applied to wood dimensional and panel products prior to purchase by the manufacturer, or after purchase.

Note that borates (which form boric acid) are distinct and very different from brominated substances (Action Items 13-39 and 10-9), used as fire retardants and known to accumulate in the environment. Borates are very benign substances, and are an environmentally preferable alternative to many common, more toxic preservatives and pesticides.

**why:** While every attempt should be taken to reduce the likelihood of mold in the first place (proper exterior construction and detailing, adequate ventilation, and adherence to building science principles), non-toxic mold inhibitors can provide a last line of defense against molds that can compromise indoor air quality in a home.

**how:** Boric acid treated wood is available for purchase from a wide variety of retailers, now that toxic chromium copper arsenate (CCA) wood preservative is banned from production.

**considerations:** An overall moisture management plan for a home that addresses common routes of moisture entry, both in terms of bulk water and water vapor, is an excellent way to holistically deal with moisture and mold problems down the road.

Proper handling and storage of building materials (Action Item 2-14) and following general procedures to avoid moisture problems later (Action Item 2-18) helps reduce the need for mold inhibitors.



**what:** Duct cleaning services use vacuum brushes to rid ductwork of dust and accumulated materials. In an older house, the accumulation can be substantial, and if the ductwork is not properly sealed prior to the remodeling process, construction dust, toxins and irritants can be added to the mix. Additionally, ductwork improvements (e.g., advanced duct sealing or insulating) can free up accumulated dust from the interior of the ductwork, leaving it to become airborne.

**why:** Cleaning ductwork after the completion of a remodel can reduce the likelihood of callbacks related to indoor air quality complaints stemming from construction dust and irritants being redistributed through the house after the ventilation system is activated. Offering this service to clients is more evidence of the special attention a remodeling firm pays to protecting a client's health and wellbeing.

Under standard home operating conditions, the US EPA considers duct cleaning an optional service; studies have shown that in homes in normal operation, the service does not appreciably enhance indoor air quality. In the case of a remodel involving any amount of construction or demolition, however, this Action Item is an advisable step, to ensure construction phase contaminants are removed from the distribution system.

**how:** Mobile duct cleaning services are readily available in most areas. Consider communicating the value of this service to clients early on, and building the cost of the service into bids as a specific line item.

During construction, all potentially affected registers and returns should be sealed with plastic and tape to reduce the likelihood of contamination by construction dust and the system should be turned off throughout this period.

## Action Item 2-21

Clean ductwork and furnace thoroughly at job completion

### Points: 2

#### Responsible party:

Contractor, HVAC

#### Intent:

Protect indoor environmental quality and occupant health by reducing the likelihood of re-contaminating the home.



#### Homeowner Benefit:

Nontoxic mold inhibitors can reduce the incidence of mold down the road, helping protect indoor air quality and reducing the need for costly removal and replacement of materials.



#### Homeowner Benefit:

A thorough ductwork cleaning will reduce the likelihood that any toxins or irritants that may have migrated into the ductwork during the remodel are not distributed throughout the home after the ventilation or heating system is reengaged. The result is improved air quality and healthier occupants.



## Action Item 2-22

Use low toxic cleaners

### Points: 1

#### Responsible party:

Contractor

#### Intent:

Protect the health of occupants, workers, and the general public.



**what:** Low toxic cleaners are free from the common substances that can cause acute and long-term health effects. Many household cleaners would require personal protective equipment and special procedures if used in the workplace.

For the purposes of this Action Item, “low toxic cleaners” are defined as those products free of the signal terms “poison,” “hazard,” and “danger” on the label, or products certified by Greenseal or other eco-labeling program approved by the Built Green Director.

**why:** Low- and nontoxic cleaning products not only keep a home healthier for occupants, they reduce the risk of worker exposure and liability issues.

**how:** Review cleaning product labels for signal words, which alert the consumer to the level of risk present when using the substance. The common signal words used on products include (in descending order of toxicity): “poison,” “danger,” and “hazard.” The safest products will contain no signal word on the label. Even relatively benign substances, such as Castile soap and borate-based cleansers may have the word “caution” on the label, to alert the user to issues related to eye, nose or throat irritation.

Alternatively, look for cleaning products certified by Green Seal, an independent third party organization that sets environmental and health standards for a wide variety of consumer products.

**resources:** For alternatives to hazardous household cleaning products, visit King County Local Hazardous Waste Management: [www.govlink.org/hazwaste](http://www.govlink.org/hazwaste) (click on Household Products, then Alternatives).

Green Seal:  
[www.greenseal.org](http://www.greenseal.org) (click on Find a Certified Product/Service, then Household Cleaning Products).

## SITE/FOUNDATION

Site and foundation work provide opportunities to restore a site’s natural hydrology and ensure drainage issues are addressed, in order to avoid moisture and durability issues. Additionally, energy efficiency opportunities are presented during the foundation work stage of a project. Finally, taking care of a site’s natural features and protecting existing trees and landscape ensure these elements thrive during and after the remodel.



### Homeowner Benefit:

Using low-toxic cleaners during a remodel sets the stage for a healthy home, and complements the use of low-toxic and nontoxic materials. Cleaning with green cleaning products means reduced exposure to toxins and irritants both during the remodel and after.

## Action Item 3-1

Use alternative fuel equipment on-site

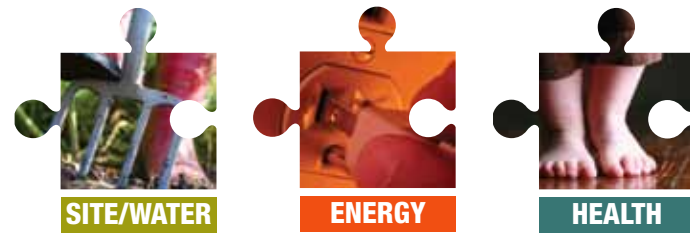
### Points: 1-5

#### Responsible party:

Contractor

#### Intent:

Encourage the development of environmentally responsible alternative fuel choices; reduce carbon emissions related to vehicle and equipment used on the jobsite.



**what:** Alternative fuels take several forms, including electric, compressed natural gas, ethanol and biodiesel vehicles and machinery.

**why:** Encouraging the transition from a fossil fuel based energy economy to one based on renewable sources is key to the concept of long-term sustainability. Sending a market signal by purchasing responsibly produced domestic biofuels is one way to encourage such a change.

Additionally, biodiesel is a very low toxicity product, with a toxicological profile similar to vegetable oil, making any potential spills much more benign than petroleum diesel spills.

**how:** This Action Item is worth 1-5 points:

- 1 point for each alternative fuel vehicle frequently on site;
  - Maximum 5 points,
- or
- 5 points for 100% alternative fuel excavation equipment.

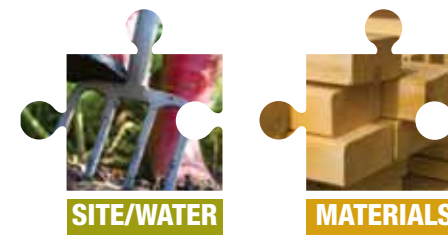
**considerations:** There is general consensus that corn-based ethanol as an alternative fuel does not provide overall environmental benefit, due to the energy intensity of the corn production process.

Other biofuels, such as biodiesel, have a more varied story to tell. Biodiesel produced from waste vegetable oil, especially when sourced locally, is a definite environmental plus (but can be difficult to find). Biodiesel sourced from imported palm oil, however, may actually be worse for the environment and climate change than standard petroleum diesel, due to forestland conversion/deforestation practices that tend to accompany the creation of palm oil plantations.

Additionally, certain biofuel crops are displacing food production, leading to rising food prices and food scarcity in some developing countries. Therefore, look first for waste vegetable oil-derived biodiesel, and secondarily for biodiesel produced from domestic crops. The science of biofuel evaluation is quickly evolving; see Resources for helpful information in choosing responsibly.

**resources:** The international Roundtable on Sustainable Biofuels is developing a sustainability standard for biofuel production: [www.cgse.epfl.ch/page65660.html](http://www.cgse.epfl.ch/page65660.html)

The US EPA Renewable Fuel Standard Program provides information on renewable fuels, including a life cycle analysis of greenhouse gas emissions from various biofuels: [www.epa.gov/OMS/renewablefuels/](http://www.epa.gov/OMS/renewablefuels/)



**what:** Compost and/or wood chips, when properly applied, serve as a protective layer on disturbed soils, reducing the risk of erosion from rain or wind.

**why:** Geotextiles, polyethylene sheeting and tarps can concentrate runoff and lead to erosion and even flooding downhill. Research has shown that compost can often outperform conventional slope stabilization methods. Using wood chips or compost allows rain to slowly percolate into the soil below, keeping stormwater on site. Compost has the added benefit of being available to mix into the disturbed soils as an amendment when the materials are ready for distribution and replanting.

**how:** This credit is only available on sites with defined slopes.

Grade the slope to a ratio no steeper than 2 horizontal to 1 vertical (the maximum allowed by the UBC), or terrace steeper slopes with retaining walls. Apply compost to cover the entire exposed soil surface (a “compost blanket”), extending approximately 3 feet over the top of the slope or meshing into existing vegetation. The compost application rate will vary depending upon degree of slope, soil type, and compost characteristics. As a rule of thumb, however, a 2 -3” blanket on slopes up to 30% or a 3-4” blanket of compost on a slope of up to 45% will help control erosion for between one and three years—more effectively if seeded with a temporary or permanent erosion control grass or vegetation mix. (Most compost blower-truck contractors can mix the seed with the compost, saving a step and providing superior seed germination in dry or cold situations.)

Coarse composts containing particles that range in size (typically from a compost product screened to 1” minus, or compost mixed with larger “overs” from the screening process) will produce a more stable blanket. Stable, relatively dry yard trimmings compost will also filter and bind pollutants from stormwater, reintroduce organic material, and enhance water retention/infiltration. Where water quality is a concern, use only compost made from yard trimmings, wood byproduct based materials (i.e., wood products free from paint, preservatives, or other contaminants), or well-stabilized biosolids. (Biosolids and manure-based composts may have higher levels of soluble nitrogen and phosphorus—a potential water-quality concern. Ask the compost supplier for analysis data.)

Wood chips provide the benefit of being stabilizer for disturbed slopes, but also rob nitrogen from the soil—apply them only to soil surfaces. Compost can be mixed into the soil at the end of the job, before planting. Thus the compost provides a “two-for-one” benefit: providing effective erosion protection, and then being tilled in to improve the soil before planting.

**resources:** “Erosion Control with Compost” is a short fact sheet from Building Soil: [www.buildingsoil.org](http://www.buildingsoil.org).

EPA’s NPDES Best Management Practices website includes a page describing construction erosion control. [www.cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm](http://www.cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm) (click on *Construction* and scroll to the *Erosion Control* list).

## Action Item 3-2

Use compost or wood chips to stabilize disturbed slopes

### Points: 1

#### Responsible party:

Intent:

#### Landscape Architect

Prevent erosion of exposed soils using natural and biodegradable materials.



#### Homeowner Benefit:

Depending on the fuel, alternative fuel use on a project can result in fewer and/or more benign emissions and a smaller carbon footprint for the project. Electric vehicles and equipment can mean no emissions on the jobsite, and quieter operation—a particular benefit if the home is occupied during remodeling activities.



#### Homeowner Benefit:

Disturbed slope stabilization is a common component of stormwater quality regulations; using natural, biodegradable materials for the job means that at the end of the stabilization period there is no disposal waste, and the materials used for stabilization can be worked into the soil.

## Action Item 3-3

Take extra care to establish and maintain a single stabilized construction entrance (quarry spall or crushed rock) or use existing driveway

### Points: 1

#### Responsible party:

Contractor

#### Intent:

Protect water quality and reduce potential for erosion by stabilizing construction entrance for vehicle and machinery traffic.



**what:** On sites without an existing driveway, a stabilized construction entrance is usually constructed from crushed rock or wood mulch placed on a bed of geotextile fabric, and allows for vehicle and machinery traffic without causing a mud pit.

**why:** Construction activities can have negative impacts on local water quality by adding silt and contaminants to storm runoff.

**how:** Basic requirements for stabilization of construction entrances are outlined in the stormwater code. Washington State Department of Ecology's BMP C105: "Stabilized Construction Entrance" in Volume II of the Stormwater Management Manual for Western Washington (see Resources) provides a detailed description of requirements for stabilization. This Action Item requires protection that meets and exceeds code requirements to highlight the importance of protecting stormwater quality during construction.

**considerations:** To minimize the risk of impacting stormwater with construction activities, restrict construction to the drier months of the year. (See Action Item 3-13).

**resources:** Washington Department of Ecology's Stormwater Management Manual for Western Washington (Vol. 2: Construction Stormwater Pollution Prevention) [www.ecy.wa.gov/programs/wq/stormwater/manual.html](http://www.ecy.wa.gov/programs/wq/stormwater/manual.html) "BMP C105: Stabilized Construction Entrance" describes best practices for creating a stabilized construction entrance.



**what:** Many existing home landscapes feature regionally native species, such as snowberry, sword and deer fern, rhododendron, salal, sweet woodruff and false Solomon's Seal. Native vegetation is adapted to the Northwest climate of rainy wet winters and dry summers.

**why:** Retaining native vegetation in a landscape (rather than removing them and then replanting) provides excellent erosion, sediment, dust, and pollution control. Native plants are also more resistant to naturally occurring disease, insects, and low levels of nutrients, thus reducing the need for fertilizer or pesticides. Finally, a native plant palette provides forage for native birds and beneficial insects, including pollinators, in a way non-native plants often cannot.

**how:** Prior to design and construction, perform a site assessment to identify existing native trees and plants. Precautions during site preparation include:

- Clear only actual areas needed to install driveways, parking areas, and building foundations.
- Clearly mark areas to be graded on plans and field stake or flag on site.
- Flag or otherwise mark non-clearing buffers, open spaces, and setbacks from streams, wetlands, and steep slopes as indicated on plat maps.
- Review site areas to be graded with excavation crew to ensure compliance with preservation plan.

**considerations:** See Action Item 3-5 below if the existing landscape preservation plan also includes trees.

**resources:** Washington Department of Ecology's *Stormwater Management Manual for Western Washington* (Vol. 2: Construction Stormwater Pollution Prevention): [www.ecy.wa.gov/programs/wq/stormwater/manual.html](http://www.ecy.wa.gov/programs/wq/stormwater/manual.html) "BMP C101: Preserving Natural Vegetation" describes best practices for maintaining existing vegetation on a site.

## Action Item 3-4

Preserve existing native vegetation as landscaping (excluding trees)

### Points: 3

#### Responsible party:

Landscape Architect, Contractor

#### Intent:

Minimize risk of erosion and maintain soil and hydrological function of a site by maintaining existing vegetation; conserve water and reduce the need for fertilizers and pesticides.



#### Homeowner Benefit:

A stabilized construction entrance, or use of the existing driveway, helps ensure vehicles and machinery do not track sediments into roadways to later wash into storm drains and water bodies. It also minimizes damage to existing topsoil and landscaping and keeps the construction site tidy.



#### Homeowner Benefit:

Preserving existing vegetation on a site reduces landscaping costs, preserves existing topsoils, reduces the need for erosion control, and reduces water resource use associated with establishing a new landscape.

## Action Item 3-5

Take extra precautions to protect trees during construction

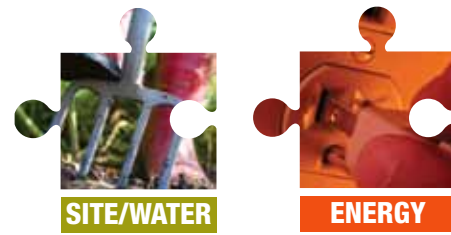
### Points: 2

#### Responsible party:

Contractor, Architect

#### Intent:

Preserve the vitality of existing trees.



**what:** Minimizing impact to a site's existing landscaping, including trees, can help keep a project's funding focused on improvements to the home, allowing for a higher level of craftsmanship and attention to detail, or the opportunity to employ advanced energy efficiency or other green features.

**why:** Preserving existing trees requires more than not cutting them down. Trees have extensive, and often quite delicate, root systems and can die years after disturbance from root damage or due to disease that is allowed a foothold by the tree's weakened condition.

**how:** Prior to design and construction, identify existing native plants, including trees and understory plants to be preserved.

Precautions during site preparation include:

- Clear only actual areas needed to install driveways, parking areas, and building foundations.
- Consider boring or using an air spade for placing utilities, rather than trenching, when working in root zones.
- Clearly mark areas to be graded on plans and field stake or flag on site.
- Identify or flag non-clearing buffers, open spaces, and setbacks from streams, wetlands, and steep slopes as indicated on plat maps.
- Review site areas to be graded with excavation crew to ensure compliance with preservation plan.

- Fence critical areas, such as tree root zones, to prevent crushing, filling, or other disturbance.
- If trees only (not understory) are designated for protection, hand clearing of understory helps protect tree roots. However, clearing around trees may cause them to become hazards in strong winds or rain. Check with an arborist.
- Check grading operations frequently to prevent accidental damage to marked areas.
- Never park heavy equipment or store heavy materials under trees. If some construction traffic is unavoidable in root zones, limit compaction by covering those zones with 6 inches of coarse wood chip (hog fuel), quarry spall, or metal plates.

**considerations:** See Action Item 1-4 for more information on protecting and retaining trees on site.



**what:** Certified arborists have extensive experience with tree identification and cultivation, including formal and on-the-job training. An arborist can provide expert review of a project's tree protection plan and provide recommendations for modification and improvement.

**why:** Specialist input provides a level of depth and expertise to a project, improving the overall approach and helping identify potential challenges as well as opportunities for enhancing the performance of a project. A more informed design can reduce the likelihood of experiencing unintended consequences, meaning fewer callbacks and more satisfied customers.

**how:** Finding a certified arborist is a straightforward exercise. Look for certification through the International Society of Arboriculture (see Resources). Additionally, call references. Over time, a firm can develop a regular relationship with a trusted arborist, similar to other subs.

**considerations:** A consulting arborist may be an expert in tree health, but may not have expertise in other areas of green building, such as passive solar design or renewable energy. Be aware of potential conflicting information between ideal placement for tree health and tree placement for passive solar shading, storm-water management, or access to unobstructed sun for photovoltaic power production.

**resources:** International Society of Arboriculture: [www.isa-arbor.com](http://www.isa-arbor.com) (Click on *Certification* for information on the ISA certifications.)

Seattle-based Plant Amnesty maintains a referral service for arborists: [www.plantamnesty.org](http://www.plantamnesty.org)

## Action Item 3-6

Bring in a consulting arborist to evaluate tree protection on-site and carry out instructions

### Points: 5

#### Responsible party:

Landscape Architect, Expert

#### Intent:

Preserve the vitality of existing trees.



#### Homeowner Benefit:

Trees add substantial value to a property. Proper protection procedures ensure that the trees on the property remain healthy and vital. Trees provide water management, energy savings, and air cleansing benefits as well.



#### Homeowner Benefit:

Employing a consulting arborist on a remodel helps ensure a comprehensive plan is developed to protect and enhance the health of trees on the property—increasing the likelihood that the site's trees will remain healthy. Additionally, it can help identify unhealthy existing trees, helping reduce the risk of damage to property.

## Action Item 3-7

Locate dumpster drop to minimize site impact

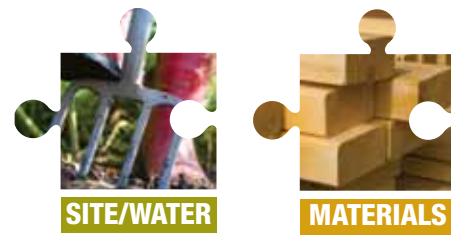
### Points: 1

#### Responsible party:

Contractor

#### Intent:

Help preserve site ecology and soil function.



**what:** Often, dumpsters and other waste and recycling receptacles are placed on site without regard for impact on the site. Careful location of receptacles requires surveying the site for valuable landscape elements, cross-referenced with the traffic patterns that will be caused by workers traveling between the project and the receptacles.

**why:** Minimizing site disturbance reduces erosion, protects existing landscaping, and protects soil function—all elements that will have to be repaired if damaged by project activities. Considerate placement of receptacles also helps maintain positive relationships with clients.

**how:** Drop box placement is not only about minimizing the direct impact of the box on the site, but the foot and machinery traffic patterns that will be created by placement. Identify a location that minimizes both impact by machinery during box pickup and the traffic caused by workers delivering materials to the box itself.

**considerations:** On sites employing source-separated recycling (see Action Item 2-9), care must be taken to ensure all drop boxes for recycling are strategically placed to avoid damaging the site. In some cases, use of multiple, smaller boxes may offer flexibility in placement and actually reduce site impact. Practicing waste prevention on a site (Action Item 2-1) can allow for the selection of smaller drop boxes and less frequent pickup, further reducing the impact of boxes on site.



**what:** Over the life of a project, one to three yards of concrete slurry and lime can be generated from washing out concrete trucks. Code requires that all concrete waste, including wash-off from tools used during concrete installation, must be disposed of in formed areas awaiting concrete installation or properly stored and recycled off-site.

**why:** Cementitious runoff can contaminate the site, harm local waterways, aquatic habitat and fish species, reduce conveyance capacity of surrounding stormwater systems, plug infiltration facilities, and contaminate treatment facilities.

**how:** The Washington State *Stormwater Management Manual* requires that Best Management Practices shall be used to prevent or treat contamination of stormwater runoff by pH modifying sources. BMPs include allowing concrete truck chutes, pumps, and internals, along with hand tools, to be washed out only into formed area awaiting install of concrete or asphalt. For equipment that cannot be easily moved or driveway wash down, the wash water cannot directly drain to natural or constructed stormwater conveyances. Wash water and leftover product can also be contained in a lined container and removed off site for proper disposal such that it does not violate groundwater or surface water quality standards.

Code allows for self-installed concrete washouts on the site. However, these self-installed structures are much less reliable and are prone to leaks. Prefabricated washout containers that are delivered to the site resist damage and protect against spills and leaks.

**considerations:** Minimizing or eliminating concrete use on a remodel avoids the need to deal with wash out slurry. Low impact foundation systems (see Action Item 1-7) help reduce concrete use. Additionally, washout pans can be rented for recycling offsite.

**resources:** *Stormwater Management Manual for Western Washington* (Vol. 2: Construction Stormwater Pollution Prevention) [www.ecy.wa.gov/programs/wq/stormwater/manual.html](http://www.ecy.wa.gov/programs/wq/stormwater/manual.html) “BMP C151: Concrete Handling” provides best practices for eliminating stormwater pollution related to concrete work.

## Action Item 3-8

Wash out concrete trucks in slab or pavement subbase areas

### Points: 1

#### Responsible party:

Contractor

#### Intent:

Protect water quality by keeping concrete-tainted water from runoff.



#### Homeowner Benefit:

Strategic location of roll-off carts on site helps preserve existing vegetation and maintain soil function, reducing costs associated with plant replacement and soil rehabilitation.



#### Homeowner Benefit:

Cement is a high pH substance containing fine particles and is damaging to plant and animal life and water quality. Properly dealing with the wash out from concrete trucks protects the health of site soils and plants.

## Action Item 3-9

Establish and post clean up procedures for spills to prevent illegal discharges. Conduct subcontractor orientation to promote good jobsite housekeeping and reduce hazardous waste issues.

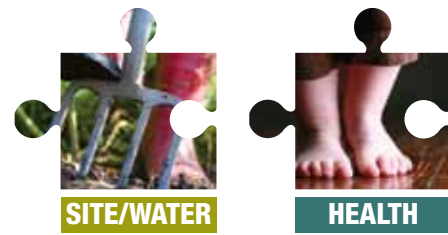
### Points: 3

#### Responsible party:

Contractor

#### Intent:

Minimize the likelihood of worker, homeowner or environmental harm by managing hazardous materials.



**what:** According to US EPA, hazardous waste is “waste that is dangerous or potentially harmful to our health or the environment.” The rules for defining hazardous waste by the EPA are complex and categorized by source and use. Preventing the generation of hazardous waste in the first place is the best tool for managing hazards.

**why:** The National Association of Home Builders estimates that constructing an average 2000 square foot home produces 50 pounds of hazardous waste. In addition, the US EPA estimates that the average home can accumulate as much as 100 pounds of household hazardous waste in storage areas including basements and garages.

**how:** Common hazardous materials a construction project may bring to a site include fuels (gasoline, diesel, kerosene etc.), oil-based paints, and cleaning compounds. Hazardous materials may also be already on site with a remodel, including mercury-containing thermostats and fluorescent bulbs, and the materials listed above. Requirements for cleaning spills or releases vary with the material. Practice prevention first by eliminating hazardous materials from the jobsite. Know cleanup procedures for the materials you use regularly. The overall Jobsite Safety Program should include cleanup procedures, which consider the range of potential spills and establish appropriate emergency actions.

Make sure everyone, especially subcontractors, is aware of clean up procedures by posting them prominently in a central location and referring to them regularly during safety meetings.

Green building goals related to least-toxic materials selection can prevent the need to manage hazardous waste in the first place; coupling toxics elimination goals with proper hazardous materials management further reduces potential risk.

Many hazardous materials present on a remodel may not fit into the Environmental Protection Agency’s regulatory definition of hazardous waste, including building materials containing asbestos and lead based paint. It is critical to properly address these hazards during the remodeling process so as to protect workers and occupants.

**resources:** Stormwater Management Manual for Western Washington (Vol. 2: Construction Stormwater Pollution Prevention) [www.ecy.wa.gov/programs/wq/stormwater/manual.html](http://www.ecy.wa.gov/programs/wq/stormwater/manual.html) “BMP C153: Material Delivery, Storage and Containment” provides best practices for managing hazardous materials on a jobsite.

The Construction Industry Compliance Assistance Center includes information on hazardous waste management for the construction industry: [www.cicacenter.org](http://www.cicacenter.org)

The Regulation of Solid and Hazardous Waste: A Builder’s Guide by the National Association of Home Builders’ Environmental Regulations Department. Available only in hard copy: phone NAHB at 800.368.5242.



**what:** Topsoil is the organic material-rich top layer of soil on a site, and the zone in which most vital root functions of plants occur. Preserve and protect all topsoil on site for reuse after grading.

**why:** Soil function is key to a healthy landscape. Retaining and reusing topsoil on-site is one of the easiest and most effective ways of ensuring this valuable resource is not lost. Disposing of topsoil in lowlands or wetlands threatens water quality and quantity and endangers wildlife habitat.

**how:** Stockpile topsoil removed during grading for use during final landscaping. The top layer of soil is the most valuable, and should be separated and used again on site as a top layer in grading planting areas. However, bare soil will erode due to wind and water, and stormwater regulations require the stabilization of soils. Protect stockpiled topsoil from erosion by covering with mulch (preferred) or plastic (less preferred because it can cause rapid runoff) until ready for reuse.

Chipped woody land clearing debris makes excellent mulch for this purpose, and can be reused later for mulching around trees and woody plantings (but not mixed into the soil). Coarse compost (1-inch minus screened) is also an effective erosion control cover for stockpiles, and has the advantage that it can be mixed with the topsoil before planting. Surround all stockpiles with a silt fence or compost sock and inspect regularly for proper coverage or sign of erosion, especially after a large storm. Screen soil to remove debris before redistributing for landscaping.

Native topsoil is best adapted to the site. Limit importing topsoil as much as possible. Imported topsoil is not adapted to the site and thus cannot offer the same nutrient structure, disease resistance, or hydrologic capabilities. Purchased topsoil blends also often bring in problem weeds; instead, amend the site’s native soil with compost.

If extra topsoil remains after final grading and landscaping, consider mixing it with inorganic and inert material to be used as fill (make sure fill materials are clean). It can also be used in the construction of slopes, or sold to homeowners, landscapers, or other businesses for reuse.

**considerations:** Even existing topsoil may be depleted of nutrients and organic matter. Refer to Action Item 14-5 for information on revitalizing soils with compost. Topsoil on site should be protected from erosion by applying a layer of compost or tarps. See Action Item 3-2 for details on the process of protecting exposed soils.

**resources:** US EPA’s National Menu of Stormwater Best Management Practices includes a section on stabilizing exposed soils: [www.cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm](http://www.cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm) (click on *Construction*).

*Stormwater Management Manual for Western Washington* (Vol. 2: Construction Stormwater Pollution Prevention): [www.ecy.wa.gov/programs/wq/stormwater/manual.html](http://www.ecy.wa.gov/programs/wq/stormwater/manual.html) “BMP C121: Mulching” provides best practices for protecting soils from erosion using mulches..

## Action Item 3-10

If disturbing topsoil, set aside and protect for re-use on site

### Points: 3

#### Responsible party:

Contractor

#### Intent:

Maintain vital soil function and reduce the risk of soil loss and erosion during and after construction.



#### Homeowner Benefit:

Proper management of hazardous materials reduces the likelihood of worker and occupant exposure to these substances and harm to the greater environment. This is especially true in a remodel situation, where the homes are often partially or fully occupied during construction.



#### Homeowner Benefit:

Topsoil is a valuable on-site amenity. Maintaining and reusing existing topsoil reduces the expense and resource use associated with bringing in new topsoil. It also helps protect existing soil ecology.

## Action Item 3-11

Construct tire wash, establish and post clean up protocol for tire wash

### Points: 2

#### Responsible party:

Contractor

#### Intent:

Protect regional water quality by keeping contaminants and sediment on the construction site.



**what:** A tire (or wheel) wash helps reduce the amount of sediment tracked onto public roadways from construction equipment, and is necessary when a stabilized construction entrance is insufficient at keeping equipment tires clean.

**why:** Dirt and contaminants tracked off site and onto roadways from construction projects damage surface water quality and can clog storm drains.

**how:** For an onsite tire wash, make sure the area is:

- Well marked as a wash area.
- No larger than the largest vehicle.
- Posted with a sign that forbids washing with solvents or changing oil and indicates nearest oil recycling area.

In addition, drain the area to an oil water separator if it is connected to the sanitary sewer, or direct tire wash water to other sediment trap or pond. Provide temporary gravel base on site to keep vehicles clean.

Post tire wash protocol for all trades or field labor using vehicles on site. Procedures may include:

- Washing vehicles off site. Take them to an appropriate location (a car wash or back to your central site).
- If taking the vehicle off site is impractical or counterproductive, perform all washing in a designated area.
- Require biodegradable detergents. Detergents or cleaners containing phosphate are prohibited. Minimize quantity of soap, detergents, or other chemicals used.

**considerations:** Limiting the scope of a remodel to eliminate the need for a tire wash area (e.g., by using the existing driveway for access to the site) is a far superior method to dealing with issues of silting and storm-water quality. Consider using any existing resource first.

**resources:** Stormwater Management Manual for Western Washington (Vol. 2: Construction Stormwater Pollution Prevention) [www.ecy.wa.gov/programs/wq/stormwater/manual.html](http://www.ecy.wa.gov/programs/wq/stormwater/manual.html) “BMP C106: Wheel Wash” provides best practices for installing and maintaining a wheel wash.



**what:** Proper drainage moves water quickly and effectively away from building elements, including the foundation.

**why:** Moisture is a major enemy of both building durability and indoor environmental quality. Concrete’s porous nature means that water near the foundation readily migrates into basements and crawl spaces, resulting in mold and humidity issues that can compromise indoor air quality and damage the home’s structure and surfaces.

**how:** At the foundation footing, install drain tile so water will flow through free-draining fill or drainage board and drain away from the house. Perforated drain-pipe must be located below the level of basement slab or crawl space surface. Backfilled dirt is graded to drain away from the building. Garage floor, driveway and all surfaces adjacent to the home are sloped to drain away from a building. Make sure the grade drains away from the building for at least 8 feet. Slopes of less than 1% do not drain effectively; the Building Science Corporation recommends a slope of 5%.

With steep slopes away from the home, be sure to create a topography that slows sheet flow, in order to avoid erosion and encourage infiltration.



**considerations:** Proper grading to direct water away from the foundation is just one part of a comprehensive water management strategy for the home. The Building Science Corporation offers good advice on comprehensive moisture management for a home (see Resources).

**resources:** Building Science Digest 013: “Rain Control in Buildings” describes a holistic approach to dealing with rain-based moisture management in homes: [www.buildingscience.com](http://www.buildingscience.com) (search for *BSD-013*).

The *High Point Natural Drainage Technical Standards*, developed for Seattle Public Utilities by SvR Design, includes information on low-impact drainage strategies: [www.svrdesign.com/high\\_pt.html](http://www.svrdesign.com/high_pt.html) (scroll down to *Additional High Point Resources*).

## Action Item 3-12

Grade to drain away from home

### Points: 1

#### Responsible party:

Contractor, Landscape Architect

#### Intent:

Enhance building durability and protect occupant health by ensuring proper drainage of water away from home and foundation.



#### Homeowner Benefit:

Moisture and bulk water from storm events can flood basements and crawl spaces, resulting in mold and rot. A drainage strategy that quickly conveys water away from the home and its foundation helps a building last longer and protects indoor environmental quality.



#### Homeowner Benefit:

A dedicated tire wash area may be required by code, and helps maintain order and cleanliness on the jobsite. It also reduces the likelihood of soils compaction, landscape damage, and contamination by containing tire wash activities to one area on the property.

## Action Item 3-13

No clearing or grading during wet weather months (October 31 to April 1)

### Points: 2

#### Responsible party:

Contractor

#### Intent:

Protect water quality and aquatic species; avoid erosion and potential property damage.



SITE/WATER

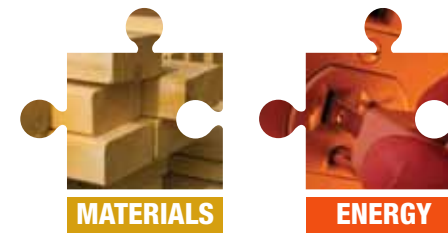
**what:** Wet months in the central Puget Sound region range from October 31 through April 1, but can extend into June. Clearing entails any action that results in exposed soils.

**why:** Clearing and earthmoving during the long wet-weather months in the Pacific Northwest greatly increases the likelihood of erosion and sedimentation, and the subsequent negative impact on water quality.

**how:** Develop a project schedule such that research, design, and indoor remodeling activities take place during the wet months.

Our region's uncertain rain patterns mean that substantial rain events occur well into the early summer months. Take extra precautions outside the guaranteed rainy months to ensure earthmoving activities do not result in erosion and sedimentation. See Volume 2 of Ecology's Stormwater Management Manual for Western Washington for best management practices.

**resources:** Stormwater Management Manual for Western Washington (Vol. 2: Construction Stormwater Pollution Prevention) [www.ecy.wa.gov/programs/wq/stormwater/manual.html](http://www.ecy.wa.gov/programs/wq/stormwater/manual.html).



MATERIALS

ENERGY

**what:** Fly ash is a combustion byproduct of coal-fired power plants. Blast furnace slag is a byproduct of the iron and steel production process. Both materials have properties that make them suitable for using in place of a certain percentage of cement in concrete production. Since they are considered byproducts (waste) of processes that create other products, their productive use is an environmental benefit.

**why:** Cement production is a highly energy intensive process. By replacing cement with waste products, it's possible to reduce the "upstream" carbon impact (embodied energy) of the remodel.

**how:** Fly ash and blast furnace slag can be specified in concrete mixes from most concrete suppliers.

Replacing fly ash for 25% of the Portland cement in a concrete mix is common; replacement of up to 50% of the cement with fly ash can be done with little effect on cured concrete strength. Check with your local permitting agency to anticipate any code challenges to high-fly ash concrete. Fly ash and blast furnace slag added to concrete mixes does extend curing time; factor this time into the construction schedule.

Specify slag and fly ash in replacement of cement. Often fly ash is added to a concrete mix without removing the cement, due to the fact that these materials can improve the workability of the concrete mix and delay curing times. However, to achieve environmental benefit (and receive points for this Action Item) from using fly ash and slag, it must reduce the amount of Portland cement used in the mix.

**considerations:** Factor in where the fly ash is sourced; sources that must be shipped long distances can reduce or even erase the environmental benefit. Fly ash often contains small amounts of heavy metals, including mercury; although leaching of these materials from cured concrete has not been verified, it raises questions about the disposal of these concretes down the road.

**resources:** ToolBase provides an overview of fly ash concrete: [www.toolbase.org](http://www.toolbase.org) (click on *Technology Inventory* and then *Fly Ash Concrete*)

The Slag Cement Association, an industry group, provides information on blast furnace slag: [www.slagcement.org](http://www.slagcement.org)

## Action Item 3-14

Use fly ash or blast furnace slag for 25% by weight of cementitious materials for all concrete (20% for flat work)

### Points: 5

#### Responsible party:

Structural Engineer

#### Intent:

Reduce energy use and pollution related to the production of cement products.



#### Homeowner Benefit:

Grading and earthmoving during wet months is a messy job, and exposed soils are prone to erosion. In some cases, exposed unstable soils may be at increased risk for landslide, or changes in site topography can lead to water intrusion in the home.



#### Homeowner Benefit:

Replacing a portion of the cement content in concrete mixes can extend curing times, a benefit in some applications that require more workability. Depending on the replacement mix, these replacement materials can result in stronger and less porous concrete. Reducing the amount of cement in a concrete mix also reduces the carbon impact of the project, due to cement being very energy intensive to produce. (It's estimated that about 7% of all CO2 emissions caused by humans are related to cement production.)



## Action Item 3-15

Use recycled concrete, asphalt, or glass cullet for base or fill for new foundation; minimum of 35%

### Points: 1

#### Responsible party:

Structural Engineer

#### Intent:

Promote the use of recycled content products; reduce the use of virgin raw materials in construction.



**what:** Crushed concrete is sourced from concrete recyclers, whose material comes from a variety of sources, including building, road, and infrastructure demolition.

Recycled asphalt mainly comes from road projects, and glass cullet is low-grade broken glass, often from local recycling programs.

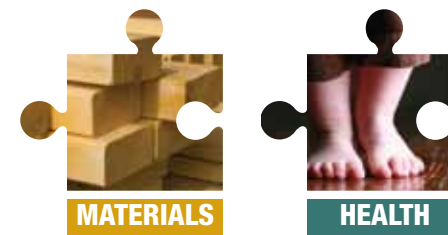
**why:** Concrete, asphalt and class cullet are plentiful waste products that can easily take the place of crushed stone, and in doing so avoid the need to quarry virgin material.

**how:** To achieve a point for this Action Item, the project must use recycled content product for at least 35% of all fill for new foundation elements on the home.

Make sure concrete, asphalt, or glass cullet is ground properly to meet base or fill specification in order to meet requirements for compaction. The Washington State Department of Transportation maintains a specification for glass cullet fill.

**resources:** The Clean Washington Center Technology Brief: "Construction Inspector's Guide to Recycled Glass Aggregate" provides information on glass aggregate application: [www.cwc.org/glass/gl\\_html/gl952fs.htm](http://www.cwc.org/glass/gl_html/gl952fs.htm)

The Portland Cement Association maintains information on recycled concrete aggregates: [www.cement.org/tech/cct\\_aggregates\\_recycled.asp](http://www.cement.org/tech/cct_aggregates_recycled.asp)



**what:** Moisture and gases can build up under a home's slab. Moisture can wick through the slab, causing dampness and durability problems. Similarly, gases can accumulate and work their way through cracks and joints in the slab, creating an exposure hazard for occupants.

**why:** A venting system can help reduce the likelihood of callbacks related to damp concrete floors or moisture issues.

**how:** Radon-prone areas have standard designs for sub-slab venting systems. "Passive" radon mitigation systems use the natural stack effect to exhaust soil gases from beneath a slab. These systems use a gravel or cullet drainage pad below the slab outfitted with perforated pipe attached to a vent stack terminating at a roof vent to pull soil gases from the ground.

US EPA provides free architectural drawings of radon systems (see Resources).

**considerations:** Adding blast furnace slag or fly ash to a concrete mix helps reduce the capillary effect in concrete (see Action Item 3-14), providing added moisture protection.

**resources:** US EPA radon drawings: 1-800-55-RADON (1-800-557-2366).

US EPA information on radon-resistant new construction: [www.epa.gov/radon/rrnc/](http://www.epa.gov/radon/rrnc/)

Building Science Corporation Information Sheet 110: "Soil Gas Control" offers information on managing soil gases: [www.buildingscience.com](http://www.buildingscience.com) (search for *Info-110*).

## Action Item 3-16

Install working vent system to eliminate potential moisture, methane, and radon problems in crawl space or under slabs on grade

### Points: 2

#### Responsible party:

Contractor, Expert

#### Intent:

Protect the health of occupants by reducing moisture and hazardous gas exposure.



#### Homeowner Benefit:

When ordered to the proper specification, recycled materials can perform equally to virgin materials and be purchased for a lower cost. The materials are often sourced very locally, meaning their environmental footprint is small.



#### Homeowner Benefit:

While radon is generally not a problem in Western Washington, venting systems designed for dealing with radon are actually quite effective at helping keep the space under a slab-on-grade foundation drier, reducing potential moisture problems. This results in drier, more comfortable floors, a more durable structure and healthier indoor air.

## Action Item 3-17

Install a minimum of R-10 rigid insulation beneath any slabs on grade for additions

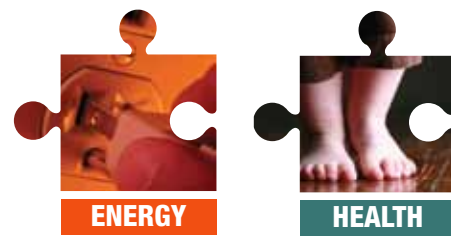
### Points: 2

#### Responsible party:

Architect

#### Intent:

Enhance the energy efficiency of the building envelope, reducing operational energy use, as well as reducing condensation-related moisture issues, protecting indoor air quality.



**what:** The most common rigid insulation used under a slab on grade is expanded or extruded polystyrene. While current building codes require insulation only at the building perimeter, to achieve this Action Item additions must install rigid insulation under the entire area of slab on grade.

**why:** Rigid Insulation under the slab will reduce the potential for condensation caused when the slab temperature is below the dew point. This condensation can result in building durability issues as well as mold growth and damage to flooring, carpeting, and other materials in the home.

Additionally, rigid insulation under a slab reduces heat loss, saving energy and making a floor more comfortable for occupants.

**how:** A key (and often overlooked) element of sub-slab insulation is insulating the slab perimeter, which can result in substantial energy loss as well as moisture problems caused by temperature differentials. Slab edge insulation can be applied to the outside edge of the slab (down to the bottom edge of the grade beam) or inside, with EPS insulation used as a bond break between the slab and the grade beam).

**resources:** Building Science Corporation's Information Sheet 513: "Slab Edge Insulation" provides insulation details for both slab on grade with perimeter foundation wall and slab with grade beam. Search for the information sheet at [www.buildingscience.com](http://www.buildingscience.com)

The Washington State Energy Code Builder's Field Guide provides construction details for insulating slab on grade in Chapter 2 of the document: [www.energy.wsu.edu/code/](http://www.energy.wsu.edu/code/)



**what:** "Structure as finish" is a design approach that eliminates finish material by using the structural component of the building as the finish layer. In this case, the foundation slab serves as the finish floor.

**why:** Having structural materials double as finish surfaces helps avoid the need to extract, process, manufacture, distribute and install materials, which saves energy, materials, and can reduce project costs as well.

**how:** Using the foundation slab as finish floor requires careful detail to installation, in order to achieve the desired aesthetic effect. Slabs can be integrally pigmented or surface stained to achieve a wide variety of colors. Alternatively, the surface can be polished to avoid much of the need to seal the final surface, saving additionally on materials.

**considerations:** Increase the energy efficiency and comfort of the finished slab by installing rigid insulation under the entire slab area (see Action Item 3-17).

**resources:** The Environmental Building News article "Polished Concrete Outshines Other Flooring Options" describes concrete floor polishing as a finishing approach: [www.buildinggreen.com/auth/article.cfm/ID/3252/](http://www.buildinggreen.com/auth/article.cfm/ID/3252/)

## Action Item 3-18

Design foundation slabs to double as a finished floor

### Points: 2

#### Responsible party:

Architect, Contractor

#### Intent:

Conserve material resources by reducing finish materials use.



#### Homeowner Benefit:

Insulated slabs save energy, reduce the potential for condensation on the slab's surface during the summer, and increase comfort by making the slab warmer to the touch than a floor without insulation. Limiting condensation reduces the likelihood of mold formation, especially in areas where slabs are covered with carpet or other floor coverings, and reduces the likelihood of wood floors buckling from excess moisture.



#### Homeowner Benefit:

Using the foundation slab as the finish floor helps reduce materials purchase costs, and can increase the energy efficiency of an in-floor heating system avoiding an insulating layer created by flooring.

## Action Item 3-19

Use less toxic form releasers

### Points: 2

#### Responsible party:

Architect, Structural Engineer, Landscape Architect

#### Intent:

Protect the health of occupants and the larger environment by reducing the use of toxic materials in building construction.



**what:** Forms are commonly coated with fuel oil to prevent the concrete from sticking to the form.

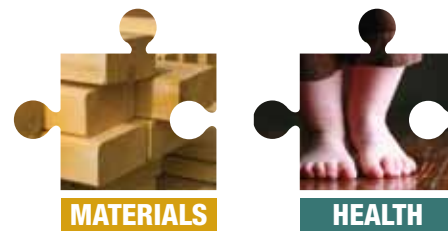
**why:** Runoff, incidental drips, and spills associated with using petrochemical form releasers contaminate soils and may enter storm drains thereby contaminating surface water.

**how:** Using vegetable oil spray, wax or paint keeps forms can help ease removal. Smooth surfaces such as medium density overlay can also help. To reduce waste, consider using reusable form boards with a polyethylene coating. Using ICFs (Action Item 1-18) reduces the need for formwork altogether, and the attendant toxics related to release agents as well as the materials needed for the forms themselves.



#### Homeowner Benefit:

Reducing toxic materials on site means a reduced likelihood of spills and resulting contamination. More globally, a shift to low- and nontoxic products means a safer environment for all.



**what:** The calcium chloride test measures the water vapor emitted by cured concrete to determine whether the surface is acceptable for flooring installation.

**why:** A typical concrete floor contains 300 pounds (nearly 36 gallons) of water per cubic yard when poured. Long after the floor

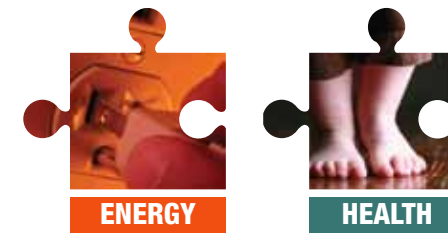
cures, this water continues to dissipate.

**how:** Prior to installing finish flooring on concrete slabs, test the concrete using the ASTM F 1869 method, and do not install flooring until the floor's moisture level is within tolerances set by the flooring manufacturer. Various manufacturers supply calcium chloride test kits.



#### Homeowner Benefit:

Ensuring a slab is appropriately dry for flooring installation helps reduce the likelihood of premature product failure or installation issues such as swelling, buckling, adhesive failure, or mold growth.



**what:** A comprehensive crawl space improvement addresses issues of energy efficiency, moisture management, and durability simultaneously.

**why:** Crawl space improvements done piecemeal can result in unintended consequences. Stand alone improvements in duct insulation, or floor insulation can actually increase energy use in the home and can lead to elevated crawl space moisture levels, mold and mildew growth, structural damage and frozen pipes.

**how:** The following measures make up a comprehensive crawl space improvement:

- Install black 6 mil plastic vapor barrier on the crawl space floor.
- Caulk and seal floor penetrations.
- Make sure ducts are securely connected.
- Seal duct work with mastic.
- Insulate floor to R-19 or better.
- Insulate ductwork. If less than R-6 add insulation to R-11.
- Insulate plumbing in unconditioned space to R-3 or better.

**considerations:** Properly grading around the home's foundation (Action Item 3-12) also helps reduce the likelihood of water intrusion.

A comprehensive crawl space improvement is an alternative to creating a completely conditioned crawl space (Action Item 1-34), which brings the crawl space within the thermal envelope of the home.

**resources:** The Department of Energy's Energy Savers resource includes information on insulating crawl spaces: [www.energysavers.gov](http://www.energysavers.gov) (click on *Insulation*, then *Where to Insulate*)

Building Science Corporation Information Sheet 512: "Crawlspace Insulation" provides information on insulating crawl spaces: [www.buildingscience.com](http://www.buildingscience.com) (search for *Info-512*)

## Action Item 3-21

Comprehensive crawl space improvement

### Points: 3

#### Responsible party:

Expert

#### Intent:

Enhance durability of structure; ensure intended levels of energy efficiency.



#### Homeowner Benefit:

Approaching crawl space improvements in a comprehensive manner ensures that energy efficiency and healthy indoor air strategies do not conflict with each other, causing unintended problems such as frozen pipes or moisture issues.

## Action Item 3-20

Perform calcium chloride moisture test on all new slabs on grade prior to installing any finish flooring in conformance with product warranties

### Points: 2

#### Responsible party:

Architect

#### Intent:

Protect building materials and indoor air quality.

## FRAMING

The framing stage offers opportunities for enhancing a home's insulation, as well as using environmentally preferable products including sustainable harvest lumber and recycled content panel goods. A pre-drywall building envelope inspection can identify and correct shortcomings in the home's air and weather barrier—saving on energy bills and avoiding potential durability issues.

## Action Item 4-1

Use energy heels of 6" or more on trusses to allow added insulation over top plate

### Points: 1

#### Responsible party:

Architect, Framers

#### Intent:

Provide for full-depth insulation coverage in attic spaces for optimal energy performance; reduce likelihood of ventilation and moisture issues related to blocked attic vents.

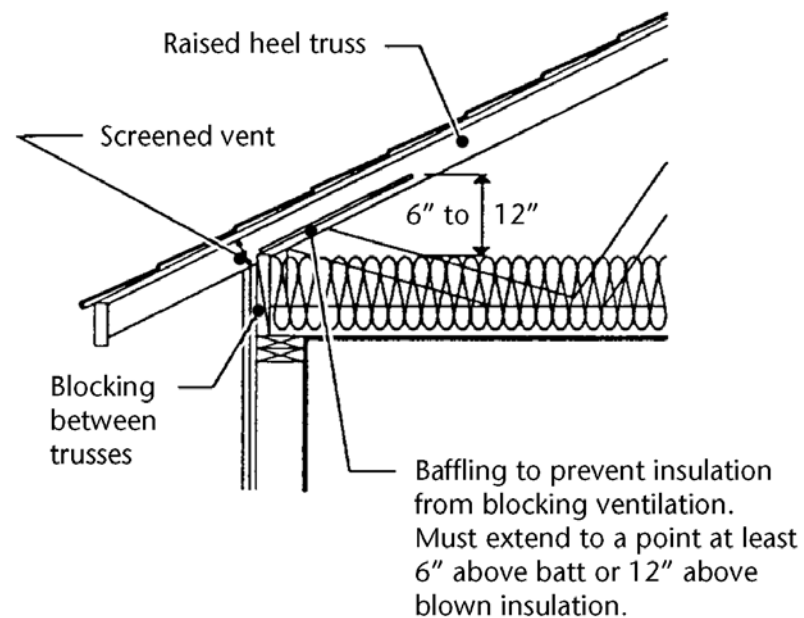


**what:** An energy heel, or "raised heel truss," is a truss with added height at the edge, rather than the conventional truss configuration that tapers to a point at the top plate. The height of a raised heel truss can vary; 10" allows for sufficient space for insulation.

**why:** Conventional trusses can leave inadequate space for insulation at the edges of an attic, reducing the overall energy efficiency of the home's thermal envelope. Attempting to insulate fully at the edges with conventional trusses can also lead to blocked attic vents as insulation contractors or homeowners attempt to add more insulation than can reasonably fit in the space. Blocked vents reduce airflow to the attic space, and can result in moisture intrusion and mold damage.

**how:** Raised heel trusses can be ordered from most truss manufacturers, and are specified and engineered similar to standard trusses.

**resources:** The Washington State Energy Code Builder's Field Guide provides construction details for raised heel trusses in Chapter 3 of the document: [www.energy.wsu.edu/code/](http://www.energy.wsu.edu/code/)



*Raised heel trusses allow insulation to be placed at full depth even at the attic perimeter. Blocking and baffles prevent loose-fill insulation from blocking vents or being shifted during strong winds.*

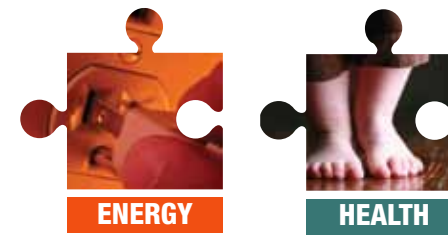
*Image: Washington State Energy Code Builder's Field Guide, courtesy of Washington State University Energy Extension.*



#### Homeowner Benefit:

Added attic insulation levels increase the energy efficiency of the home's thermal envelope, lowering energy bills and reducing the home's carbon footprint.

Advanced insulation levels can also help reduce the size and complexity of a heating system, leading to savings in construction cost if modifications to the heating system are part of the remodel.



**what:** Air infiltration barriers, or house wraps, form a barrier to air infiltration, thus improving energy performance. House wraps are vapor permeable, but airtight. They achieve this state either through micro-perforations or by being manufactured from polyethylene or polyolefin materials specially designed to allow vapor to pass through.

**why:** A house wrap is only as good as its installation. To act as a true air infiltration barrier, the house wrap must be a contiguous, unbroken unit. Improper installation can result in lower than expected energy savings by allowing air infiltration, and creating moisture and durability problems.

**how:** Closely follow product manufacturers' house wrap installation instructions. All applications should be installed shingle-style, with ample overlap and all seams either taped or caulked as per instructions.

Many house wraps are very sensitive to ultraviolet degradation; siding should be applied as soon as possible after the air barrier is installed. Additionally, some house wraps are degraded by contact with wood oils present in materials such as cedar siding.

## Action Item 4-2

Addition wrapped with an exterior air infiltration barrier to manufacturer's specifications

### Points: 1

#### Responsible party:

Contractor

#### Intent:

Reduce energy use and moisture issues related to unwanted air infiltration.



#### Homeowner Benefit:

Air leakage can represent up to 30% of a home's energy bill. Air infiltration barriers help reduce the leakiness of a home, resulting in heating and cooling savings throughout the years.

## Action Item 4-3

Inside the house, use only low-VOC, low-toxic, water-based, solvent-free sealers, caulks, adhesives for framing

### Points: 2

#### Responsible party:

Contractor

#### Intent:

Protect occupant health by reducing exposure to toxic and irritating substances.



**what:** One of the first steps in creating a healthy indoor environment is to avoid the introduction of toxins and irritants. Many wet-applied building products contain a variety of toxic materials as well as VOCs (volatile organic compounds: substances that readily convert to a gas at room temperature and pressure).

**why:** According to the US EPA, three out of five homes in the United States suffer from unhealthy levels of indoor pollutants. These pollutants come from a variety of sources, including wet-applied building products such as paints, sealers, adhesives, caulks, grouts and joint compounds. Conventional versions of these products may off-gas large amounts of toxic VOCs (including solvents and aromatic hydrocarbons).

Using safer, low-toxic, low-VOC alternatives helps reduce both occupant and worker exposures to these substances, and can mean fewer hazardous substances on the jobsite.

**how:** Choose healthier low-VOC options. A standard definition for low-VOC is the limits set by the Bay Area Air Quality Management District. Based on these guidelines, the following table provides recommended VOC limits for adhesives in grams per liter (g/l):

- Indoor floor covering adhesives: 150
- General purpose adhesives: 200
- Varnish: 350

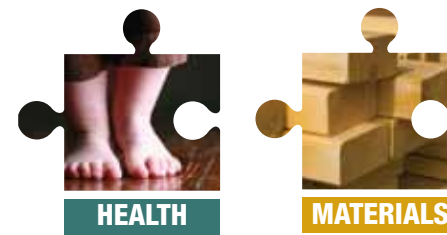
- Primers, sealers, undercoaters: 200
- Flat coatings: 50
- Nonflat coatings: 100
- High-gloss coatings: 150
- Floor coatings: 100
- Form release compounds: 250
- Stains: 250

In addition, clearly communicate with all subs the project's indoor air quality goals, and provide them with product names to increase the likelihood of compliance with goals. (It is very easy for a subcontractor to simply use "extra" materials on hand, which may not meet a green project's criteria for performance.)

**considerations:** Specify low toxic, low VOC products for other applications in the home, such as caulks and adhesives for drywall joint compound (Action Item 11-2), tile and grout products (Action Item 13-34) and paints and finishes (Action Item 13-35).

**resources:** Bay Area Air Quality Management District: [www.baaqmd.gov](http://www.baaqmd.gov) (click on Work, then Rules and Regulations).

US EPA information on VOCs: [www.epa.gov/iaq/voc.html](http://www.epa.gov/iaq/voc.html)



**what:** Particleboard, interior grade medium density fiberboard (MDF), and other interior use, resin-containing products often use urea-formaldehyde glue as a binder. With a half-life of more than 10 years, urea formaldehyde continues to emit formaldehyde long after manufacture.

**why:** Formaldehyde in the indoor environment can cause health problems for the occupants, including headaches and flu-like symptoms, and can be a cause of sick building syndrome. Formaldehyde is classified as a "known human carcinogen" by the International Agency for Research on Cancer.

**how:** Specify materials containing no added urea formaldehyde, such as exterior grade MDF, OSB and plywood. Many of these products use phenolic resins (phenyl formaldehyde). Unlike urea formaldehyde resins, these resins offgas during the curing process, and nearly all of the remaining formaldehyde is bound in the final product (and prevented from release into the air). Other urea formaldehyde resin alternatives include MDI (methylene diphenyl diisocyanate) and soy-based binders.

Natural processes, including the decay of wood fibers, can produce small amounts of formaldehyde. Therefore, most products avoid the term "formaldehyde-free," instead using the terms "no added formaldehyde" or "no added urea formaldehyde."

**considerations:** Avoid added urea formaldehyde in other interior products as well, including cabinetry (Action Item 13-27), interior and exterior doors, and trim molding. Also be aware of formaldehyde in materials later introduced into the home by the homeowner, including composite wood furniture (tables, bookshelves, etc.). Consider providing information on these additional formaldehyde sources to the homeowner.

**resources:** The Green Seal *Choose Green Report: Particleboard and Medium Density Fiberboard* describes the indoor air quality and other environmental issues related to composite wood products: [www.greenseal.org](http://www.greenseal.org) (click on *Publications and Resources*, then *Choose Green Reports*).

US EPA information on formaldehyde: [www.epa.gov/iaq/formalde.html](http://www.epa.gov/iaq/formalde.html)

## Action Item 4-4

Use plywood and composites of exterior grade or with no added urea formaldehyde (for subfloor use)

### Points: 3

#### Responsible party:

Contractor, Architect

#### Intent:

Protect occupant health by avoiding exposure to carcinogens.



#### Homeowner Benefit:

Avoiding building products that contain toxic substances, VOCs and solvents helps create a healthier, more comfortable indoor environment.



#### Homeowner Benefit:

Avoiding products containing urea formaldehyde helps protect the indoor environment, enhancing occupant health and comfort.

## Action Item 4-5

Have crawlspace, attic, and garage building performance tested for disconnection to the living space of house

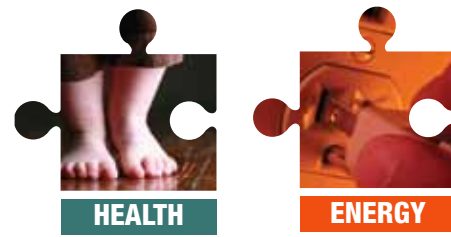
### Points: 2

#### Responsible party:

Contractor, Expert

#### Intent:

Protect indoor air quality and occupant health by limiting exposure to air pollution present in garages, attics and crawl spaces.



**what:** Air leaks can introduce unhealthy air into living spaces, including moldy, stale air from crawl spaces and attics, and stored chemical offgassing and carbon monoxide and other exhaust products from garages.

**why:** To ensure indoor air quality integrity of the living space, it is best to have the crawl space, attic, and most importantly, the garage, fully air sealed from the living space.

**how:** Air and toxins from garages and unconditioned spaces can enter through air leaks in walls, ceilings or floors, or through leaky ductwork. Use blower door and/or duct leakage tests to verify performance. A home performance contractor (see Action Item 1-16) can perform these tests. Projects with conditioned crawlspaces (Action Item 1-34) and/or attics are exempt from this Action Item's requirement for crawlspace or attic disconnection. Performance testing for this Action Item can occur in conjunction with testing conducted for Action Item 10-11, reducing testing costs and allowing the opportunity for identifying and correcting air leaks. Find home performance contractors through services such as Home Performance Washington (see Resources).

**considerations:** Employing building practices that help maintain a continuous barrier between conditioned and unconditioned space, including separating or air sealing the garage (Action Item 1-33), advanced sealing of ducts (Action Item 7-20) and employing the Airtight Drywall Approach (Action Item 11-1) increase the likelihood of good performance tests results.

**resources;** Home Performance Washington:  
[www.homeperformancewashington.org](http://www.homeperformancewashington.org)

The ENERGY STAR Thermal Bypass Checklist identifies common places for air leakage in new construction, which can be instructive in finding leaks in existing homes as well: [www.energystar.gov](http://www.energystar.gov) (search for Thermal Bypass Checklist).



**what:** Layout, or framing plans, let a framer know exactly where the framing members are designed to go. A cut plan identifies the exact number and length of each framing piece, to be provided to the lumberyard to assemble the proper pieces. Together, these two plans guide both the purchase and on-site use of framing lumber.

**why:** Having a list identifying the intended use of each piece of lumber reduces the overall volume of lumber needed to construct the house as well as the volume of leftover scraps, by reducing the likelihood of large pieces being unintentionally cut for alternative uses. Such a list increases accountability of framers and suppliers and can result in significant savings.

**how:** Work with the project architect to create a layout and cut plan. The process is as follows:

- Using a set of project plans and an architect's scale, identify the length and number of framing members.
- Mark up a set of plans with the framing schedule,
- From this, create a board-by-board take-off that can be used as an order list for the framing material supplier and a cut list for framers.

**resources:** The King County GreenTools website includes a variety of information on jobsite waste reduction: [www.greentools.us](http://www.greentools.us) (click on *Construction Recycling*, then *Prevent Jobsite Waste*)

## Action Item 4-6

Provide (to framer) and use layout and cut plan

### Points: 3

#### Responsible party:

Architect

#### Intent:

Reduce material use and waste related to framing activities.



#### Homeowner Benefit:

Testing for air routes between unconditioned and conditioned space in the home helps identify and fix any breaches in the system, protecting indoor air quality and occupant health.



#### Homeowner Benefit:

Using a framing layout and cut plan can help save materials and reduce construction and disposal costs by minimizing waste.

## Action Item 4-7

Use central cutting area or cut packs

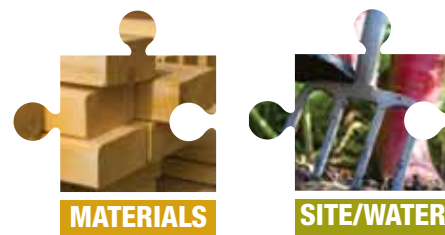
### Points: 1

#### Responsible party:

Contractor

#### Intent:

Reduce waste and resource use related to house framing activities.



**what:** A centralized cutting area is a dedicated location for all materials cutting. Cut packs are pre-cut framing and lumber packages.

**why:** Designating a centralized cutting area reduces wood waste, reduces the total amount of wood that must be supplied to the site, and saves time by making it convenient for carpenters to reuse cutoffs and scrap. It also makes the cutting process itself more efficient. Studies of construction sites with a centralized cutting area showed total construction waste reduction volume of as much as 15%.

Cut packs greatly reduce on site waste since they are pre measured and cut at the lumberyard.

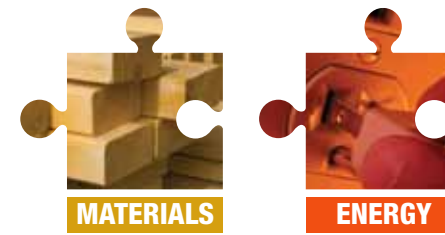
**how:** Dedicate space on the jobsite for materials cutting, and notify all employees and subs about the expectation to use the central cutting area. Post signage, notifying workers to use cutoff materials first before cutting a new piece.

**considerations:** Cut packs and centralized cutting areas are just two of many waste prevention activities that can occur on a jobsite. Refer to the King County GreenTools program for many more ideas for waste prevention and maximizing recycling (see Resources.)

A central cutting area also creates an ideal location for the wood scraps bin or pile, convenient for subcontractors so they'll reuse the wood. (See Action Item 2-6 for more on requiring subcontractors to participate in waste reduction efforts.)

See Action Item 4-8, for lumber reuse suggestions.

**resources:** The King County GreenTools website includes a variety of information on jobsite waste reduction: [www.greentools.us](http://www.greentools.us) (click on Construction Recycling, then Prevent Jobsite Waste).



**what:** Lumber reuse entails sourcing material from the current project, other jobsites, or purchased from salvage and reuse operations.

**why:** Reusing building materials provides wide-ranging environmental benefits including, reducing waste, preserving embodied energy, reducing pollution, and preserving natural resources and habitats.

**how:** Reusing lumber requires careful salvage (usually a deconstruction, or dismantling of another structure) in order to maintain it in a condition fit for reuse. Used building materials retailers also sell salvaged lumber, ready-to-use.

Old lumber can be dry and brittle, requiring special care when nailing to avoid splitting. Crews experienced in installing salvaged lumber will have an easier time with the process. There may be code restrictions to using salvaged lumber in structural applications, or the permitting authority may require an engineer's stamp to verify load-bearing capacity. Reusing lumber in non-structural applications, including the secondary framing for double-stud wall configurations for energy efficiency, presents no code barriers.

**resources:** The Northwest Building Salvage Network provides links to used building materials retailers and resources on building salvage: [www.nbsnonline.org](http://www.nbsnonline.org)

The Building Materials Reuse Association provides a directory of used building materials retailers and salvage consultants: [www.bmra.org](http://www.bmra.org)

The Green Home Remodel Salvage and Reuse guide provides general information on building materials salvage and reuse: [www.greentools.us](http://www.greentools.us) (click on *Residential Buildings*, then *Residential Remodeling Guides*).

Seattle Department of Planning and Development Client Assistance Memo 336: "Sustainable Building and Reuse of Building Materials" provides a good overview of issues code officials may be concerned with when reusing building materials. Available at [www.seattle.gov/dpd](http://www.seattle.gov/dpd) (click on *Resource Center*, then *Publications*, then *Client Assistance Memos*).

EPA information on avoiding lead based paint hazards: [www.epa.gov/lead](http://www.epa.gov/lead) Homeowners should read the EPA document: "Renovate Right: Important Lead Hazard Information for Families, Child Care Providers and Schools."

## Action Item 4-8

Reuse lumber

### Points: 2

#### Responsible party:

Contractor, Framers

#### Intent:

Reduce resource extraction and protect forests by lessening demand on forest products through materials reuse.



#### Homeowner Benefit:

Cut packs and central cutting areas help reduce wood waste on the jobsite, reducing project materials costs and saving money on disposal and recycling fees.



#### Homeowner Benefit:

According to EPA statistics, a 2000 square foot home generates 127 tons of demolition debris. Ten percent of this is recoverable framing lumber, which averages 6,000 board feet or 33 mature trees. Reusing lumber can reduce a project's expenditures on disposal as well as materials purchases.



## Action Item 4-9

Use no endangered wood species

### Points: 3

#### Responsible party:

Contractor, Owner, Architect

#### Intent:

Protect endangered plant species and forest ecosystems by specifying responsibly harvested wood products.



MATERIALS

**what:** Endangered wood species are those that have been determined to be in immediate danger of extinction.

**why:** Healthy forests are critical to the proper functioning of many ecosystems. Forest practices affect much more than trees. Endangered species are an indication that forests are being managed unsustainably.

**how:** Wood species listed in the Convention on International Trade in Endangered Species (CITES) list represents plant species determined endangered or threatened if international trade were left unrestricted where international trade could threaten their survival. This is the best source for a complete listing; see Resources.

As a general rule of thumb, avoid these endangered species:

- Teak, except material meeting the criteria for sustainable harvest wood (see Action Item 4-14)
- African and Honduran Mahogany
- Ipe (except third party certified products with Chain of Custody verification—see Action Item 4-14)
- Luan (Philippine Mahogany)
- Rosewood
- South American walnut
- Brazilian Cherry/Jojoba (except third party certified products—see above)
- Alaskan Yellow Cedar (except salvaged wood)
- First or old growth West Coast Redwood or Douglas Fir (except salvaged wood)

Old growth refers to trees that are 200 years or older. British Columbia is the largest source of old growth wood products used in the U.S. Old growth wood also comes from Central American, Brazilian, Malaysian, Indonesian, African rainforests, Chile, Russia, and the Western U.S. Unless a wood is labeled third party certified for responsible harvest or “100% post-consumer recycled” there is no way to ensure it is not a product of old growth or endangered forests.

**considerations:** In general, seek out wood with independent, third party certification for being responsibly managed (see Action Item 4-14 for more on certified wood). Independent certification helps ensure that forestry practices are protective of sustainable harvest rates, local ecosystems, and worker’s rights.

**resources:** CITES maintains a searchable database of species: [www.cites.org/eng/resources/species.html](http://www.cites.org/eng/resources/species.html) (requires knowing the common or botanical name of the species).

Rainforest Relief offers information on tropical wood species to avoid: [www.rainforestrelief.org](http://www.rainforestrelief.org)



MATERIALS



HEALTH



SITE/WATER

**what:** Third-party certification is based on standards developed by an unaffiliated organization. Third-party certification standards establish criteria and verify manufacturer claims regarding the environmental, social and economic benefits of their products.

**why:** As green becomes mainstream, more manufacturers and retailers are focusing marketing dollars on the environmental attributes of their products. While some of these claims are valid, many others fall into the realm of “greenwash,” or unsubstantiated—even dishonest—claims. Verifying environmental claims is time-consuming and sometimes impossible given the proprietary nature of some building products’ compositions. Certification programs help reduce this barrier to information, and provide a mechanism for verification of claims.

**how:** To receive credit for this Action Item, use any certified products from any the following organizations, other than carpet and wood products (these products receive points under other Action Items). Submit other third-party certification programs to the BUILT GREEN Director for approval.

- Scientific Certification Systems (SCS) is a third-party certifier that promotes sustainable development in the forms of environmental protection and social responsibility.
- Greenguard Environmental Institute, another third-party certification organization that provides information related to Indoor Air Quality on insulation, air filters, doors, floor finish, flooring, and wall finish.

- Green Seal is a third-party certification organization that evaluates, tests and visits manufacturing facilities to identify a product as environmentally preferable.
- FloorScore, developed by the Resilient Floor Covering Institute (RFCI) in conjunction with Scientific Certification Systems (SCS), tests and certifies flooring products for compliance with indoor air quality emission requirements. Flooring products include linoleum, laminate flooring, wood flooring, ceramic flooring, rubber flooring, wall base, vinyl, and associated sundries.
- Cradle to Cradle, developed by chemist Michael Braungart and architect William McDonough, evaluates a wide variety of products for life cycle environmental performance.

Carpet and wood products are not eligible for this Action Item.

**considerations:** See Action Item 13-10 for installing third party certified carpet; see multiple Action Items for using sustainable harvest lumber with third party certification (Tier 1 definition).

#### resources:

Scientific Certification Systems: [www.scs-certified.com](http://www.scs-certified.com)

Greenguard: [www.greenguard.org](http://www.greenguard.org)

Green Seal: [www.greenseal.org](http://www.greenseal.org)

FloorScore: [www.rfci.com/int\\_FloorScore.htm](http://www.rfci.com/int_FloorScore.htm)

Cradle to Cradle: [www.c2ccertified.com](http://www.c2ccertified.com)

## Action Item 4-10

Use environmentally preferable products with third-party certification, minimum of three applications (excluding carpet and wood)

### Points: 2

#### Responsible party:

Contractor, Owner

#### Intent:

Encourage the use of certification systems to verify products’ environmental and health performance. Protect indoor environmental health.



#### Homeowner Benefit:

Products independently certified for environmental and health performance provide an added measure of assurance that manufacturer claims are valid. By setting standards and independently testing products with respect to achieving those standards, certification systems help move the marketplace toward sustainability.

## Action Item 4-11

Use salvaged lumber

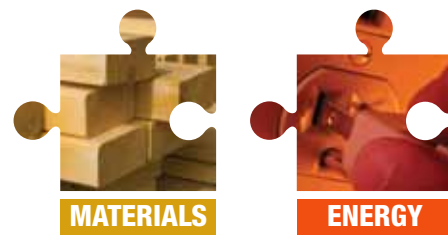
**Points: 1-5**

**Responsible party:**

Contractor, Owner, Architect

**Intent:**

Reduce raw material extraction by increasing reuse of building materials.



**what:** Salvaged lumber refers to dimensional lumber that is removed from existing buildings for reuse.

**why:** Reusing building materials provides wide-ranging environmental benefits including, reducing waste, preserving embodied energy, reducing pollution, and preserving natural resources and habitats.

**how:** Find salvaged lumber at regional used building materials retailers (see Resources, below).

This Action Item is worth 1-5 points.

- 200-399 board feet: 1 point
- 400-599 board feet: 2 points
- 600-799 board feet: 3 points
- 800-999 board feet: 4 points
- 1000+ board feet: 5 points

**resources:** The Northwest Building Salvage Network provides links to used building materials retailers and resources on building salvage: [www.nbsnonline.org](http://www.nbsnonline.org)

The Building Materials Reuse Association provides a directory of used building materials retailers and salvage consultants: [www.bmra.org](http://www.bmra.org)

The Green Home Remodel Salvage and Reuse guide provides general information on building materials salvage and reuse: [www.greentools.us](http://www.greentools.us) (click on Residential Buildings, then Residential Remodeling Guides).

EPA information on avoiding lead based paint hazards: [www.epa.gov/lead](http://www.epa.gov/lead) Homeowners should read the EPA document: "Renovate Right: Important Lead Hazard Information for Families, Child Care Providers and Schools."



**what:** Urban salvage refers to trees removed from urban parks, campgrounds, and recreation areas, possibly damaged from disease or considered a hazard. Other sources include trees removed from construction sites for clearing and grading.

Forest salvage refers to trees recovered from forest restoration projects or removed from forestland to make way for roads, campgrounds, or utility lines. It may also refer to hazardous trees removed from campgrounds. Instead of being chipped or used as firewood, these trees are sent to a mill and processed into flooring, trim, and other finish materials.

**why:** Much urban wood ends up being chipped for mulch, a definite "downcycling" of potential use. Milling this wood or residential use provides an opportunity for useful application of this often-plentiful material.

**how:** This action item is worth 2-3 points:

- 200+ board feet lumber salvaged from urban or forest resources: 2 points
- 200+ board feet lumber salvaged from building site\*: 3 points

This credit applies to new wood recovered from urban or forest salvage operators. It does not apply to forest products recovered from areas affected by forest fires. (Often, logging operations will remove standing trees from fire-damaged areas to sell as salvage; this practice actually interferes with the natural process of a forest recovering from fire and can severely damage a very sensitive site.)

Many wood suppliers offer new wood products that are made from wood salvaged from urban or forest resources, including flooring and cabinetry.

**considerations:** If harvesting wood on site, work with an arborist (Action Item 3-6) to identify and preserve the healthiest trees, and select trees for felling that are potential hazards or are in ill health.

\*Over-harvesting on the site to achieve the points for this credit is contrary to the intent of this Action Item. Only salvage trees that were originally planned for removal. Retaining healthy trees on site is a goal of the BUILT GREEN program (see Action Item 1-4).

## Action Item 4-12

Use urban or forest salvaged lumber, minimum 200 board feet

**Points: 2-3**

**Responsible party:**

Contractor, Architect

**Intent:**

Maximize beneficial use of otherwise waste wood.



### Homeowner Benefit:

Reusing lumber can reduce materials purchase costs and reduce disposal fees related to disposing of existing lumber on a home.



### Homeowner Benefit:

Using urban salvage lumber can bring a unique touch to a home by featuring wood with local provenance and a rich story.

## Action Item 4-13

Use finger-jointed framing material (e.g. plates and studs), minimum of 500 board feet

### Points: 3

#### Responsible party:

Contractor, Framers

#### Intent:

Protect and extend forest resources by increasing the efficiency of forest product use in lumber production.



**what:** Finger-jointing (gluing short lengths of wood together) makes use of wood that traditionally would have been disposed of as waste.

**why:** Finger-jointed products are generally straighter and stronger than solid wood, meaning fewer rejected and wasted warped or split boards.

**how:** To achieve points for this Action Item, the project must use at least 500 board feet of finger-jointed framing material. Finger-jointed framing material is available from most lumberyards.



#### Homeowner Benefit:

Finger-jointed framing materials are more dimensionally stable than solid-sawn wood, meaning more uniformity in construction.

## Action Item 4-14

Use third-party certified sustainably harvested wood

### Points: 1-15

#### Responsible party:

Contractor, Framers

#### Intent:

Protect forest ecosystems and ensure sustainable harvest of wood resources.



**what:** Third party certification entails an independent entity confirming that a set of agreed upon standards have been followed in the growth, harvest and distribution of forest products. Definitions of sustainable harvest vary depending on the certification body (see “how” below for details).

**why:** Many of the world’s forests are in serious decline due to overharvesting and other poor forestry practices. Purchasing certified sustainable harvest wood sends a market signal to producers that responsibly managed forests and the products that come from them have value. In addition, some certification programs require worker safety and compensation standards



#### Homeowner Benefit:

Using third party certified sustainable harvest wood products helps protect forest ecosystems and resources. Additionally, sustainable harvest wood can be superior in quality when compared to wood produced using standard forestry practices.

be met as well, helping fulfill social sustainability goals in addition to environmental sustainability. Certified sustainable harvest lumber is available from regional producers, meaning that economic sustainability and regional economic development can be a third benefit of purchasing certified wood.

**how:** There are over 50 voluntary forestry standards programs worldwide at the time of this writing. To achieve points for these Action Items, the BUILT GREEN program requires that the wood products selected for the project can be independently certified to meet one of the two tiers of criteria outlined below.

Tier 1 certification systems must meet the following criteria:

Independently third-party audited chain of custody. Chain of custody refers to a certification that guarantees a wood product has been tracked from a certified forest to the final product to ensure it came from a sustainable forestry source. Tracking also guarantees that products will not be mixed with non-certified products during processing, manufacturing and distribution.

- No conversion of natural forest to plantation
- No mass harvest of old growth trees
- No genetically-modified organisms (GMOs) or pesticides
- Multi-stakeholder governance with transparent decision-making process

- Rules for control of non-certified components in certified products
- Supported by leading environmental and social organizations
- Policy of removal for non-compliance.

Currently, only the Forest Stewardship Council (FSC), a voluntary, market based certification organization, meets Tier 1 requirements. It is one of few programs that require a chain of custody for certification. FSC sets standards for sustainable forestry practices and depends on independent companies for third-party certification of forestlands. It evaluates and monitors certifiers to ensure public credibility.

Tier 2 certification systems must meet the following criteria:

- Independently third-party audited chain of custody
- No conversion of natural forest to plantation
- No mass harvest of old growth trees
- Rules for control of non-certified components in certified products
- Policy of removal for non-compliance.

Currently, no certification systems meet Tier 2 requirements. Acceptance of new certifications for Tier 2 compliance will be evaluated by the BUILT GREEN Director.

## Action Item 4-14

This Action Item is worth 1-15 points. For all materials below, at least 50% by weight or value of the wood of that category used in the project (exclusive of salvaged materials) must meet either Tier 1 or Tier 2 criteria to be eligible for points.

- Dimensional lumber, Tier 1: 7 points
- Dimensional lumber, Tier 2: 1 point
- Sheathing, Tier 1: 5 points
- Sheathing, Tier 2: 1 point
- Beams, Tier 1: 3 points
- Beams, Tier 2: 1 point

**resources:** The Yale University Program on Forest Policy and Governance provides information on wood certification programs and links to certified wood locators: [www.yale.edu/forestcertification/faq.html](http://www.yale.edu/forestcertification/faq.html)

Forest Stewardship Council: [www.fscus.org](http://www.fscus.org)

The Northwest Natural Resource Group is an association of small and midsize regional timberland owners and others that produce sustainable harvest wood to BUILT GREEN Tier 1 standards: [www.nnrg.org](http://www.nnrg.org) The website includes information on certified forestry and resources for finding products.

## Action Item 4-15

Use 100% recycled content HDPE, salvaged lumber, or lumber that is third-party certified sustainably harvested wood that meets the Tier 1 requirements for decking and porches

### Points: 3

#### Responsible party:

Contractor

#### Intent:

Encourage more sustainable use of forest products; enhance the market for recycled content products.



**what:** 100% recycled high density polyethylene (HDPE) lumber is created from milk jugs and other post-consumer plastic items, mixed with pigment and extruded to create dimensional material.

Salvaged lumber is material removed from buildings and reused, either by purchasing from a used building materials retailer or salvaged on site or from another property.

For a definition of sustainable harvest wood meeting BUILT GREEN Tier 1 requirements, see Action Item 4-14.

**why:** Purchasing recycled plastic lumber provides a market for recycled content products, and reduces household toxics by eliminating the need for wood maintenance or preservative products.

Using salvaged lumber or specifying sustainable harvest lumber lessens strains on forest resources. Sustainable harvest lumber comes from forests maintained with ecological integrity in mind, helping provide “ecosystem services” (watershed protection, carbon sequestration, and habitat maintenance, among others).

**how:** Specify the desired environmentally preferable lumber product based on client priorities and application. Recycled HDPE lumber is used for non-structural purposes, primarily decking materials. Salvaged lumber can be used for nearly identical applications as new lumber, although in structural applications, building inspector approval will be necessary (see Action Item 4-8). Sustainable harvest lumber comes in all styles and applications, from structural material to decking.

All types of environmentally preferable lumber are available through lumberyards and may be available for special order through home improvement retailers. Research the time it takes for special order products to arrive, and build this into the construction schedule.

**considerations:** See Action Item 4-14 for more applications of sustainable harvest wood.



**what:** Standard particleboards are traditionally used for the purpose of underlayment, even though they are known to be the primary source of formaldehyde gas in new homes.

Recycled content underlayment products incorporate waste materials from other processes, usually agricultural operations.

**why:** Reducing demands for virgin renewable materials and non-renewable materials overall helps reduce humanity’s impact on the natural environment. Putting waste products to productive use enhances the efficiency of materials use, reducing environmental and health impacts related to resource extraction, refining and manufacturing.

**how:** Make sure not to trade off recycled content for good indoor air quality. Many composite wood products contain urea formaldehyde, a carcinogen (cancer causing agent) and potent irritant. Quick to volatilize, urea formaldehyde can offgas into the indoor environment and present health risks to occupants.

OSB does not apply unless certified with recycled content. No added urea formaldehyde wood fiberboard with recycled-content is a superior choice for underlayment. Other environmentally preferable materials for flooring underlayment include natural cork and options made with recycled rubber, paper, jute hemp and/or agricultural fiber. Look for materials certified through credible third-party verification programs for recycled content, such as Scientific Certification Systems.

See Action Item 4-4 for information on subfloor with no added urea formaldehyde.

**resources:** The California Integrated Waste Management Board maintains a Recycled Product Directory: [www.ciwmb.ca.gov/rcp/](http://www.ciwmb.ca.gov/rcp/) (click on *Construction*, then *Panels*)

Green Seal Choose Green Report: Particleboard and Medium Density Fiberboard describes issues with composite wood products and how to avoid them: [www.greenseal.org](http://www.greenseal.org) (click on *Publications and Resources*, then *Choose Green Reports*)

## Action Item 4-16

Use recycled-content subfloor

### Points: 1

#### Responsible party:

Contractor

#### Intent:

Increase demand and develop market for recycled content materials.



#### Homeowner Benefit:

Recycled plastic “lumber” is low maintenance and very durable, making it a very cost-effective product from the life cycle perspective. Salvaged lumber can be of superior quality to new, while costing less. Sustainable harvest wood provides the benefit of knowing the purchaser is helping protect forest health.



#### Homeowner Benefit:

Using underlayment products below wood, tile, resilient flooring, or carpet and carpet cushion provides a level surface, covers cracks, and helps insulate floors from sound transmission and some heat loss.

## Action Item 4-17

Use factory framed wall panels (panelized wall construction) for all new walls

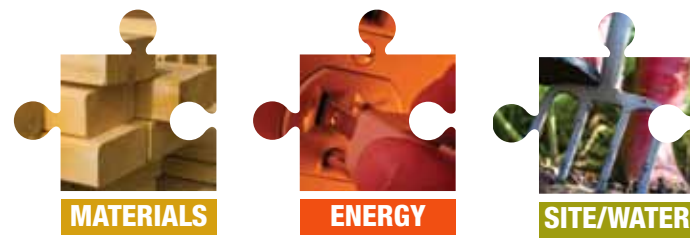
### Points: 3

#### Responsible party:

Architect

#### Intent:

Reduce waste at the jobsite through specifying panelized wall products.



**what:** Pre-fabricated wall panels are built in a factory based on individual building plans.

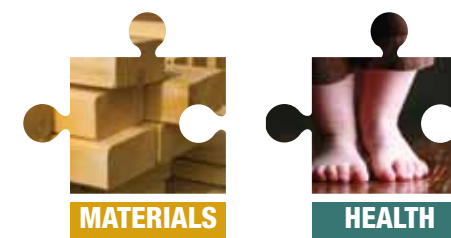
**why:** Since the panels are manufactured in a quality-controlled environment, they are stronger, more dimensionally accurate, and more durable structures.

**how:** Work with a panel manufacturer to create a panel package for the home. Since panels are delivered to the site ready to install and will likely be difficult or impossible to modify, make sure all dimensions sent to the manufacturer are final and exact.

Prefabricated panels are built, labeled for assembly and shipped to the job site. Builders follow assembly procedures defined by factory specifications.

**considerations:** A sustainable harvest wood option may be available from the manufacturer (see Action Item 4-14).

**resources:** ToolBase provides information on panelized wall and roof systems for builders: [www.toolbase.org](http://www.toolbase.org) (click on Technology Inventory, then Panelized Wall and Roof Systems).



**what:** A drainage plane is a water repellent material (e.g., building paper, house wrap, or rigid foam panels), applied shingle-style or otherwise sealed to create a continuous surface behind a home's siding. Drainage planes are integrated with flashing and other building details to protect the structure from moisture. A properly installed drainage plane allows any water that penetrates a home's cladding to quickly exit the assembly. Assemblies with a capillary break (1/4" or larger gap) between the siding and the drainage plane are superior at drying.

**why:** Rain penetration management is the single most important factor in assuring building durability. Especially in the rainy Pacific Northwest, moisture damage from bulk water and wind-driven rain can result in expensive call-backs and repairs to a home's major structural elements. Rainfall in King and Snohomish Counties average 40-65" a year in most areas, and can average over 100" a year in the foothills of the Cascades.

**how:** Building scientists recommend that walls include rain screens, vented cladding, or vented drainage spaces in locations with 40 to 60 inches of rain per year. A pressure equalized rain screen is recommended if average rainfall exceeds 60 inches per year. In all climates, properly flashed window details are recommended.

This Action Item is worth 1-6 points.

- Each 200 square feet of siding installed with a drainage plane and capillary break: 1 point.
- Maximum 6 points.

Drainage plane construction details are available from the Building Science Corporation (see Resources).

**considerations:** A drainage plane is part of several strategies that help a building manage moisture, including flashing details (Action Item 4-20), and roof overhangs (Action Item 1-35).

**resources:** Building Science Corporation Building Science Digest 105: "Understanding Drainage Planes:" [www.buildingscience.com](http://www.buildingscience.com) (search for *BSD-105*).

ToolBase has a description of the rain screen siding approach: [www.toolbase.org](http://www.toolbase.org) (click on *Technology Inventory*, then *Rain Screen Exterior Walls*).

"Rain Screen Walls: A Better Way to Install Siding" by M.A. Snyder. *Fine Homebuilding* Feb/Mar 2001.



The rain screen approach allows for a wide variety of siding applications, from modern to traditional.

Image: Jon Alexander.

## Action Item 4-18

For any newly sided wall install a capillary break between siding/trim and building paper or house wrap (1 point per every 200 sf)

### Points: 1-6

#### Responsible party:

Contractor, Architect

#### Intent:

Protect occupant health and building durability by reducing moisture penetration into the exterior wall assembly.



#### Homeowner Benefit:

Similar to Structural Insulated Panels (Action Item 1-18), pre-fabricated wall panels offer the benefits of off-site manufacturing: quicker assembly, reduced waste, and less site and homeowner disruption. They can also reduce construction time.



#### Homeowner Benefit:

Capillary breaks between siding and the home's drainage plane enhance the durability of exterior walls, reducing moisture intrusion and facilitating quick drying of the wall assembly, helping protect indoor air quality.

## Action Item 4-19

Install a sloped sill pan with end dams and back dams for windows, and back dams for all exterior doors exposed to the weather

### Points: 2-8

#### Responsible party:

Contractor, Architect

#### Intent:

Enhance building durability and protect indoor air quality by reducing moisture penetration at windows and doors.



**what:** Sill pans and all flashings should be sloped for quick drainage to the outside.

**why:** Back dams prevent wind- and pressure-driven rain from migrating into the home. Improperly detailed sill pan slopes and the lack of back dams allow rain to penetrate windows and doors, creating moisture issues and promoting rot.

Careful detailing of window and door penetrations can reduce the likelihood of callbacks related to water damage or premature failure.

**how:** This Action Item is worth 2-8 points.

2 points for each 25% of total windows and doors meeting the following standards:

- Window perimeters shall have flashings (sill, jambs and head) that are integrated with the waterproofing at adjacent walls. Self-adhered membrane flashing and metal flashing are both acceptable strategies for preventing water ingress.
- Slope head and sill flashings to the exterior for prompt drainage. Many windows leak at sill-to-jamb corners. To collect this leakage and drain it to the exterior, sill flashings with a panned up interior leg and end dams are required.
- Do not penetrate the horizontal portion of the sill flashing with window fasteners. Instead, where attachment of the sill frame is required, provide an attachment angle inboard on the windowsill and fasten through the upturned leg of the sill flashing into the back of the sill frame.

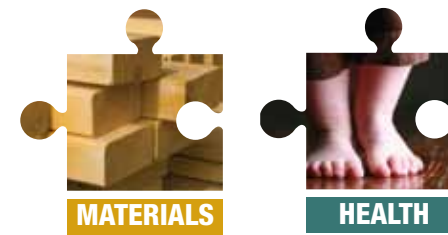
New products are also available that offer greater performance than traditional entry door and window flashing. Sloped sill pans feature durable synthetic construction, sloped surfaces, integral drainage, lock-in end caps and can be cut to desired lengths. Other products include a one-piece sill drain mat that installs under the windows on the rough opening.

To create a back dam, fold flashing into rough opening, adhere flashing to the sill, and use overhang of flashing that extends beyond the depth of the sill to form the back dam. The window sits inside sill pan; the back dam of the sill pan should just clear the back edge of windowsill when placed in the rough opening. The back dam of the sill flashing assembly should be even with the interior surface of the window. Flashing bends up and over the back dam to form a permanent air and watertight connection. Then tape the interior side of the window/wall interface with air seal tape.

**considerations:** See Action Item 4-20 for complementary information on proper flashing at window and door heads.

Verify the performance of sills and back dam installation on the project using a hose test (Action Item 4-21).

**resources:** Building Science Corporation Building Science Primer 020: Water Management Details for Residential Buildings: [www.buildingscience.com](http://www.buildingscience.com) (search for BSP-020). Figure 24 shows a section drawing of a sill with a sloped sill pan and back dam.



**what:** Window and door flashing guides rainwater away from the wall assembly and drains it to the exterior.

**why:** See Action Item 4-21

**how:** Window heads: Flashing must be durable, weather resistant, able to accommodate movement, and compatible with adjacent materials. The traditional overlapping assembly composed of multiple layers of flashing adjusts to movement like the scales of a fish and provides repetitive layers of resistant materials while covering the fasteners with each lap. Overlapping the material below prevents water from migrating in opposition to the forces of gravity when an unequal pressure condition exists, as in high windstorms. Longer laps provide greater protection.

Non-corrosive metals such as aluminum and stainless steel are durable, malleable, and benign to humans and water quality. New continuous drainage barriers employ self-adhering membrane and tape materials to work in conjunction with doors and windows with integral nailing fins.

Door heads: The head detail must intercept water draining down the wall above the window and divert it away from the vulnerable joint between the window and wall. In order to achieve this, a diverter flashing is required. The flashing must be carefully integrated with the wall assembly above to ensure that all elements are positively lapped. The flashing laps over the door frame and is in turn lapped by the sheathing paper in the wall assembly.

See Action Item 4-21 for complementary information on proper detailing at windowsills and doors.

**considerations:** Verify the performance of installed flashing on the project using a hose test (Action Item 4-21).

**resources:** Building Science Corporation Building Science Primer 020: "Water Management Details for Residential Buildings:" [www.buildingscience.com](http://www.buildingscience.com) (search for *BSP-020*)

## Action Item 4-20

Install metal flashing at all windows and at heads of all doors

### Points: 3

#### Responsible party:

Contractor, Architect

#### Intent:

Enhance building durability and protect indoor air quality by reducing moisture penetration at windows and doors.



#### Homeowner Benefit:

Moisture management at windows and doors helps enhance building durability and protect indoor air quality by reducing moisture penetration into wall assemblies and into the home.



#### Homeowner Benefit:

Moisture management at windows and doors helps enhance building durability and protect indoor air quality by reducing moisture penetration into wall assemblies and into the home.

## Action Item 4-21

Hose test first installed windows to verify resistance to wind driven rain

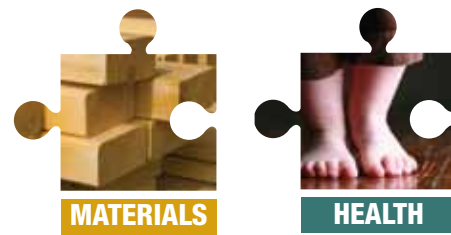
### Points: 3

#### Responsible party:

Contractor

#### Intent:

Enhance building durability and protect indoor air quality by reducing moisture penetration at windows and doors.



**what:** A hose test uses a standard garden hose to determine an installed window's resistance to water penetration.

**why:** Windows are factory-tested for water intrusion, but job-site installation can lead to potential water and air leakage into the building assembly. For instance, joints between windows and walls may not have been properly sealed, nor may there have been proper sealing to the adjoining cladding.

Hose testing provides a low-cost, quick determination of the success of the planned approach for installing windows on a project. Any failures on the first window can be quickly identified, and the installation approach corrected in advance, rather than after the fact or down the road when the homeowner calls with water intrusion issues.

**how:** This test is designed to verify the performance of the window installation in terms of resistance to water penetration. As a test case, use the first installed window, fully installed with all appropriate flashing and sealing into the wall system. To test the window, spray it thoroughly with a garden hose and check for water penetration. If subcontracting the project's window installation, provide the window contractor with best practice flashing information, and use the sill pan construction details provided in Action Item 4-19.

Correct any improperly sealed areas and retest.

**considerations:** Key to resisting wind-driven rain is proper flashing and sill detailing. See Action Items 4-19 and 4-20. A rain screen drainage plane assembly can provide added protection against wind-driven rain to a building (see Action Item 4-18).

**resources:** Idiot's Guide to: Water Testing Windows by Daniel Urroz (Builders Book, Inc., 1996).



**what:** A pre-insulation moisture inspection evaluates a home's moisture management strategies to identify missing elements or improperly installed components.

**why:** A pre-insulation inspection is designed to ensure that all air leakage elements of the building shell have been addressed. By identifying and correcting any deficiencies prior to insulation, correction costs are reduced and the likelihood of call-backs related to moisture problems is diminished.

Securing an independent evaluator for the inspection helps provide an objective perspective, which can be of value to a homeowner and useful in settling disputes over responsibility for correcting deficiencies.

**how:** This inspection is performed by an independent auditor, separate from the project team. The inspection should address:

- The use and proper installation of airtight recessed cans.
- Comprehensive building envelope penetration sealing.
- Confirming chases are capped and sealed.
- Examining windows and doors for airtightness.
- Confirming proper roof venting.
- Heating and cooling systems, including ducts supported and run properly.
- Ensuring ducts are not run through insulated cavities.
- Confirming moisture management and indoor air quality strategies, such as having all fireplaces with flues and inlets.

A qualified professional is a specialist in air sealing inspections, such as a home performance contractor (see Resources). Built Green Verifiers are able to perform an envelope inspection.

**considerations:** An envelope inspection can be accomplished simultaneously with blower door tests at the appropriate point in construction (see Action Item 10-11) to confirm proper installation and detailing of both air sealing and moisture management strategies and correct any mistakes.

**resources:** Home Performance Washington is the primary association of home performance contractors in Washington State: [www.homeperformancewashington.org](http://www.homeperformancewashington.org)

A list of BUILT GREEN Verifiers is available on the BUILT GREEN website: [www.builtgreen.net](http://www.builtgreen.net)



Professional envelope inspections can identify air leaks and potential future moisture problems easily overlooked in a visual inspection.

Image: Jon Alexander, Sunshine Construction.

## Action Item 4-22

Envelope inspection by a qualified professional prior to installing insulation

### Points: 3

#### Responsible party:

Expert

#### Intent:

Enhance building durability and indoor environmental quality by identifying and correcting any deficiencies in design or construction early in the process.



#### Homeowner Benefit:

Hose testing helps verify that window installation will result in a weather-resistant approach, enhancing building durability and protecting indoor air quality.



#### Homeowner Benefit:

An independent inspection of the project for moisture-related issues helps confirm that the home's expected features are in place, and provides a low-cost route for correcting any problems that are encountered.

## WINDOWS

Windows can be put to work for a variety of functions beyond capturing views, including helping warm a space using passive solar design, and helping provide fresh air with natural ventilation. Additionally, selecting energy efficient windows and frames helps lower heating (and cooling) bills. Finally, selecting environmentally friendly materials further reduces a window's impact on the planet.



## Action Item 5-1

Use NFRC certified windows with a U-factor of 0.32 or better for new or replaced windows

### Points: 3

#### Responsible party:

Contractor, Architect

#### Intent:

Reduce energy use associated with window selection.



**what:** The National Fenestration Rating Council (NFRC) is a US nonprofit that establishes testing protocols for window efficiency.

U-factor is the inverse of R-value (e.g., a window with a U-factor of 0.20 is equivalent to an R-value of 5). U-factors measure the energy efficiency of an entire window assembly, rather than just the glazing. This is important, given the fact that different window frames have vastly different thermal qualities.

For example, aluminum windows without a thermal break to stop conductance of heat between the outside and inside of the frame increase the overall U-factor of a window (i.e., reduce its thermal performance) so much that even with the highest performing glazing, the window assembly will not meet code. According to the Efficient Windows Collaborative (see Resources), wood, composite and vinyl window frames have similar thermal conductance, meaning that similar windows in any of these materials will provide similar U-values. Insulation-filled vinyl and fiberglass frames have the lowest thermal conductivity, resulting in these windows having the greatest opportunity to be energy efficient. Insulation-filled fiberglass frame windows, for example, can have U-factors of .18 or lower—more than twice as efficient as current code requirements.

**why:** Windows are a weak link in a home's thermal envelope: even the best windows (U-value of 0.20 or better) are about 1/4 as energy efficient as an equivalent amount of well-insulated solid wall. Windows can be responsible

for 25-50% percent of a home's energy loss, according to the National Association of Home Builders. Additionally, if poorly positioned and not shaded, windows can also be responsible for considerable unwanted heat gain and discomfort during the summertime.

According to ENERGY STAR, replacing existing single-pane windows with high performance windows can save a typical home between \$126-465 annually in heating bills; for homes with standard clear double-pane windows that savings can range from \$27-111.

**how:** Both the Efficient Windows Collaborative and ENERGY STAR provide locators to identify efficient window manufacturers and products.

**considerations:** Consider passive solar design principles when selecting windows. See Action Item 1-23 to learn more about passive solar design; additionally, see Resources for help on identifying windows based on the window's orientation and additional energy-saving and comfort-enhancing strategies, including shading strategies.

**resources:** Visit the Efficient Windows Collaborative website to learn more about high performance windows; the site includes information on different glazing and frame technologies and a product locator: [www.efficientwindows.org](http://www.efficientwindows.org)

The ENERGY STAR program: [www.energystar.gov](http://www.energystar.gov) (click on Explore Products and scroll down to the Home Envelope section).



**what:** Vinyl windows use polyvinyl chloride (PVC) and a variety of plasticizers and stabilizers to create window frames.

**why:** Vinyl windows are commonly used materials and are often preferred for economy and presumed durability. It is not environmentally preferred, however, due to the toxic manufacturing process required and limited potential for recycling the material after it has been used as a window material. PVC windows also use more energy to produce than other window assemblies.

**how:** Specify low environmental impact window frames constructed of wood or fiberglass. Regional and national manufacturers now make window frames from these materials. Specify efficient windows (see Action Item 5-1).

Windows made of fiberglass produce the highest energy efficiency and the lowest environmental impact. Fiberglass requires less energy to produce into a final product than PVC or aluminum. Wood windows sport the lowest "embodied energy" (take the least energy to produce) but are not as energy efficient as insulated fiberglass. Fiberglass reduces condensation, won't contract or expand like wood or PVC, and is least likely to crack, corrode, rot or leak.

See Action Item 5-3 for alternatives to vinyl windows.

**resources:** The Efficient Windows Collaborative provides information on window frame materials and technologies, including a product locator: [www.efficientwindows.org](http://www.efficientwindows.org) (click on *Window Technologies*)

The Washington Toxics Coalition maintains a fact sheet on PVC: [www.watoxics.org](http://www.watoxics.org) (click on *Healthy Homes and Gardens*, then *Home Repair and Building Materials*)

## Action Item 5-2

If replacing windows no vinyl windows

### Points: 4

#### Responsible party:

Contractor, Architect

#### Intent:

Protect human health and the environment by reducing polyvinyl chloride building materials manufacture.



#### Homeowner Benefit:

If replacement windows are already on the agenda for a remodel, upgrading to high performance windows is a minimal investment that yields financial and comfort benefits. High performance windows help reduce the discomfort associated with a cold window surface, which draws heat from the inside of the home and can create drafts. Additionally, high performance windows often have better sound-dampening capacity, a welcome feature in neighborhoods with street or other extraneous noise. Finally, high performance windows yield energy savings resulting in lower utility bills.



#### Homeowner Benefit:

Avoiding vinyl windows reduces a home's upstream and downstream environmental burden related to the manufacture and disposal of polyvinyl chloride.

## Action Item 5-3

Use wood/composite or fiberglass windows

### Points: 3

#### Responsible party:

Contractor, Architect

#### Intent:

Increase the energy efficiency and durability of windows, enhancing the overall energy performance of the home.



MATERIALS



ENERGY



HEALTH

**what:** Window frame materials from a composite of recycled polyvinyl chloride (PVC) or high-density polyethylene (HDPE) plastics and waste wood fiber are available. Wood/plastic composites consist primarily of waste sawdust and scrap PVC generated in the production of wood and vinyl windows, or from post consumer bottle waste. Wood content ranges from 40 to 70%, depending on the manufacturer. According to recent tests, the frames have roughly the same energy performance as solid wood, but perform slightly better than vinyl window frames.

**why:** Dimensional stability is a common problem with PVC plastic frame materials. Composite wood windows do not absorb moisture and will not swell like wood. Combining the two materials offers the dimensional stability and thermal performance of wood, and the uniformity and decay resistance of plastics. The cost of wood/plastic composite windows is often less than that of wood or vinyl.

Fiberglass requires less energy to produce into a final product than PVC or aluminum. The coefficient of expansion of fiberglass more closely matches glass than vinyl and helps keep the seal between the frame and glass intact for long-term performance. It reduces condensation, won't contract or expand like wood, and is least likely to crack, corrode, rot, or leak.

**how:** A variety of composite and fiberglass window frames are offered by major and regional window manufacturers. Specify efficient windows (see Action Item 5-1).

**resources:** The Efficient Windows Collaborative provides information on window frame materials and their impact on overall window energy performance: [www.efficientwindows.org](http://www.efficientwindows.org) (click on Window Technologies). The site also includes a product locator.

The ENERGY STAR program establishes performance criteria for windows: [www.energystar.gov](http://www.energystar.gov) (click on Products).

Search the Database of State Incentives for Renewables and Efficiency for possible energy efficiency incentives: [www.dsireusa.org](http://www.dsireusa.org)



MATERIALS

**what:** Third party certification entails an independent entity confirming that a set of agreed upon standards have been followed in the growth, harvest and distribution of forest products. Definitions of sustainable harvest vary depending on the certification body (see "how" below for details).

**why:** Many of the world's forests are in serious decline due to overharvesting and other poor forestry practices. Purchasing certified sustainable harvest wood sends a market signal to producers that responsibly managed forests and the products that come from them have value. In addition, some certification programs require worker safety and compensation standards be met as well, helping fulfill social sustainability goals in addition to environmental sustainability. Certified sustainable harvest lumber is available from regional producers, meaning that economic sustainability and regional economic development can be a third benefit of purchasing certified wood.

**how:** This Action Item is worth 1 or 4 points. To receive credit for this Action Item, use windows that meet Certified Wood Products Tier 1 or 2 Requirements listed under Action Item 4-14.

- Meet Tier 1 requirements: 4 points
- Meet Tier 2 requirements: 1 point

Custom window manufacturers may be able to use certified wood. Alternately, use a certified wood product locator (see Action Item 4-14, Resources) to identify manufacturers and suppliers.

**considerations:** Look also for ENERGY STAR qualified windows to ensure energy efficiency; look for the lowest U-value rating, certified through the National Fenestration Rating Council. See Action Item 5-1 for more information.

**resources:** See Action Item 4-14 for resources related to sustainable harvest wood.

## Action Item 5-4

Use wood windows that are third-party certified sustainably harvested wood that meet Tier 1 or Tier 2 requirements

### Points: 1-4

#### Responsible party:

Contractor, Architect

#### Intent:

Protect forest ecosystems and ensure sustainable harvest of wood resources.



#### Homeowner Benefit:

Composite and fiberglass windows provide durability and energy efficiency in a window. Fiberglass windows are also less likely to produce stress on the window glazing, meaning fewer broken seals and continued energy performance and durability.



#### Homeowner Benefit:

Using third party certified sustainable harvest wood products helps protect forest ecosystems and resources. Additionally, sustainable harvest wood can be superior in quality when compared to wood produced using standard forestry practices.

## ROOFING

Roofing design and materials choices affect a home's longevity, maintenance, and energy bills. Additionally, roofing materials can be selected for environmental attributes, including recycled content and long life.

## Action Item 6-1

New roofs are flashed properly

### Points: 1

#### Responsible party:

Contractor

#### Intent:

Increase the durability of the home by avoiding moisture intrusion.



**what:** Proper flashing techniques respect the nature of physics, employing approaches that allow water to drain down and out, away from the structure as quickly as possible.

**why:** Proper flashing techniques mean fewer callbacks and complaints down the road related to water intrusion.

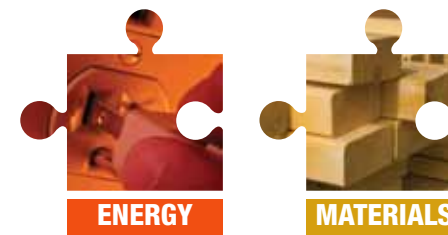
**how:** The following flashing techniques must be followed to achieve this credit:

- All flashing sloped to drain away from the wall assembly, toward the exterior.
- Flashing is shingle lapped (upper elements are lapped exterior to the flashing below)
- Where walls meet lower roofs, step flashing is shingle lapped, and siding material is kept at least 1" above the adjoining roof plane and the lowest flashing is a diverter to push water away from the wall below and into the gutter.

The Building Science Corporation (see Resources) provides detailed information on proper flashing and drainage detailing. Select roofing contractors based on their familiarity and experience with best practices related to flashing and moisture protection.

**considerations:** The fewer the penetrations on a roof and the simpler the design, the less likely it is to leak. See Action Item 1-19, to learn more about minimizing or eliminating skylights, for example.

**resources:** Building Science Corporation Building Science Primer 020: "Water Management Details for Residential Buildings." [www.buildingscience.com](http://www.buildingscience.com) (search for BSP-020). Section 3 describes best practice flashing details.



**what:** See Action Item 1-18 for information on SIP construction.

**why:** See Action Item 1-18 for information on the benefits of SIPs and other airtight building methods.

**how:** SIPs are manufactured to architectural and engineering specifications, custom to a project. Select a supplier

**considerations:** Aspects to consider when designing a new roof include proper pitch (Action Item 1-14) and overhang size for water management (Action Item 1-35) and passive solar design (Action Item 1-23). Some SIPs manufacturers can provide products constructed of sustainably harvested plywood.

**resources:** Structural Insulated Panel Association: [www.sips.org](http://www.sips.org)

*Builder's Guide to Structural Insulated Panels* by Joseph Lstiburek

## Action Item 6-2

Use Structurally Insulated Panels for all new roofing

### Points: 3

#### Responsible party:

Architect, Expert

#### Intent:

Reduce energy use by enhancing the home's thermal envelope.



#### Homeowner Benefit:

Proper flashing techniques help avoid bulk water intrusion that can damage the home's structure and finishes, compromise insulation, and result in mold growth and poor indoor air quality. A properly flashed roof will help the home last longer and avoid costly tear-out and replacement related to leaks.



Structural insulated panel roofs eliminate installation problems that can result in roofs and walls performing at lower than specified thermal values.

Image: Jon Alexander, Sunshine Construction.



#### Homeowner Benefit:

Structural Insulated Panel roofs are highly energy efficient and airtight, reducing household energy bills. Additionally, due to their modular nature, SIPs can be installed more quickly than a framed roof, reducing construction time and disruption.

## Action Item 6-3

Use light colored roofing

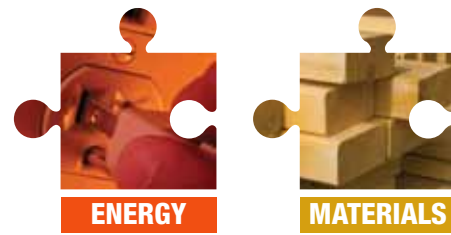
### Points: 2

#### Responsible party:

Contractor, Architect

#### Intent:

Reduce unwanted heat gain and associated cooling loads by reducing roof surface temperature.



**what:** Light colored roofing materials reflect sunlight back into the sky rather than absorbing this incident solar energy. These types of roofing materials are often described to as “high emissivity,” “high albedo,” or, more simply, as “cool roofs.”

**why:** The Puget Sound area’s mild climate means that with a few simple design approaches (including installing light colored roofing materials), a home can easily avoid the need for installing air conditioning equipment. Nationally, air conditioning accounts for one-sixth of all energy used in the United States, or \$40 billion annually.

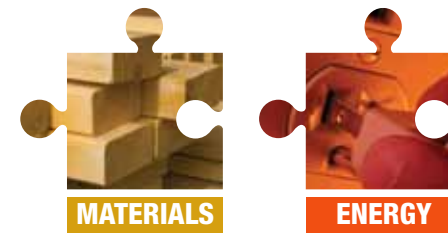
**how:** ENERGY STAR qualified roofing materials can reduce a roof’s surface temperature by 100 degrees compared to standard roofing materials. Lawrence Berkeley Laboratories’ Heat Island Group estimates that selecting light colored roofing materials could save \$750 million a year in cooling costs nationally.

Choose the lightest color roofing material available that works with the aesthetic and functional needs of the project. Look for ENERGY STAR labeled roofing materials, although the ENERGY STAR program focuses primarily on commercial roofing products.

**considerations:** Additional cool roof strategies include green roofs (see Action Item 1-12) and shading with deciduous trees on the south and west sides of the house (Action Item 14-19).

**resources:** The ENERGY STAR program qualifies roofing materials that meet standards for solar reflectance to earn points for this Action Item: [www.energystar.gov](http://www.energystar.gov) (click on Explore Products and scroll down to the Home Envelope section). The website also provides technical information about emissivity and other criteria for evaluating a roofing material’s energy performance.

Lawrence Berkeley Laboratories’ Heat Island Group provides technical information on the energy impact of roofing materials and the potential monetary and energy savings related to cool roofs: [www.eetd.lbl.gov/HeatIsland/CoolRoofs/](http://www.eetd.lbl.gov/HeatIsland/CoolRoofs/)



**what:** Recycled-content roofing materials take many forms, including cement composite tile, asphalt shingles, plastic shakes, and metal shingles. Asphalt shingles contain recycled “mixed” waste paper or reclaimed mineral slag resulting in 20-25% recycled content. Roof panels made from recycled plastic resins provide a lightweight roofing alternative; recycled aluminum shingles that may contain up to 100% recycled content.

**why:** The building industry in the United States is responsible for 40 percent of all materials extraction, and a similar percentage of waste creation. Increasing the recycled content of building materials helps reduce the waste related to the building industry.

**how:** Given the diversity of recycled content materials available, it should be easy to find a product that meets the functional and aesthetic needs of the home. Look for long-warranty materials (see Action Item 2-11) and experienced installers.

**considerations:** The benefits of recycled content should be measured holistically, considering a product’s other environmental, health and performance attributes. In particular, make sure roofing choices meet water quality (especially if the roof surface is used for rainwater harvest), durability, and energy conservation goals (especially related to unwanted heat gain resulting from dark roofing surfaces—see Action Item 6-3).

**resources:** The California Integrated Waste Management Board maintains a Recycled Product Directory: [www.ciwmb.ca.gov/rcp/](http://www.ciwmb.ca.gov/rcp/) (click on *Construction*).

## Action Item 6-4

Use recycled-content roofing material for new/replaced roofing

### Points: 2

#### Responsible party:

Contractor, Roofing

#### Intent:

Reduce resource depletion by encouraging recycled-content building products.



#### Homeowner Benefit:

Light colored roofing helps reduce summertime roofing materials temperatures, which can routinely exceed 150 degrees Fahrenheit. This excess heat often overheats the attic and living spaces. Light colored roofing combats this phenomenon, increasing comfort and potentially decreasing energy bills associated with air conditioning.



#### Homeowner Benefit:

Using recycled content building products can help reduce a home’s environmental footprint by encouraging wise resource use.

## Action Item 6-5

Install a metal, tile, concrete or slate roof

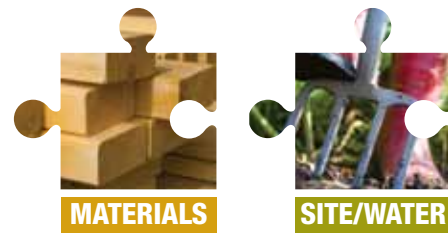
### Points: 4

#### Responsible party:

Architect

#### Intent:

Reduce waste and conserve resources by extending the lifespan of roofing installation.



**what:** Metal, tile, concrete and slate roofs all are extremely durable roofing materials, with expected service lives ranging from 40 to 100 years.

**why:** Metal roofs are made of recycled material and are recyclable at the end of their service life. They come with warranties ranging from 30 to 50 years compared to 15 to 20 years for asphalt shingles. Metal roofs will not decompose under sun exposure, are noncombustible, can fit over existing roofing materials, are less than 1/3 the weight of asphalt and can withstand winds up to 140 mph. Metal is naturally heat and light reflective and can reduce cooling energy costs by as much as 25%.

**how:** Discuss roofing materials choices with the client, determining the best material based on environmental priorities, cost, and aesthetics. The Seattle/King County Green Home Remodel Roofing guide is helpful in discussing roofing choices with homeowners (see Resources). Relay these priorities and decisions to the roofing contractor. Select a contractor with demonstrated experience installing the chosen roofing type.

**considerations:** Given the long service life of these roofing materials, be sure to consider aesthetic durability (timelessness) when selecting styles and colors.

See Action Item 2-11 for more on the benefits of long service life building materials.

Metal roofs are a better choice for rainwater collection for irrigation; see Action Item 14-4 for more on installing a cistern for rainwater harvest.

**resources:** The Green Home Remodel Roofing guide provides information for homeowners on roofing material selection and environmental attributes: [www.greentools.us](http://www.greentools.us) (click on Residential Buildings, then Residential Remodel Guides).



#### Homeowner Benefit:

Metal, tile, concrete and slate are "lifetime roof" choices, likely becoming the last roofing choice. In the long run, the investment in a durable roof results in lower total cost of ownership, saving money. In addition, many of these roofing choices are extremely low maintenance, further reducing their total cost.

## HVAC

Heating, ventilation and air conditioning choices can have dramatic impacts on both a home's energy efficiency and its indoor environment. System design and equipment selection and sizing play important roles.

## Action Item 7-1

Locate heating/cooling equipment, ducts and the distribution system inside the conditioned space

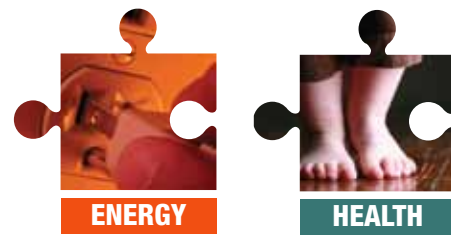
### Points: 5

#### Responsible party:

HVAC, Architect

#### Intent:

Reduce energy losses associated with conditioned air distribution.



**what:** A building's thermal envelope is the contiguous insulating layer that surrounds the home's conditioned space. Often, heating/cooling equipment and ductwork is located outside of this thermal envelope, in garages, attics, basements and crawl spaces.

**why:** Up to 30% of the heat in a conventional distribution system can be lost to leaks and poor insulation of ductwork outside the thermal envelope. Additionally, leaky ductwork outside conditioned space can entrain dust and mold from crawl spaces and attics, compromising indoor air quality.

**how:** While on a new construction project locating heating/cooling equipment and ductwork can be a low-cost or no-cost measure, it is more challenging with an existing home with a forced air system that has ductwork in an unheated attic.

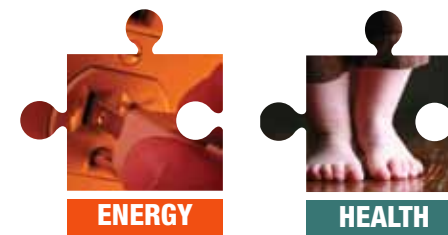
One way to achieve points for this Action Item is to redefine the home's thermal envelope by insulating an attic at the ceiling joists rather than at the attic floor—essentially making the attic part of the home's conditioned space. See Action Item 10-3 for more on insulating attics.

Decommissioning a ducted heating system and replacing it with a ductless system (e.g., a hydronic or ductless mini-split system) can also be used to earn credit for this Action Item; however, the hydronic system must also be within the heated space. Many hydronic retrofit systems place tubing between floor joists, losing substantial heat to an unheated basement or crawl space. Insulating below existing floor joists is one way to get around this issue.

**considerations:** Evaluate this credit in conjunction with other Action Items associated with forced air systems, such as Action Item 2-6 (optimize air quality in bedrooms), Action Item 7-7 (system balancing), and Action Items 7-25 and 7-26 (advanced filtration).

**resources:** Building Science Corporation's Information Sheet 602: "Ducts in Conditioned Space" describes different configurations for ductwork within a home's thermal barrier: [www.buildingscience.com](http://www.buildingscience.com)

The California Energy Commission's Home Builder's Guide to Ducts in Conditioned Spaces provides design and construction guidance. The New Buildings Institute hosts the publication on their Guidelines webpage: [www.newbuildings.org/guidelines.htm](http://www.newbuildings.org/guidelines.htm)



**what:** The Air Conditioning Contractor's Association (ACCA) has developed manuals and software for the design and sizing of heating and cooling equipment. ACCA Manual J is a load calculation methodology for sizing systems; Manual D is for residential duct systems.

**why:** Regardless of the choice of heating or cooling systems for a home, properly sizing the system is a key element of efficient operation. A home's heating/cooling system is often grossly oversized due to the use of worst-case scenario heating or cooling assumptions and a lack of consideration that many green homes feature an enhanced thermal envelope in the form of added insulation and high performance windows, lowering demands on the HVAC system. The result is an inefficient system that is consistently being run below capacity. This wastes fan and fuel energy, and can shorten the life of a system.

**how:** Work with the HVAC contractor to set goals for sizing the heating/cooling system based on the demands of the home. Refer to the ACCA's Manual J or D to identify the proper size of heating and/or cooling system and ductwork for the project.

Other approved software can help account for unique features of green remodel projects, including passive solar design strategies and the use of heat recovery ventilators. REM/Rate™ is specifically developed for projects employing HERS (Home Energy Rating System) raters. Energy Gauge USA, developed by the University of Central Florida, uses the Department of Energy's DOE 2.1 hourly building energy simulation software to provide modeling data.

**considerations:** Other heating and cooling system features, such as variable speed fan drives, can save additional energy (Action Item 7-10).

**resources:** The NAHB's Tool Base program publication, "Right-Size Heating and Cooling Equipment" discusses the importance and benefits of selecting the optimal size system. Available on the Tool Base website: [www.toolbase.org](http://www.toolbase.org) (click on *Design & Construction Guides*, then *Heating, Ventilation & Air Conditioning*).

ACCA Manuals J and D are available from the Air Conditioning Contractors of America: [www.acca.org](http://www.acca.org) (click on *Online Store*, then *Technical Books and Manuals*).

REM/Rate is a product of the Architectural Energy Corporation: [www.archenergy.com/products/rem/](http://www.archenergy.com/products/rem/)

Energy Gauge:  
[www.energygauge.com](http://www.energygauge.com)  
(click on *USA Residential*)

## Action Item 7-2

Size heating/cooling system to 130% using manual J or D, or other approved software (REM/Rate™, Energy Gauge)

### Points: 5

#### Responsible party:

HVAC

#### Intent:

Facilitate the optimal operation of a home's heating/cooling system, maximizing energy efficiency and operational costs.



#### Homeowner Benefit:

Locating heating/cooling equipment and the distribution system within a home's thermal envelope minimizes the energy losses associated with leaky, poorly insulated ductwork and captures otherwise wasted heat generated by the equipment itself. The result is lower energy bills and healthier indoor air.



#### Homeowner Benefit:

Properly sized space conditioning systems are more efficient, saving fuel and reducing utility bills, as well as enhancing indoor comfort and extending the life of mechanical equipment.

## Action Item 7-3

Select high efficiency heat pumps instead of electric resistance heat (HSPF 8+, 10+)

### Points: 3-4

#### Responsible party:

HVAC

#### Intent:

Increase the energy efficiency of the heating/cooling system, reducing energy use and the home's carbon footprint.



**what:** Heat pumps transfer heat from air, water or ground into the dwelling. Heat pumps are an efficient alternative to electric resistance heat, providing several times the heat per unit of electricity. Heat pumps vary in efficiency based on product and type of system. Air-source heat pumps are the most common and are available in a ductless version, called a mini-split system. Ground Source Heat Pumps are described in Action Item 7-4. Also available are hybrid heat pumps, which provide the option of switching between an air-source heat pump and a natural gas combustion furnace as a heat source.

**why:** The more efficient the heat pump, the lower the heating/cooling-related energy costs for the homeowner. These systems offer an energy-efficient alternative to furnaces and air conditioners. In fact, high-efficiency heat pumps also dehumidify better than standard central air conditioners, resulting in less energy usage and more cooling comfort in summer months, according to the Department of Energy. All of these varieties are suitable to the Pacific Northwest climate.

**how:** To select the highest efficiency heat pump ENERGY STAR models. Heating efficiencies are rated according the heating season performance factor (HSPF) and the cooling efficiency is determined by the seasonal energy efficiency ratio (SEER). High efficiency pumps will have a HSPF greater than 8, and a SEER greater than 14. In the Pacific Northwest, focus should be on getting the highest HSPF possible, as the unit will primarily operate in heating mode.

This Action Item is worth 3 or 4 points, depending on the HSPF of the unit chosen:

- HSPF of 8-9.9: 3 points
- HSPF of 10 or greater: 4 points.

Finally, as with any system, performance is affected by leaky ducts. Be sure to maintain 400-500 cubic feet per minute (CFM) airflow for each ton of the heat pump's air conditioning capacity. Efficiency and performance deteriorate if airflow is less than 350 CFM per ton. To ensure optimum functioning, be sure to include appropriate servicing information in the Homeowner Operations & Maintenance Manual.

**considerations:** For maintaining the efficiency of distribution, see Action Item 7-1, which provides points for locating ductwork within the conditioned space, using a ductless system (e.g., ductless mini-split heat pumps).

**resources:** The ENERGY STAR program sets efficiency criteria for qualified heat pumps, and includes information on selecting high efficiency models, product locators, and rebate and tax incentives: [www.energystar.gov](http://www.energystar.gov)

The US Department of Energy's Energy Savers program provides consumer information on heat pumps: [www.energysavers.gov](http://www.energysavers.gov) (click on *Heating and Cooling*, then *Heat Pumps*).

The Northwest Energy Efficiency Alliance's Northwest Ductless Heat Pump Project: [www.nwductless.com](http://www.nwductless.com)



**what:** Geothermal, or ground-source heat pumps (GSHPs) use the relatively constant temperature of the ground instead of variable-temperature outside air to provide heating, cooling, and in many cases, hot water for domestic use. Tubing loops are laid either horizontally (if enough land is available) or vertically (by drilling holes up to 300 feet into the ground), through which fluid is run. Using the relatively constant temperature of the ground as the exchange medium for these systems results in efficiencies unavailable to air source heat pumps at low air temperatures. Conventional ductwork is generally used to distribute conditioned air with these systems.

**why:** Heat pumps are most efficient when extracting heat from warmer temperature sources. Air-source heat pumps become inefficient at temperatures below 30 degrees Fahrenheit (advanced low-temperature systems can extract heat from even colder air). GSHPs take advantage of the earth's constant temperature to avoid this low-temperature inefficiency.

**how:** A GSHP system should be designed and installed by qualified, experienced professionals. Factors including lot size, subsoil characteristics, and landscape features can affect the applicability of this system to a particular site. The up-front cost of a GSHP is large, primarily due to installation costs, unless extensive excavation is already part of the remodel project. In the Pacific Northwest's mild climate, the payback on ground-source heat pumps can be very long, especially compared to the new low-temperature air-source heat pumps (see Action Item 7-3).

Many systems are being equipped with a separate heat exchanger to meet a household's hot water needs, particularly when the system is not operating (typically in spring through fall in the Pacific Northwest).

Some advanced geothermal systems have coupled solar thermal (hot water) systems that "charge" the ground in the area of the thermal loops with heat during the summertime to increase average ground temperature and the efficiency of the system during the wintertime. Such systems need careful design and specific geologic conditions to work well.

**considerations:** GSHP installation can present tradeoffs, including substantial site disturbance exposing soils to erosion during construction and the potential of damaging tree and plant roots during trenching. Drilling vertical wells, while generally more costly than trenching, can substantially reduce site disturbance.

**resources:** The US Department of Energy's Energy Savers program provides consumer information on geothermal heat pumps: [www.energysavers.gov](http://www.energysavers.gov) (click on *Heating and Cooling*, then *Heat Pumps*).

International Ground Source Heat Pump Association: [www.igshpa.okstate.edu/](http://www.igshpa.okstate.edu/)

## Action Item 7-4

Install geothermal heat pumps

### Points: 10

#### Responsible party:

Architect, Expert

#### Intent:

Increase the energy efficiency of the heating/cooling system, reducing energy use and the home's carbon footprint.



#### Homeowner Benefit:

High efficiency heat pumps can be 3-5 times more efficient at generating heat from an electricity than electric resistance heat, generating substantial savings in terms of reduced electric bills associated with heating a home.



#### Homeowner Benefit:

Ground-source heat pumps can provide effective heating and cooling even with low or high outside air temperatures, saving on heating and cooling-related electricity bills.



## Action Item 7-5

Convert home heating system to natural gas

### Points: 5

#### Responsible party:

HVAC

#### Intent:

Reduce energy grid system losses.



**what:** Natural gas furnaces and boilers combust natural gas on site to create heat for the home.

**why:** Burning natural gas or coal to create electricity that is distributed through the grid, only to turn the electricity back to heat within the home, is an inherently wasteful process. Converting an existing home from electric resistance heat to natural gas can reduce a home's upstream environmental footprint. (The size of this impact depends on the utility's fuel mix that serves the home.)

**how:** Gas furnaces and boilers are readily available; look for the highest efficiency system for the job at hand. Inquire with the local gas utility to determine whether financial incentives are available for retrofitting to gas systems. With a super-insulated home, space heating may be feasible with a gas water heater.

**considerations:** Receive additional points by specifying ENERGY STAR natural gas furnaces or boilers (Action Item 7-9), and for forced air furnaces, look for models with a variable speed drive (Action Item 7-10).

Evaluate a system's distribution efficiency as well as the efficiency of the furnace or boiler itself; see Action Item 7-1 for information on locating ductwork within conditioned space, and Action Items 7-19 and 7-20 for information on duct sealing and insulating. Additionally, ensure airtightness of ductwork by hiring a third party to test ductwork for air leakage (Action item 7-31).

**resources:** Find ENERGY STAR qualified natural gas heating options: [www.energystar.gov](http://www.energystar.gov) website.

EPA Indoor Air Quality in Homes: Preventing Problems with Combustion Equipment: [www.epa.gov/iaq/homes/hip-combustion.html](http://www.epa.gov/iaq/homes/hip-combustion.html)



**what:** Air conditioners use electricity to extract heat from the air, cooling a room in the process. In the Pacific Northwest, air conditioners can be easily avoided by employing insulation, shading, and air movement strategies that provide a similar level of comfort without the energy use of an air conditioning system. In homes with existing air conditioning systems, this Action Item requires the decommissioning of the system.

**why:** Nationally, air conditioning represents 1/6 of our total energy use. In the Pacific Northwest, this number is smaller, but many new homes are being built with air conditioning systems. Air conditioning increases a home's energy consumption, and adds strain to the Pacific Northwest power grid when our hydroelectric energy supplies are already stretched thin, in the dry summer months.

**how:** The Pacific Northwest's mild climate makes it possible to maintain a comfortable indoor environment in the summertime on all but the hottest of days without air conditioning. A variety of strategies accomplish this, including:

- Passive solar design (Action Item 1-23).
- Using building and landscaping elements that reduce heating and cooling loads (Action Item 1-25), and more specifically, adding deciduous trees on the south and west sides of the house (Action Item 14-19).

- Installing ENERGY STAR ceiling fans (Action Item 9-12).
- Positioning windows to provide cross ventilation (Action Item 1-43).
- Using light colored roof surfaces (Action Item 6-3).
- Installing a green roof (Action Item 1-12).
- Enhancing the home's thermal envelope, especially attic/roof (Action Item 10-3) and wall insulation (Action Item 10-1) and/or using exterior rigid insulation (Action Item 10-8).

**considerations:** In homes with heat pumps, air conditioning is a part of the home's heating system. If air conditioning is an integral part of the planned or existing heating system, consider adding information to the Homeowner Operations and Maintenance manual regarding methods for reducing the need for activating a heat pump's cooling mode.

**resources:** The National Institute of Building Science's *Whole Building Design Guide* includes a section on sun control and shading devices: [www.wbdg.org/resources/suncontrol.php](http://www.wbdg.org/resources/suncontrol.php)

## Action Item 7-6

No air conditioner

### Points: 2

#### Responsible party:

HVAC, Architect

#### Intent:

Reduce home energy use related to cooling.



#### Homeowner Benefit:

At current energy prices, natural gas is a cost-effective heating source, reducing annual heating bills compared to electric resistance heat. Additionally, combusting gas on site for heat avoids the energy losses associated with gas-fired or coal-fired power plants, and the "grid losses" associated with distributing electricity via the grid.



#### Homeowner Benefit:

Combining energy efficiency measures such as attic and wall insulation with strategic landscaping to reduce unwanted heat gain, ceiling fans, and proper window placement and shading devices can obviate the need for central air conditioning. Homes without air conditioning benefit from lower energy bills related to cooling.

## Action Item 7-7

Balance airflow system based on filter being used

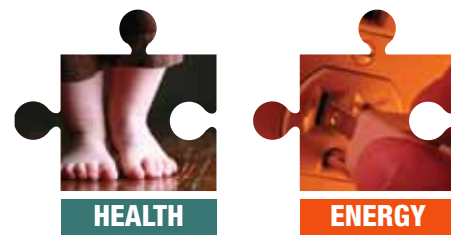
### Points: 1

#### Responsible party:

HVAC

#### Intent:

Protect and enhance indoor environmental quality by increasing the efficiency and effectiveness of the ventilation system.



**what:** All filters pose added resistance to airflow. Advanced filtration media (e.g., HEPA filters) are extremely thick, requiring additional fan energy to push air through the filter at a prescribed flow rate.

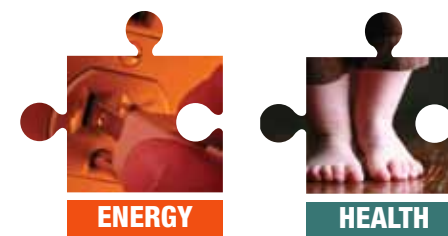
**why:** Ventilation systems must be properly balanced to function optimally. Not factoring in the resistance caused by the filter will result in improper flow rates and suboptimal ventilation. This can lead to excessive energy use and occupant discomfort and complaints.

**how:** Communicate to the HVAC contractor the system balancing goals of the project. Specifically, communicate the need to make sure the air filter is installed prior to final ventilation system balancing, and that the system is installed according to Air Conditioning Contractors of America (ACCA) manual J specifications. This Action Item requires sign-off by a professional mechanical engineer.

**considerations:** Consider other factors that affect the home's overall ventilation effectiveness, such as return ducts in bedrooms (see Action Item 2-6).

**resources:** The Air Conditioning Contractors Association ACCA Manual J: [www.acca.org/design/](http://www.acca.org/design/)

Performance Tested Comfort Systems Northwest: [www.ptcsnw.com](http://www.ptcsnw.com)



**what:** Existing air distribution system present many opportunities for upgrades. Existing systems may be poorly designed or installed in the first place, or they may have become damaged or worn out over time. This Action Item calls for a systematic evaluation of the existing system, identification of shortcomings and broken parts, and the correction of those deficiencies.

**why:** Poorly designed and maintained systems reduce efficiency and can lead to air quality, moisture and durability problems. An HVAC system tune-up helps identify and remedy any problems with the existing system. For example, bath, kitchen and laundry exhaust are sometimes vented to the attic, where the warm, moist air can lead to mold growth and even structural damage.

**how:** This Action Item applies only to remodel projects that maintain existing HVAC systems. All of the following measures must be performed:

- Check and thoroughly clean ducts, exhaust fans, and fresh air intakes. Verify exhaust fans in bath, kitchen, etc. are properly connected and terminate outdoors. Review location of exhausts and gas flues in relation to intakes; relocate if too close. Check for the presence of mold, moss, or discoloration, which signify moisture problems. Take measures to increase air intake if necessary.
- Inspect furnace; check for defects in air exchanger causing leaks into air stream.
- Upgrade filtration MERV rating (see Action Item 7-25 and 7-26)

- Install return air ducts or transfer ducts to new bedrooms (see Action Item 2-6).
- Add a fresh air inlet duct (Action Item 7-22) to the air handling system (if one does not exist, or the system does not include a Heat Recovery Ventilator). This will bring fresh air into the return air duct and can be controlled by a simple hand-operated damper.

Augment air distribution by other means, such as ceiling fans (Action Item 9-12) and cross ventilation (Action Item 1-43).

Consider hiring technicians certified through Performance Tested Comfort Systems (see Resources).

**considerations:** See Action Item 7-7 for information on balancing airflow based on filter being used.

**resources:** The ENERGY STAR program includes information for consumers on tuning up and optimally maintaining heating and cooling equipment, including an equipment maintenance checklist: [www.energystar.gov](http://www.energystar.gov) (click on *Home Improvement* and then *Heat and Cool Efficiently*).

The Home Ventilation Institute *Guide to Home Ventilation and Indoor Air Quality*: [www.hvi.org](http://www.hvi.org) (click on *Builders/Contractors*).

Performance Tested Comfort Systems Northwest: [www.ptcsnw.com](http://www.ptcsnw.com)

## Action Item 7-8

"Tune up" HVAC system(s)

### Points: 3

#### Responsible party:

HVAC

#### Intent:

Conserve energy and reduce moisture and indoor air quality problems related to poorly maintained or designed HVAC systems.



#### Homeowner Benefit:

A properly balanced ventilation system provides the proper amount of ventilation and the correct pressure, providing healthier indoor air and reducing the risk of moisture and durability problems related to pressure imbalances.



#### Homeowner Benefit:

An HVAC system tune up helps ensure systems are operating optimally, enhancing indoor air quality and enhancing comfort. Additionally, finding and correcting leaky and/or improperly installed ductwork can realize substantial energy savings.

## Action Item 7-9

Select ENERGY STAR heating/cooling equipment or documented equivalent

### Points: 3

#### Responsible party:

HVAC

#### Intent:

Increase efficiency of heating and cooling equipment.



**what:** The US EPA and Department of Energy's ENERGY STAR program identifies the top performing products in a vast array of categories in terms of energy performance—usually in the top ten to twenty percent of performers for the product class.

**why:** According to ENERGY STAR, as much as half the energy used in existing homes goes to heating and/or cooling. Heating and cooling equipment efficiency can have a substantial effect on a home's energy use. One in four furnaces in US homes is more than 20 years old.

A 90% AFUE furnace, for example, is 15% more efficient than 2009 industry averages, while an ENERGY STAR boiler is approximately 6% better than industry standard.

**how:** This Action Item encompasses many different types of equipment, including 90% AFUE furnaces, 7.4 HSPF heat pumps, and ground source heat pumps.

Work with the project's HVAC contractor to select the optimal equipment given the specific characteristics of the home. A good HVAC contractor will spend significant time evaluating the current conditions of the home and taking into consideration energy efficiency upgrades to the home prior to specifying equipment.

The Energy Policy Act of 2005 provides a federal income tax credit to consumers who purchase ENERGY STAR qualified products; use these as guidelines when choosing products:

- Furnaces: 95% AFUE or greater
- Boilers: 95% AFUE or greater
- Gas and Oil-Fired Water Heaters: 80 EF or greater
- Electric Heat Pump Water Heaters: 2.0 EF or greater.

**considerations:** Heating and cooling must be viewed as a system in a home. The efficiency of advanced heating and cooling equipment is reduced if it's attached to a leaky, inefficient distribution system or viewed separately from thermal envelope upgrades such as attic and crawl space insulation.

**resources:** The ENERGY STAR program offers information on efficient heating and cooling products: [www.energystar.gov](http://www.energystar.gov)

Research potential federal tax incentives and local utility rebate programs for high efficiency heating and cooling equipment. Incentives lists are available at: [www.dsireusa.org](http://www.dsireusa.org).



**what:** A variable speed fan adjusts airflow based on system requirements.

Electronically commutated permanent magnet (ECM) motors (also called "brushless DC motors") are the most efficient of small-scale variable speed motors.

**why:** Compared to standard motors, ECMs are up to 60% more efficient; compared to other variable speed motors they can be 15% more efficient. Additionally, ECM motors can assist with a project's indoor air quality goals, by providing a ventilation benefit to the furnace's operation.

**how:** This Action Item is only available to projects installing forced air furnace systems. This Action Item is worth 2 or 3 points.

- Variable speed fan: 2 points
- Variable speed fan w/ECM: 3 points

Work with the HVAC contractor to identify furnaces with variable speed/ECM motors for fans. Unfortunately, ENERGY STAR product lists do not specify whether a furnace has a variable speed blower; the HVAC contractor can identify this by reviewing product spec sheets.

Specify a variable speed blower that meets the heating and ventilation design needs for the home.

**considerations:** Proper sizing of a home's heating and cooling system (Action Item 7-2) is also important in optimizing the efficiency of a home's conditioning system.

## Action Item 7-10

If installing a furnace, install with a variable speed fan (extra points for ECM)

### Points: 2-3

#### Responsible party:

HVAC

#### Intent:

Increase efficiency of heating equipment.



#### Homeowner Benefit:

Selecting ENERGY STAR® qualified heating and cooling equipment can save a household 20% on home energy costs, and provide a more comfortable indoor environment.



#### Homeowner Benefit:

Furnaces that adjust fan speed according to airflow requirements reduce fan-related energy use, creating a more efficient heating system and lowering energy bills.

## Action Item 7-11

Install power venting for combustion furnaces and water heating equipment

### Points: 2

#### Responsible party:

HVAC

#### Intent:

Protect indoor air quality and building durability by reducing the risk of backdrafting from combustion appliances.



**what:** Power venting equipment supplements the natural exhaust process that occurs with combustion equipment via exhaust vents. In negative pressure situations (where the home's air pressure is less than that outdoors), natural exhaust may be overridden, bringing combustion gases and particulates into the home (most specifically, carbon monoxide). By adding a fan to the exhaust process, power venting helps reduce the likelihood of backdrafting.

**why:** According to the Centers for Disease Control and Prevention, more than 2,600 deaths occurred in the United States between 1999 and 2005 due to carbon monoxide (CO) poisoning related to activities such as unvented combustion appliances, automobile exhaust, and backdrafting. Additionally, backdrafting can introduce significant amounts of moisture and combustion byproducts other than CO into the home.

**how:** Specify a power venting combustion appliance.

This Action Item cannot be taken in addition to Action Item 7-29 (installing sealed combustion equipment).

If the HVAC system is properly balanced (see Action Item 7-7), power venting is less necessary. However, power venting provides a backup to make sure combustion products do not backdraft into the home due to system malfunction or improper maintenance over time.

**considerations:** When selecting furnace and water heating equipment, be sure to specify high-efficiency, ENERGY STAR qualified equipment.

#### resources:

The ENERGY STAR program:  
[www.energystar.gov](http://www.energystar.gov)



**what:** Due to the significant pollution generating potential of wood fireplaces, US EPA created a certification program to identify fireplaces and inserts with designs and technologies that limit the toxins and particulates related to wood combustion.

**why:** Wood smoke is a complex mixture of combustion byproducts, including small particulate matter that settles deep in the lungs. Short-term effects can include aggravation of bronchitis or asthma, and long-term effects can include aggravated heart and/or lung disease. These effects are not limited to the home's occupants; wood smoke compromises the air quality in the surrounding area as well, depending on atmospheric conditions.

Converting to an EPA certified wood stove can reduce emissions from a stove by 90 percent or more; according to EPA, older uncertified stoves and fireplaces can release 40-60 grams of smoke per hour, while a certified stove releases between two and five grams (as little as 1/30 as much).

Pellet stoves are even cleaner than EPA woodstoves; according to the Puget Sound Clean Air Agency, an EPA certified woodstove used to heat a home in the Pacific Northwest will emit 97 pounds of fine particle pollution annually; a pellet stove will release 27 pounds. (For reference, an uncertified woodstove releases an average of 224 pounds of fine particle pollution, while a natural gas furnace releases 1/6 of a pound.)

**how:** The US EPA maintains a list of EPA certified wood stoves and their manufacturers (see Resources). Specify a product that meets the EPA certification and the needs and desires of the homeowner.

**considerations:** While properly sourced wood is a renewable resource and an alternative to fossil fuel use, wood-fueled fireplaces are much dirtier than their natural gas or propane fired cousins when it comes to air emissions. A homeowner's priorities should drive the decision whether to go with the air quality benefits of a gas fireplace or the carbon benefits of a wood fireplace.

**resources:** US EPA's resource on cleaner burning wood stoves and fireplaces:  
[www.epa.gov/woodstoves](http://www.epa.gov/woodstoves)  
Includes information on the health and pollution issues related to wood burning, and a list of EPA-certified wood stoves and inserts.

The Puget Sound Clean Air Agency offers information tailored to the Puget Sound region:  
[www.pscleanair.org/actions/woodstoves](http://www.pscleanair.org/actions/woodstoves)

## Action Item 7-12

Retrofit existing wood fireplace with EPA certified fireplace insert

### Points: 2

#### Responsible party:

HVAC, Architect

#### Intent:

Reduce indoor and outdoor air pollution related to wood fireplaces.



#### Homeowner Benefit:

Power venting appliances provide an added level of indoor air quality and moisture protection by reducing the likelihood of backdrafting.



#### Homeowner Benefit:

Inefficient wood stoves can be a major source of outdoor and indoor air pollution. Replacing or retrofitting an existing wood fireplace with an EPA certified model will dramatically benefit indoor and outdoor air quality and save money on fuel wood.

## Action Item 7-13

Install an AFUE rated sealed combustion direct vent natural gas hearth product as part of an integrated heating system

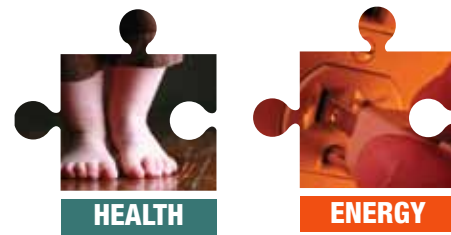
### Points: 3

#### Responsible party:

HVAC

#### Intent:

Reduce indoor and outdoor air pollution related to wood fireplaces.



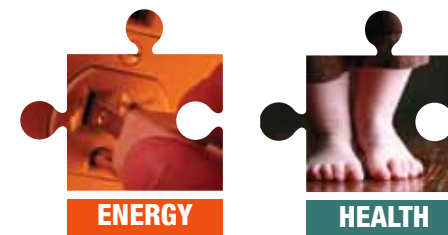
**what:** Sealed combustion, direct vent gas appliances, including hearth products, use outside air to combust the natural gas used for heat. The combustion chamber on these products is physically isolated from indoor air, eliminating the risk of water vapor and combustion byproducts escaping into occupied space.

The Gas Appliance Manufacturers Association (GAMA) publishes Annual Fuel Utilization Efficiency (AFUE) ratings for natural gas hearth products. The AFUE is a US Department of Energy defined measure of a combustion appliance's efficiency, which identifies the percentage of a fuel's heating potential that an appliance can convert to usable heat.

**why:** Beyond the homeowner benefits, sealed combustion direct vent appliances also benefit the remodeling professional by dramatically reducing the likelihood of call-backs related to moisture or air quality issues that may arise from other types of hearth products. Unvented gas or propane fireplaces, for example, introduce large amounts of water vapor and combustion byproducts including carbon monoxide into the indoor environment.

**how:** Sealed combustion, direct vent hearth products are readily available. Specify these products during the design process, and ensure that they're properly installed by following all manufacturer instructions.

**resources:** EPA Indoor Air Quality in Homes: Preventing Problems with Combustion Equipment: [www.epa.gov/iaq/homes/hip-combustion.html](http://www.epa.gov/iaq/homes/hip-combustion.html)



**what:** A heat recovery ventilator (HRV), also known as an air-to-air heat exchanger, provides an energy efficient and effective ventilation system that cannot be matched by exhaust-only ventilation systems commonly used in houses. With these units, waste heat in the exhaust air stream is transferred by a heat exchanger into the incoming air stream, significantly reducing the energy required to heat cold outdoor air to interior comfort levels. Energy Recovery Ventilators (or ERVs) differ from HRVs in that ERVs transfer moisture as well as heat from the exhaust air into the incoming air. There is considerable debate about the efficacy of ERVs in the Pacific Northwest; therefore, only HRVs are eligible for points under this Action Item.

**why:** In Western Washington's mild climate, the energy savings pay for the HRV long before the equipment reaches its rated service life. Another advantage of an HRV system is that it provides high quality ventilation to the house for maintaining indoor air quality. See also Action Item 1-42 for information on providing balanced air pressure in a home.

**how:** HRVs are becoming increasingly available, and HVAC subcontractors are becoming better versed at installing these systems. Installing an HRV can cost in the range of \$1,000-2,500 in new construction; the cost can be higher in an existing home if work includes running ductwork through finished space. Keeping systems simple is key to controlling installation costs. Look for HRV units certified through the Home Ventilating Institute (see Resources).

Installing an HRV in an existing home requires sufficient space, usually near the existing furnace.

**considerations:** HRVs should be checked and filters changed on a quarterly basis; include maintenance and care information in the Homeowner's Operation and Maintenance Manual.

**resources:** ToolBase provides a technology overview of HRVs for builders: [www.toolbase.org](http://www.toolbase.org) (click on *Technology Inventory*, then browse for *Energy and Heat Recovery Ventilators*).

The Home Ventilating Institute establishes criteria for HRV certification, and maintains a list of certified HRVs and ERVs: [www.hvi.org](http://www.hvi.org) (click on *HVI Resource Library*, then *Product Directory*).

## Action Item 7-14

Install a heat recovery ventilator

### Points: 3

#### Responsible party:

HVAC

#### Intent:

Reduce a home's energy use related to heating and cooling.



#### Homeowner Benefit:

Natural gas fireplaces have very low particulate emissions compared to wood fireplaces, making them superior from the indoor and outdoor air quality perspective. Additionally, a sealed combustion, direct vent model ensures that no combustion gases or moisture enter the home, further protecting indoor air quality and building durability.



#### Homeowner Benefit:

Heat recovery ventilators capture otherwise wasted heat from stale air exiting the home and transfer it to the incoming fresh makeup air. Such systems can capture up to 80% of this waste heat, substantially reducing the energy needed to heat the incoming air. The primary benefit of HRV technology is reduced heating and cooling bills. Additionally, some units include advanced air filtration, helping protect indoor air quality and occupant health.

## Action Item 7-15

Install hydronic heating systems (point range based on boiler efficiency)

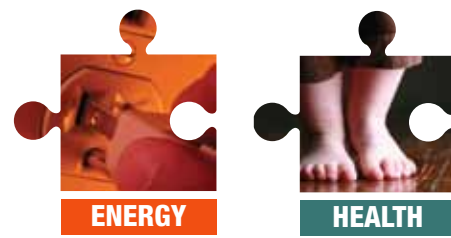
**Points: 5-10**

**Responsible party:**

Architect, Plumbing, HVAC

**Intent:**

Reduce a home's energy use related to heating.



**what:** Hydronic heating systems work by first heating water in a boiler using natural gas, electricity, propane, biofuel or solid fuel; then the heated water is circulated through a heat transfer device, radiators, radiant loops, or in-floor systems. After reaching the heat transfer device the water is returned to the boiler for re-heating.

In-floor systems can be either high thermal mass or low thermal mass. High thermal mass systems usually have hydronic coils embedded in concrete or gypcrete, or, less often, in a sand layer under the finish floor supported by sleepers. Low thermal mass systems are often plywood subfloor with a groove routed for tubing placement, and using aluminum fins to transfer heat from the tubing to the floor.

**why:** Hydronic systems eliminate space-consuming ductwork when air is heated instead of water. Other advantages include even heat and the ability to adapt for zoned heating (see Action Item 7-16).

**how:** This Action item is worth 5 or 10 points, depending on the efficiency of the installed equipment.

For boilers:

- .85 AFUE: 5 points
- .90+ AFUE: 10 points.

For tankless systems:

- EF 81: 5 points
- EF 90+: 10 points

A hydronic system should be designed and installed by qualified and certified technicians, with the system specified in response to the home's expected energy efficiency at the end of the remodel. Hydronic systems rely on proper system programming and maintenance. Include information on this system in the Homeowner's Operations and Maintenance Manual.

To determine boiler efficiency for natural gas boiler systems look for the AFUE (Annual Fuel Utilization Efficiency) rating on equipment. Condensing equipment is now widely available at 90-97% AFUE rating.

If using gas instant water heaters instead of a boiler, use the Energy Factor (EF) for efficiency (see Action Item 8-24). Instant water heaters with efficiency factors above 80 are widely available.

Electric resistance boilers are not eligible for this credit.

Reverse cycle chiller heat pumps generate hot and cold water rather than air, allowing it to be used with a variety of heating and cooling distribution systems, including radiant floor systems. See Action Item 7-3 for more on high efficiency heat pumps.

There is an ongoing debate as to the true energy efficiency benefits of hydronic systems on houses with high levels of insulation. Radiant heat systems, including hydronic in-floor systems, rely on the air temperature being cooler than the radiating surface (in this case, the floor). As the floor and air temperature reach equilibrium, the sense of warmth emanating from the floor will cease.

In homes employing thermal mass for passive solar energy, careful planning must be taken to avoid the hydronic systems and any floor mass being used for solar thermal storage not working at cross purposes.

High thermal mass systems can take hours to heat up, and so are often left on constantly throughout the heating season. In a highly insulated home, this may not introduce much of an energy penalty, but in a leaky or poorly insulated home, the energy use can be substantial.

Zoning a hydronic system can help increase efficiency and comfort, and also help integrate the hydronic system with any passive solar design elements in the home, e.g., floors used as thermal mass. See Action Item 7-16 for more on zoning a hydronic system.

**considerations:** Hydronic system installers should be made aware of the thermal efficiency goals of the project, in order to properly size and design the system. See Action Item 7-2 for information on avoiding over-sizing a home's heating system.

**resources:** ToolBase Technology Inventory includes an entry on "dry system hydronic" (hydronic that is not embedded in concrete or gypcrete): [www.toolbase.org](http://www.toolbase.org) (click on *Technology Inventory*, then browse for *Radiant Floor Heating*).

The ENERGY STAR program establishes energy performance criteria for boilers and tankless water heaters: [www.energystar.gov](http://www.energystar.gov) (click on *Products*).

The US Department of Energy's Energy Savers program provides consumer information on boilers and furnaces: [www.energysavers.gov](http://www.energysavers.gov) (click on *Heating and Cooling*, then on *Heating Systems*).



### Homeowner Benefit:

Hydronic heating systems provide even, radiant heat—heating the bodies in the room rather than the air. Hydronic heating systems eliminate the need to distribute conditioned air around the house, cutting down on dust and improving indoor air quality.

## Action Item 7-15

## Action Item 7-16

Install individual thermostatically controlled zones for radiant systems

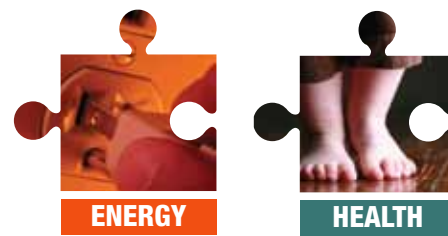
### Points: 3

#### Responsible party:

HVAC

#### Intent:

Increase occupant comfort, as well as the efficiency of the heating system, to reduce energy use and carbon footprint.



**what:** Heating systems arranged in zones allow for the homeowner to control the temperature of different spaces in the home. For example, many occupants prefer cooler bedrooms and warmer family and social areas.

**why:** Added control avoids the need to heat the entire home to the warmest desired temperature, or, alternatively, occupant discomfort enduring cooler spaces than desired.

**how:** HVAC contractors well versed in radiant systems should be able to create a zoning scenario for the home that meets occupant needs. However, make sure the contractor is aware in the other elements of the home's green features, such as passive solar heating elements and the anticipated insulation levels in the home. Super-insulated homes will require less zoning, as the temperature differentials between rooms will become less pronounced as envelope insulation levels increase.

**resources:** *Modern Hydronic Heating for Residential and Light Commercial Buildings* by John Siegnenthaler (Delmar Cengage Learning, 2003).



**what:** Smooth ductwork is manufactured from flat sheets of galvanized metal, joined together with seams and rivets or sheet metal screws.

**why:** The rough surface of flexible ductwork creates turbulence in the air that flows through the ducts, increasing resistance and energy related to fan use to distribute the air.

**how:** This Action Item is worth 2-4 points.

- Rigid ductwork in addition: 2 points
- Rigid ductwork throughout home: 4 points

Smooth ductwork is commonly available for many heating and ventilation applications. Finding smooth ductwork for other applications, such as dryer venting, may require more searching but is often available at major home improvement retailers.

**considerations:** In general, flexible ductwork is often more tightly constructed than rigid ductwork (due to fewer seams to allow leakage). Proper sealing of ductwork with mastic can dramatically reduce leakage. See Action Item 7-20 for more on proper duct sealing. Installing ductwork within heated space (Action Item 7-1) will also dramatically increase a system's distribution efficiency.

**resources:** ToolBase Technology Fact Sheet: "Air Distribution Design: Good Duct Design Increases Efficiency:" [www.toolbase.org](http://www.toolbase.org) (click on *Design and Construction Guides*, then *Heating, Ventilation and Air Conditioning*).

## Action Item 7-17

Install only rigid ductwork

### Points: 2-4

#### Responsible party:

HVAC

#### Intent:

Reduce energy use associated with heating and ventilation distribution.



#### Homeowner Benefit:

Zoning a heating system adds control and efficiency to the system, potentially reducing energy bills and enhancing comfort.



#### Homeowner Benefit:

Smooth ducting reduces resistance of air traveling through ductwork, requiring less energy to distribute air to the home—saving energy and reducing wear and tear on the fan.

## Action Item 7-18

Create individual return pathways for air in bedrooms

### Points: 2

#### Responsible party:

HVAC, Architect

#### Intent:

Protect indoor air quality and building durability by maintaining adequate ventilation in bedroom spaces.



**what:** Return pathways for bedrooms reduce the pressure differential that can form when bedroom doors are closed and rooms are outfitted only with supply air.

**why:** In many homes, the air handling system supplies air to bedrooms, but return air is collected centrally. Unless substantial space is provided under doors, this can create a damper effect, trapping air in the bedroom, creating large pressure differentials between rooms, and decreasing the ventilation effectiveness. In turn, this can compromise air quality in the bedroom, and result in moisture issues and mold growth.

Doors require substantial undercuts in order to accommodate for adequate airflow. Often this approach is not aesthetically acceptable to the homeowner, and the pathway can be easily blocked by the future installation of carpeting or placement of area rugs. Glazed transoms can provide the additional benefit of natural light from the hallway into the bedroom or vice versa, but are often left closed for privacy, eliminating their utility as a return air pathway.

**how:** For this Action Item, acceptable return air pathways are those that can reduce pressure differentials between the bedroom and hallways without being blocked. They can take a variety of forms, including offset registers placed in the walls between the bedroom and the hallway, and ductwork running between supply-fed bedrooms and rooms with return ducts. Use a manometer to test for pressure balances between rooms when the doors are closed. Pressure differentials between bedrooms and the hallway should not exceed 5 Pascals with bedroom doors closed.

**considerations:** Overall HVAC system balancing (Action Item 7-7) helps provide benefit to the entire home.

**resources:** “Unbalanced Return Air in Residences: Causes, Consequences and Solutions,” by Cummings and Withers. Florida Solar Energy Center: [www.fsec.ucf.edu](http://www.fsec.ucf.edu) (search Publications using the term Unbalanced Return Air).



**what:** Duct insulation, either batt insulation or fiberboard, reduces heat loss from ductwork in unheated space.

**why:** Energy losses related to air distribution through ductwork can be as much as 30% or more, due to a combination of leaky ductwork and uninsulated ductwork running through unheated space.

**how:** This Action Item is available only to homes with ductwork located outside conditioned space.

Duct insulation is readily available from home improvement centers and building materials suppliers. When working with insulation contractors to accomplish this Action Item, make sure that the homeowner’s goals for ductwork airtightness are also addressed. In some cases, the duct tightening is the job of the HVAC contractor, and insulation is the job of the insulation contractor. Lack of communication between these two subcontractors can result in lost opportunities.

**considerations:** Duct insulation should occur after ducting has been properly sealed with mastic (see Action Item 7-20 for details on proper duct sealing), and the completed system should be tested for leakage (see Action Item 7-21). See also Action Item 3-21 for information on conducting a comprehensive crawl space improvement, if crawl space ductwork is part of the project.

In older homes, some existing ductwork may be covered with asbestos insulation; disturbing the material is a hazard to workers and homeowners. See Resources for information on asbestos.

Locating ductwork within conditioned space (Action Item 7-1) eliminates the need and expense of insulating ductwork.

**resources:** The Department of Energy’s Energy Savers resource for consumers includes information on duct insulation: [www.energysavers.gov](http://www.energysavers.gov) (click on *Insulation and Air Sealing*, then on *Insulation* and *Where to Insulate*).

Asbestos information from the Puget Sound Clean Air Agency: [www.pscleanair.org/regulated/asbestos](http://www.pscleanair.org/regulated/asbestos)

## Action Item 7-19

If existing duct insulation is less than R-6, insulate ducts to R-11

### Points: 2

#### Responsible party:

HVAC

#### Intent:

Increase the energy efficiency of the home by reducing energy loss related to the heat distribution system.



#### Homeowner Benefit:

Individual return pathways for ventilation in bedrooms helps ensure the proper level of ventilation in a bedroom, increasing occupant comfort and exhausting stale air. It also helps maintain proper air pressure, which reduces the risk of moisture damage from water being driven into the wall assembly.



#### Homeowner Benefit:

Installing or upgrading insulation on ductwork located outside the home’s thermal envelope will reduce unwanted heat loss, lowering energy bills and keeping the home more comfortable.



## Action Item 7-20

Use advanced sealing of all ducts using low-toxic mastic (including existing ductwork, new ductwork, and furnace box)

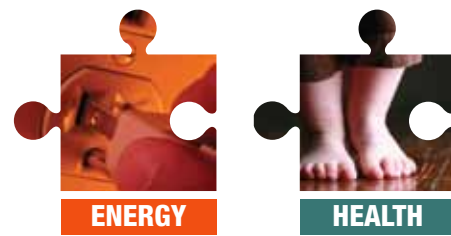
### Points: 4

#### Responsible party:

HVAC

#### Intent:

Increase the energy efficiency of the home by reducing energy loss related to the heat distribution system.



**what:** Long gone are the days where duct tape is considered sufficient for sealing ductwork; in fact, sealing ducts with duct tape does not meet code requirements in Washington State. Advanced sealing of ductwork entails using sealant that actually works—usually a brush-applied water-based mastic. For this Action Item, mastics must comply with Underwriters Laboratories UL 181 standard.

**why:** Efficiency of the heating distribution system can be improved by 15% if the ducts located in the crawlspace or attic are sealed better than standard practice. Using mastic to seal commonly used fittings or using improved duct fittings with gaskets reduce the air leakage rate of the heating system and the structure as a whole.

Additional benefits may include improved comfort by reducing drafts, improved occupant control of the distribution of heat to individual rooms, and a reduction of dirt introduced into the home.

**how:** Find experience and qualified technicians certified through Performance Tested Comfort Systems Northwest (see Resources), and have them follow PTCS standards and testing procedures. Specify water-based, low-VOC, UL 181-compliant mastic. Ask to review results of duct airtightness tests on the contractor's previous projects to determine the quality of the firm's installations.

**considerations:** Couple advanced sealing of ducts with duct performance testing (see Action Item 7-21). Testing helps provide assurance that systems will perform as expected, and offer an opportunity to identify and correct mistakes.

The home needs to be pressure balanced (see Action Item 7-7) with the goal of reducing backdrafts. If the furnace return is adjacent to a combustion appliance it can backdraft even with a perfectly airtight duct system.

Also use this sealing technique for Heat Recovery Ventilator systems (see Action Item 7-14).

**resources:** The US Department of Energy's Energy Savers program provides consumer information on duct sealing: [www.energysavers.gov](http://www.energysavers.gov) (click on Heating and Cooling, then on Supporting Equipment).

Performance Tested Comfort Systems Northwest provides training and certification for Performance Tested Comfort Systems®: [www.ptcsnw.com](http://www.ptcsnw.com)

*Performance Tested Comfort Systems Duct Program Standards and Testing Procedures* (Regional Technical Forum, 2006). This manual, for PCTS certified technicians, describes procedures for duct sealing and duct performance testing. Available at: [www.ptcsnw.com](http://www.ptcsnw.com)



**what:** Sound insulation or other fibrous materials are installed inside the ductwork to reduce noise transfer between rooms or different parts of the house.

**why:** Although in-duct sound insulation can be effective at reducing noise transmission, it also significantly reduces the airflow, which in turn compromises indoor air quality for these rooms. Additionally, certain fibrous materials, such as glass fiber insulation, become airborne and can be inhaled by occupants. Inhalation of glass fibers is very dangerous, and can result in serious and permanent lung damage over time.

**how:** To achieve desired sound insulation for noisy rooms consider additional wall, floor, and ceiling insulation rather than adding material to the ducts, or double wall framing. Other ideas include using foam gaskets under plates around receptacles and switches, caulking between baseboard (or drywall) and floor, avoiding recessed can lights (see Action Item 9-18), sealing around HVAC registers and surface light fixtures. The ENERGY STAR Thermal Bypass Checklist (see Resources) offers a variety of air sealing options that can help with both energy savings and reduced sound transmission.

Non-ducted heating systems such as hydronic (Action Item 7-15) or ductless mini-splits (Action Item 7-3) can help reduce the need for ductwork. However, green homes that encourage natural ventilation and access to daylight will, by definition, be more open and thus more vulnerable to sound transmission. On the positive side, added exterior insulation and high-performance windows help keep a home quieter in terms of street, neighborhood or flyover noise. Discuss with clients the potential tradeoffs between efficiency and privacy in the indoor environment, in order to manage expectations.

## Action Item 7-21

No sound insulation or other fibrous materials installed inside ducting

### Points: 1

#### Responsible party:

HVAC, Contractor

#### Intent:

Protect indoor air quality and enhance occupant health by reducing inhalation hazards.



#### Homeowner Benefit:

According to US EPA, a typical home's ductwork loses 20% of the air moving through it to leaks. Additionally, leaky ductwork can pull unhealthy air and contaminants from attics and crawl spaces, compromising indoor air quality.

Thorough duct sealing can provide immediate energy savings and improve indoor air quality.



#### Homeowner Benefit:

Eliminating sound insulation and other fibrous materials from within ductwork increases air distribution efficiency, which saves energy. Additionally, it enhances indoor air quality by removing potential irritants from the air stream.

## Action Item 7-22

Install ducting/damper for fresh air intake

### Points: 1

#### Responsible party:

HVAC

#### Intent:

Maintain good indoor air quality by introducing a consistent stream of fresh air into the ventilation system.



**what:** A fresh air inlet duct brings fresh air into the return air duct and can be controlled by a simple hand operated damper.

**why:** Fresh air helps provide both makeup air to a system and provide slightly positive pressure, if the system is properly balanced. This enhances occupant comfort, and can reduce the likelihood of moisture problems related to de-pressurized homes.

**how:** Communicate with the HVAC contractor the desire to include a fresh air intake. This Action Item requires design and approval by a professional mechanical engineer. Studies have shown that ad hoc changes to mechanical systems can actually cause more problems than they solve.

Additionally, make sure the system is optimized by:

- Ensuring the ducts are tightly sealed (see Action Item 7-20 and 7-31).
- Measuring the flow through the intake using a flow hood or flow grid, to assure the correct flow is being supplied, and adjusting the damper if needed.
- Assuring that isolated rooms can communicate with the return duct to prevent moisture damage and energy loss due to pressure imbalances (see also Action Item 7-33 regarding limiting kitchen exhaust flow volumes). Install return ducts in rooms that receive large volumes of air or provide passive ductwork or openings between bedrooms (see Action Item 7-18).

Use a manometer to test for pressure balances between rooms when the doors are closed. Pressures between rooms should not exceed 5 Pascals. Pressure between indoors and outdoors should not exceed 3 Pascals, or equivalently, the test meets the Performance Tested Comfort Systems (PTCS) performance criteria. The PCTS program provides training to HVAC contractors for this testing (see Action Item 7-31). See Resources to access a list of PTCS certified technicians in the Pacific Northwest.

**considerations:** See also Action Item 9-9 for information on installing a whole-house fan beyond code requirements.

**resources:** The Home Ventilation Institute publishes a Guide to Home Ventilation and Indoor Air Quality: [www.hvi.org](http://www.hvi.org) (click on Builders/Contractors).

Performance Tested Comfort Systems Northwest: [www.ptcsnw.com](http://www.ptcsnw.com)



**what:** A hybrid (also called dual fuel) heating system can draw from two fuel sources as needed: an electric air-source heat pump or natural gas.

**why:** A hybrid heating system offers the efficiency of heat pump space heating during warmer weather, with the fuel source turning to natural gas when outside temperatures make heat pump-derived heat inefficient. The primary benefit is monetary savings to the homeowner; additionally, such systems can reduce environmental impact by avoiding energy-intensive electric resistance backup heat common with standard heat pumps.

**how:** Work with the HVAC contractor to identify a hybrid heating system that works best with the home. In homes with existing forced-air heating ductwork and access to natural gas, this can be an efficient and cost-effective furnace replacement. Look for ENERGY STAR qualified heating systems.

## Action Item 7-23

Properly install a hybrid heating system

### Points: 5

#### Responsible party:

HVAC, Plumber, Electrical

#### Intent:

Reduce a home's carbon footprint by increasing the energy efficiency of the home heating system.



#### Homeowner Benefit:

Adding a fresh air inlet duct provides an opportunity to control the amount of fresh air introduced into conditioned air, helping improve indoor air quality.



#### Homeowner Benefit:

A hybrid heating system provides flexibility to a homeowner in terms of fuel source for home heating, saving on energy bills.

## Action Item 7-24

Do not install electronic, metal mesh, horse hair, or non-pleated fiberglass filters

### Points: 2

#### Responsible party:

HVAC

#### Intent:

Protect and enhance indoor air quality by specifying high-quality filtration media.



HEALTH

**what:** Electronic filters create an electrostatic charge that captures dust from the air as it passes through the furnace/ventilation system. Fiberglass, wire mesh and horsehair filters are primarily meant to protect the fan in the air distribution system, and provide very little filtration.

**why:** Electronic filters are a high maintenance item. Unless the filter elements are cleaned frequently, and in practice this is rarely done, the result will be air quality that is degraded, rather than improved. Additionally, electronic filters can produce ozone, a lung irritant. Metal mesh, horsehair filters and non-pleated fiberglass filters fail to capture 99% of particles in indoor air.

**how:** High quality filters are readily available from HVAC contractors and home improvement stores. Some super-high efficiency filters (e.g., HEPA filters) require additional space within the unit for installation. Provide information to homeowners regarding purchasing replacement filters and the frequency of replacement. Such information should be also supplied in the Homeowner's Operations and Maintenance Manual.

See Action Item 7-25 for information on selecting a higher efficiency air filter.

**considerations:** Reference Action Item 7-7, balancing airflow after installing filter. High efficiency filters, by virtue the thicker filtration media needed to capture smaller particles, require more fan energy to force air through the filter.

**resources:** American Lung Association information on home air filtration: [www.lungusa.org](http://www.lungusa.org) (click on Air Quality, Indoor Air Quality and select Residential Air Cleaning Devices).

US EPA Residential Air Cleaning Devices: A Summary of Available Information: [www.epa.gov/iaq/pubs/residair.html](http://www.epa.gov/iaq/pubs/residair.html)



HEALTH

**what:** Filter efficiency is based on the Minimum Efficiency Reporting Value, or MERV, an industry rating that measures the ability of a filter to trap particulates. The MERV rating scale ranges from 1 to 16. Medium efficiency pleated filters filter air through a larger surface area (accordion-like pleating) to remove between 40% and 50% of all particulate matter. They are relatively inexpensive and sufficient for most home applications.

**why:** Standard low-quality filters are primarily designed to protect the furnace blower from damage occurring when foreign objects are drawn into the intake, and do very little to protect indoor air quality.

**how:** When purchasing filters, look for the highest efficiency filter that works with the furnace. MERV ratings are usually listed on the product packaging. In order to achieve this Action Item, a project must install a filter with a minimum MERV 10 rating.

**considerations:** See also Action Item 7-26, to consider specifying a high-efficiency pleated filter. After upgrading furnace filters, a system should be balanced to compensate for the restricted airflow caused by the filter. See Action Item 7-7 for more on balancing airflow.

**resources:** American Lung Association information on home air filtration: [www.lungusa.org](http://www.lungusa.org) (click on Air Quality, Indoor Air Quality and select Residential Air Cleaning Devices).

US EPA Residential Air Cleaning Devices: A Summary of Available Information: [www.epa.gov/iaq/pubs/residair.html](http://www.epa.gov/iaq/pubs/residair.html)

## Action Item 7-25

Use medium efficiency pleated filter, MERV 10

### Points: 1

#### Responsible party:

HVAC

#### Intent:

Protect and enhance occupant health by specifying higher efficiency air filtration media.



#### Homeowner Benefit:

Specifying high quality filters protects occupant health, creating a more comfortable indoor environment.



#### Homeowner Benefit:

More effective air filtration removes additional irritants and contaminants from the air, protecting the health and comfort of occupants.

## Action Item 7-26

Use high efficiency pleated filter, MERV 12 or better, or HEPA

### Points: 5

#### Responsible party:

HVAC

#### Intent:

Protect and enhance occupant health by specifying higher efficiency air filtration media.



**what:** A HEPA (High Efficiency Particle Air) Filtration System is 99.97% efficient at removing particles 0.03 microns in size.

**why:** See Action Item 7-25.

**how:** Because of its high efficiency at filtering even the smallest particulates, HEPA filtration is recommended for those individuals who suffer from allergies, asthma, or other respiratory problems.

Use high efficiency pleated filters with a MERV of 12 or better, or a HEPA filter. The filtration media on high-efficiency filters can be quite thick, requiring a retrofit to an existing furnace. Alternatively, if a new furnace is being installed, select a unit that can accommodate a HEPA filter.

**considerations:** HEPA filters have multiple thick layers of filtration media, which requires additional fan energy to force air through the system. However, selecting a high-efficiency, variable speed motor for the furnace's blower (see Action Item 2-3) can help reduce this energy tradeoff. It is also important to balance a ventilation system's airflow after installing added filtration. See Action Item 7-7 for more on balancing airflow.

**resources:** See Action Item 7-25 for more resources related to filtration.



**what:** These air filtration systems connect in-line with the furnace ductwork and offers three-stage filtration. An anti-microbial polyester pre-filter with a five-pound, activated carbon filter is attached to the filtration system.

**why:** Filtering the air is key to removing airborne contaminants and to keeping the air handling system clean.

**how:** Work with the HVAC contractor to identify an air cleaner that works best with the existing heating and ventilation system, and with the homeowner to determine the desired level of filtration for the system. Air cleaners can include filtration media up to HEPA standards.

Include information about the air filter system chosen (including filter size, type, quality, and the ideal replacement schedule) in the Homeowner Operations and Maintenance Manual.

## Action Item 7-27

Install furnace and/or duct-mounted air cleaner or high efficiency air filter (non-electronic)

### Points: 1

#### Responsible party:

HVAC

#### Intent:

Protect and enhance occupant health by specifying higher efficiency air filtration media.



#### Homeowner Benefit:

More effective air filtration removes additional irritants and contaminants from the air, protecting the health and comfort of occupants.



#### Homeowner Benefit:

More effective air filtration removes additional irritants and contaminants from the air, protecting the health and comfort of occupants.

## Action Item 7-28

Install exhaust fans in rooms where office equipment is used

### Points: 1

#### Responsible party:

HVAC, Electrician

#### Intent:

Protect occupant health by reducing exposure to substances emitted by office equipment.



**what:** More residences include home offices or dens where computers, faxes, photocopiers, and other business machines are used; exhaust fans to ventilate these rooms are usually models used for ventilating bathrooms.

**why:** Office equipment and the supplies associated with it can emit VOCs, toner particulates and gases, including ozone, which is carcinogenic in high concentrations. Providing ventilation helps exhaust these substances to the outside, and provides a slight negative pressure to the office, keeping the contaminants contained.

**how:** Install a high-efficiency (preferably ENERGY STAR; see Action Item 9-11) ventilation fan of moderate volume (100-200 cubic feet per minute) on a switch, preferably with a timer, to allow users to engage the fan when needed.

Make sure to allow for fresh air intake elsewhere in the building to balance the system and ensure adequate ventilation.

Look for the most energy efficient fan for the job (see Resources). Look for “low-Sone” (a Sone is a measure of fan noise) fans; the quietest fans are barely audible. Use straight, short, smooth ductwork to reduce drag caused by air turbulence—this makes the exhaust fan more efficient in operation.

See also Action Item 9-11 (install ENERGY STAR exhaust fans).

**considerations:** The same low-toxic, healthy rules should apply in a home office as the rest of the house, including sourcing equipment that is free from toxins and irritants. Additionally, encourage the homeowners to purchase ENERGY STAR office equipment.

**resources:** The ENERGY STAR program lists qualified ventilation fans on its website: [www.energystar.gov](http://www.energystar.gov) (click on Products).

US EPA information on residential indoor air quality: [www.epa.gov/iaq/](http://www.epa.gov/iaq/)



**what:** Sealed combustion equipment (also known as “direct vent” units) draws combustion air from outside and exhausts combustion by-products to the outside, allowing no backdrafting into the living space.

**why:** According to the Consumer Product Safety Commission, there are over 200 deaths annually from carbon monoxide poisoning. Combustion heating and hot water equipment that is not direct vented can easily backdraft, releasing carbon monoxide and other byproducts into the living space.

**how:** Specify sealed combustion or direct-vented units when selecting space and water heating equipment, and communicate the goal of including sealed combustion, direct vent equipment in the home to the HVAC and plumbing subcontractors.

Maximize the distance between exhaust vents and fresh air intakes.

**considerations:** See also Action Item 7-13 for information on direct vent hearth products, and Action Item 9-19 for information on installing a carbon monoxide detector.

**resources:** Building Science Corporation Information Sheet 601: “Sealed Combustion:” [www.buildingscience.com](http://www.buildingscience.com) (search for *Info-601*).

## Action Item 7-29

Install sealed combustion heating and hot water equipment

### Points: 3

#### Responsible party:

HVAC

#### Intent:

Protect occupant health by reducing the risk of exposure to combustion byproducts, including carbon monoxide.



#### Homeowner Benefit:

Spot ventilation to the outdoors, installed in a home or commercial office, is an effective means of reducing protecting the health of occupants by dealing with the pollution at its source.



#### Homeowner Benefit:

Sealed combustion heating and hot water equipment helps protect indoor air quality and reduce the risk of carbon monoxide poisoning.

## Action Item 7-30

Install central vacuum, exhausted to outside

### Points: 1

#### Responsible party:

HVAC

#### Intent:

Protect indoor air quality and occupant health.



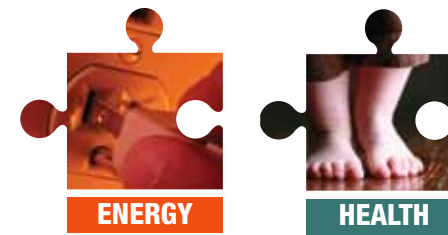
**what:** Central vacuums place the vacuum motor and dust storage in a central location outside the living space, usually the garage. A series of tubes with inlets throughout the house provide a location for a vacuum hose to be connected, and deliver vacuumed material to the central storage. Vacuum exhaust is vented to the outside.

**why:** Central vacuum systems protect indoor air by efficiently removing particles without stirring up microscopic dust particles and re-emitting them into the home's interior.

**how:** Central vacuums do not have particularly efficient filters, however, so make sure the outdoor exhaust isn't directed into a basement or garage or located near a fresh air inlet. To minimize occupant exposure to potential dust leaking from the storage canister, and off-gassing (and noise) from the motor, install the central unit in the garage. Take special care to seal any penetrations made for the distribution system that traverse indoor and outdoor space. This will help retain the integrity of the home's air barrier, and reduce air infiltration and unwanted heat loss.

In a remodel and homes with existing ductwork, the tubing can run through air returns, reducing installation cost.

**considerations:** Make sure the garage is air sealed from living spaces (see Action Item 1-33).



**what:** Duct leakage is determined using a DuctBlaster® test, where the duct system is pressurized (usually to 25 Pascals) and leakage is determined in cubic feet per minute (CFM). Tests can either measure the total duct leakage of a system or focus specifically on leakage outside the home's thermal envelope. (The latter is in general more important, as leakage within the heated space is of minimal consequence on the energy front.)

**why:** Duct performance tests prove the airtight integrity of the ductwork and provide third-party verification to show customers. Ensuring that ductwork performs to specification lends greater assurance to a system performing as expected, increasing the likelihood of customer satisfaction and that energy bills will match expectations. As a form of quality control, independent verification of duct performance can provide quick information on unseen problems and allow immediate correction.

**how:** This Action Item is worth 3, 5 or 7 points.

To achieve 3 points under this Action Item, the results of the duct test performed by a third-party must be less than 10% loss of floor area to outside/total flow, e.g., a 1,000 square foot house should have less than 60 CFM ductwork leakage. If the ductwork is sealed tightly with mastic and other moderate sealing efforts are employed it should at least pass at level of duct tightness of 6-7% of the floor area.

An additional 2 points are earned if the project can achieve 6%, and a further 2 points (for a total of 7) is available for projects achieving 3%.

Many of the same contractors who perform blower door tests (See Action Item 3-6, Blower Door Test), can accomplish DuctBlaster tests. Use acceptance criteria such as the Performance Tested Comfort Systems (PTCS) standards, and PTCS Certified technicians (see Resources).

#### considerations:

Achieving this result could be difficult in a large structure; see Action Item 1-3 for information on not adding to the existing building's footprint.

**resources:** Performance Tested Comfort Systems Northwest: [www.ptcsnw.com](http://www.ptcsnw.com) Provides training and certification for Performance Tested Comfort Systems.

Performance Tested Comfort Systems *Duct Program Standards and Testing Procedures* (Regional Technical Forum, 2006). This manual, for PCTS certified technicians, describes procedures for duct sealing and duct performance testing. Available at: [www.ptcsnw.com](http://www.ptcsnw.com)

## Action Item 7-31

Performance test ducts for air leakage meets third-party review and certification achieving less than 10%, 6%, or 3% loss of floor area to total flow

### Points: 3-7

#### Responsible party:

HVAC, Expert

#### Intent:

Reduce energy use associated with heating and ventilation distribution by ensuring quality installation.



#### Homeowner Benefit:

Central vacuums protect indoor air quality and occupant health by placing the vacuum outside the living space.



#### Homeowner Benefit:

Confirming duct leakage rates provides a measure of certainty that the HVAC contractor has done a thorough job with a home's air distribution system. The benefits from tight ductwork include lowered energy bills and healthier indoor air.

## Action Item 7-32

Flow test all fans in the house

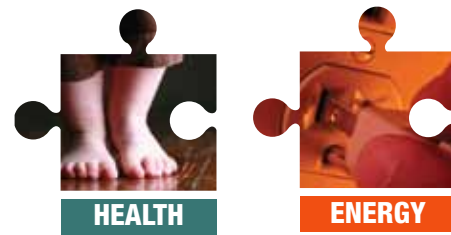
### Points: 2

#### Responsible party:

HVAC

#### Intent:

Confirm the performance of ventilation equipment, to ensure indoor air quality goals and construction specifications are met.



**what:** Ventilation fans are rated to move a specific amount of air, expressed in cubic feet per minute (CFM). Research shows that code required ventilation rates are adequate, but are not always met in the field.

**why:** If the home is not receiving the expected level of ventilation effectiveness, the result is inadequate moisture and contaminant removal. This can produce indoor air quality problems, mold and mildew, and damage to the home's structure and belongings.

**how:** Have the HVAC contractor test ventilation fan installations using a flow hood, flow grid, or exhaust fan flow meter to verify that measured flow rates meet code requirements. The flow test should meet 75% of rated capacity of the installed fan. The Performance Tested Comfort Systems (PTCS) program provides training to HVAC contractors for this testing (see Action Item 7-31, Performance Test Duct for Air Leakage Meets Third Party Review and Certification).

Flow testing can also be conducted by a Home Performance Contractor (see Action Item 1-16) or by certain Built Green verifiers.

#### resources:

Home Performance Washington:  
[www.homeperformancewashington.org](http://www.homeperformancewashington.org)



**what:** Kitchen exhaust fans, especially downdraft models for ranges, can commonly exhaust 500 or even 900 cubic feet per minute (CFM) of indoor air.

**why:** With respect to kitchen exhaust range hoods, bigger is not always better. Range hoods should be carefully sized and installed. Depressurization caused by ventilation fans can result in combustion pollutants being drawn into the home from fireplaces, water heaters, and furnaces, and can force moisture into wall assemblies, creating mold, mildew and durability issues.

In addition, these units use more electricity, increasing a home's energy use—by exhausting large amounts of conditioned air, and by the energy use of the fan itself.

**how:** If combustion appliances are present or the fan flows are high, provide make-up air to assure safe operation. In these situations, test to assure that pressure imbalance caused by the exhaust fans do not exceed minus 2Ps indoors to outdoors, or equivalently, the test meets PCTS performance criteria for controlling de-pressurization (see Action Item 7-32).

100 CFM is the minimum ventilation rate required by ASHRAE Standard 62, for kitchen ventilation and is generally adequate when using hood vents rather than downdrafts. The industry recommendation is for a minimum of 40 CFM per linear foot of cook top, thus a 48" cook top requires 160 CFM.

## Action Item 7-33

Limit kitchen exhaust fan to 300 CFM max (unless providing appropriate make up air or doesn't depressurize building more than 2 Pascals and fan is 2.5 sones or less)

### Points: 1

#### Responsible party:

HVAC, Electrician

#### Intent:

Protect indoor air quality and occupant health by reducing the likelihood of home depressurization caused by oversized ventilation fans.



#### Homeowner Benefit:

Cooking produces odors, water vapor, and particulates such as grease and smoke. Bathrooms, laundry rooms, and pool and hot tub rooms generate lots of moisture. Exhaust fans capture and remove these pollutants from the interior of the house to prevent airborne contamination.



Testing exhaust fans for flow helps confirm minimal ventilation rates are being met, promoting healthy indoor air quality and reducing the likelihood of moisture damage.

Image: Jon Alexander, Sunshine Construction



#### Homeowner Benefit:

Properly sizing kitchen exhaust helps reduce the risk of home depressurization, which protects occupants against exposure to carbon monoxide and other combustion byproducts caused by backdrafting combustion appliances. Avoiding depressurization also helps enhance a home's durability by reducing moisture problems related to maintaining a home under negative pressure.

## PLUMBING

Water heating choices, plumbing design and materials selection all impact a home's environmental performance. Green building options related to plumbing include rainwater and greywater use, efficient systems and fixtures, and solar water heating.



## Action Item 8-1

Plumb for greywater or rainwater for irrigation

### Points:

#### Responsible party:

Plumber

#### Intent:

Reduce potable water use for irrigation, extending the capacity of regional water supplies and leaving more water in streams and lakes for people and wildlife.



**what:** Greywater is all wastewater generated in the house except from toilet flushing, and, depending on the applicable code definition, kitchen sinks. Sometimes referred to as “reclaimed” or “recycled” water, this includes wastewater from laundry, showers, and sinks. Greywater can be collected and stored for reuse as a nutrient-rich irrigation source, which conserves water. According to [www.h2ouse.org](http://www.h2ouse.org), an average household produces 40 gallons of greywater per day that can be reused.

Plumbing for graywater use entails running parallel plumbing from sinks, showers and the clothes washer to be used in the event of installing a graywater irrigation system. Plumbing for a rainwater-fed irrigation system requires installing lines to connect a cistern to the irrigation system.

**why:** Pre-plumbing for future services helps facilitate the retrofit process down the road, and is often easier during a remodel when walls and plumbing are more accessible. The benefits of using graywater onsite include reducing wastewater volumes (in turn reducing energy use and pollution associated with wastewater treatment) and reducing potable water use for irrigation purposes. Additionally, greywater provides a dry-season source of irrigation water, independent of precipitation patterns. Rainwater harvest also accomplishes potable water conservation goals and can reduce stormwater discharge, which can scour streams and result in sewer overflows during storm events, depending on the configuration of a municipality’s stormwater management system.

**how:** Installing a greywater system is easiest on a major renovation project where plumbing will be upgraded. To use greywater, a dual plumbing system must be installed to separate it from blackwater (wastewater generated from toilet flushing). On a smaller remodel project, or in existing homes where the current plumbing waste stack configuration is not conducive to separating the permitted wastewater from non-permitted, it may be more practical to divert only the clothes washer’s output for reuse; Washington Department of Health’s document on greywater reuse includes a provision for this approach (see Resources).

Greywater systems are currently treated as an “exception” to the code. Systems are approved individually as “experimental” systems, requiring compliance with stringent local and state regulations. If approved, greywater irrigation systems are generally required to be subsurface. Factors affecting the approval and feasibility of greywater irrigation systems include soil depth and characteristics as well as drainage and site hydrology. Other guidelines include setbacks for greywater irrigation lines from property or potable water line.

Greywater systems require careful design, installation and maintenance; requiring a professional with demonstrated experience, and ideally one having permitted a system within the project’s jurisdiction. The Washington State Department of Health maintains a web resource on greywater irrigation systems (see Resources). Improperly designed systems can create an environmental hazard or a public health issue. The Department of

Health’s greywater page includes information on plants more tolerant of the salts present in greywater, as well as information on soaps and detergents appropriate for use with such systems.

Using rainwater for irrigation is much more straightforward in terms of code approvals. Work with an irrigation professional to determine a proper configuration for irrigation pipe installed to connect to a future cistern.

**considerations:** Projects choosing to plumb for greywater irrigation can also consider providing plumbing to use greywater for toilet flushing (see Action Item 8-2).

See also Action Item 8-3 and 14-4 to determine whether a rainwater catchment system should be installed at the same time as the plumbing for such a system. As always, conservation is the first step in greening a home: consider all ways to reduce demand for potable water both inside and outdoors prior to designing and sizing a greywater reuse or rainwater harvesting system.

### resources:

Greywater resources

Washington State Department of Health information on greywater: [www.doh.wa.gov/ehp/ts/WW/greywater/greywater.htm](http://www.doh.wa.gov/ehp/ts/WW/greywater/greywater.htm)  
Available on this site is the document “Subsurface Drip Systems: Recommended Standards and Guidance for Performance, Application, Design, and Operation and Maintenance.”

Tool Base provides information on drip irrigation leach fields: [www.toolbase.org](http://www.toolbase.org) (click on *Building Systems*, then *Plumbing*).

Rainwater resources

*The Texas Manual on Rainwater Harvesting* is an excellent general guide for designing and installing rainwater harvest systems: [www.twdb.state.tx.us/iwt/Rainwater.asp](http://www.twdb.state.tx.us/iwt/Rainwater.asp) (This manual is primarily meant for designing systems using captured rainwater for potable purposes. Rainwater harvest systems for landscape use are much less complicated. Consult with a rainwater harvest expert for systems designed for irrigation.)

Washington State Department of Ecology’s website on rainwater harvest: [www.ecy.wa.gov/programs/wr/hq/rwh.html](http://www.ecy.wa.gov/programs/wr/hq/rwh.html)



### Homeowner Benefit:

Including plumbing for graywater or rainwater for irrigation facilitates a future retrofit, or sets the stage for immediate use of these resources. Using graywater or rainwater for irrigation reduces or eliminates the use of potable water for irrigation, reducing water bills.

## Action Item 8-1

## Action Item 8-2

Stub-In plumbing to use greywater or rainwater for toilet flushing

### Points: 3

#### Responsible party:

Plumber

#### Intent:

Reduce potable water use for non-potable indoor uses, extending capacity of water resources and reducing problems related with stormwater runoff.



**what:** Use of rainwater or greywater for toilet flushing requires separate plumbing lines dedicated to non-potable water. Depending on the system, additional plumbing is run to toilets from the location best suited for future greywater or rainwater storage.

**why:** See Action Item 8-1 for the rationale for rainwater and greywater reuse.

**how:** Installing water lines for greywater or rainwater use requires a plumber with experience in systems of these kinds. Look for demonstrated experience and references. Green building membership organizations including the Northwest EcoBuilding Guild (see Resources) can serve as sources for qualified professionals. Properly label plumbing lines carrying non-

potable water sources per code requirements. Consult with local permitting authorities about whether greywater is permitted for toilet flushing, and which system(s) are allowed. Also consider providing for the use of greywater for irrigation (see Action Item 8-1).

**resources:** See Action Item 8-1 for resources.

The H2ouse Water Saver Home includes information on graywater and dual plumbing systems: [www.h2ouse.org](http://www.h2ouse.org) (click on Take Action and then Greywater under Alternate Supplies).

The Northwest EcoBuilding Guild's *Green Pages* is a print and online directory of green building professionals in the Pacific Northwest [www.ecobuilding.org](http://www.ecobuilding.org)



**what:** Toilet flushing can be accomplished with either rainwater or greywater (see Action Item 8-1 for a definition of greywater); rainwater can additionally be used for clothes washing. Greywater reuse systems for inside the home usually capture wastewater from lavatory sinks, showers, and clothes washers, filter the water and then store it for toilet flushing. A pressurization system delivers the water to the toilet fixtures. A rainwater harvest system gathers rainwater (usually from the home's roof), filters it, and stores it in a cistern for indoor use.

**why:** Using recycled greywater or captured rainwater for toilet flushing conserves our valuable potable water resources.

**how:** Rainwater and greywater systems for toilet flushing require careful design and construction. Work with experts who have experience with the design and permitting of such systems within the jurisdiction of the remodel project. See the Resources section to assist with finding a professional to help on with project.

Rainwater harvest systems used for toilet flushing must follow specific code requirements for design and installation. In King County, specific code language is developed for these systems (see Resources).

In some jurisdictions, greywater reuse for toilet flushing requires a variance from existing code and is only approved on a case-by-case basis. In Seattle and King County, for example, a single off-the-shelf system has been approved (the BRAC System) for reusing greywater for toilet flushing. Any other "experimental" systems will

require compliance with stringent local and state regulations and submittals to building code regulators for approval. See Chapter 16 of the Uniform Plumbing Code (if adopted by the project's jurisdiction) for information on greywater reuse.

Greywater systems used for toilet flushing (the only currently approved use for graywater indoors in Washington State) require regular maintenance, including changing filters. Be sure to apprise homeowners of the maintenance requirements of such a system, and include this information in the Homeowner Operations and Maintenance Manual.

Greywater and rainwater systems can gain projects up to 25 points through associated action items that employ these resources for indoor or landscape use; see Action Items 8-1 (plumb for greywater or rainwater irrigation), 14-3 (sub-surface or drip irrigation), and 14-1 (install a landscape requiring no potable water for irrigation after establishment).

#### resources:

Rainwater resources

*The Texas Manual on Rainwater Harvesting:*  
[www.twdb.state.tx.us/iwt/Rainwater.asp](http://www.twdb.state.tx.us/iwt/Rainwater.asp)

Department of Ecology:  
[www.ecy.wa.gov/programs/wr/hq/rwh.html](http://www.ecy.wa.gov/programs/wr/hq/rwh.html)

Greywater resources

WA Department of Health:  
[www.doh.wa.gov/ehp/ts/WW/greywater/greywater.htm](http://www.doh.wa.gov/ehp/ts/WW/greywater/greywater.htm)

The BRAC System:  
[www.bracsystemsbc.com/home.html](http://www.bracsystemsbc.com/home.html)

## Action Item 8-3

Use greywater or rainwater for internal potable water substitute

### Points: 10

#### Responsible party:

Plumber, Expert

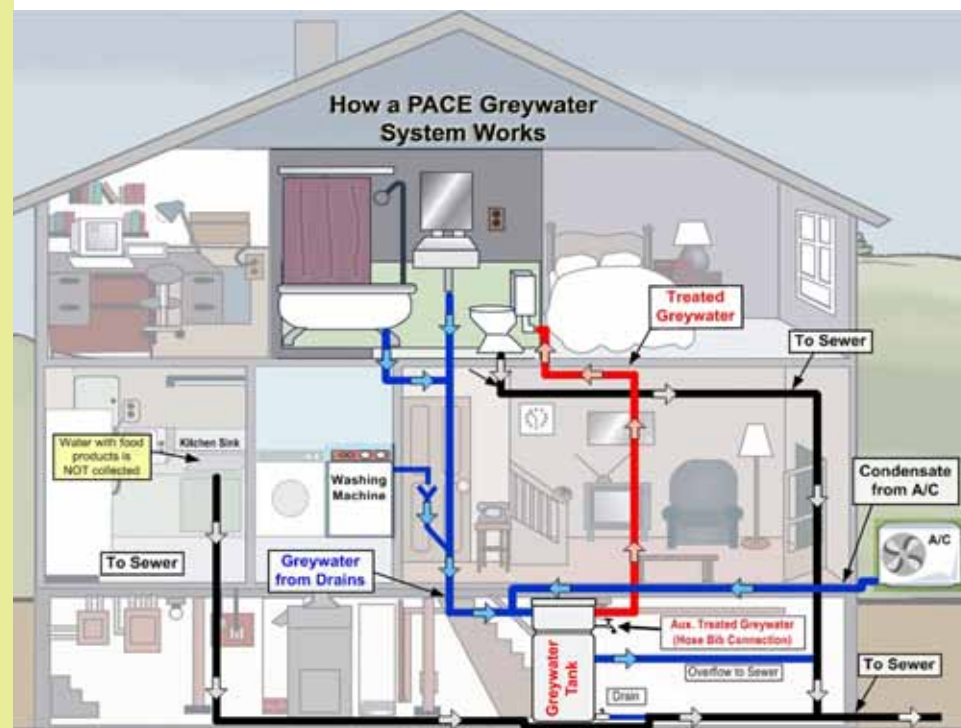
#### Intent:

Reduce potable water use for non-potable indoor uses, extending capacity of water resources and reducing problems related with stormwater runoff.



#### Homeowner Benefit:

Requing a home for use of greywater or rainwater for toilet flushing reduces the cost of installing these systems down the road and has the potential to save on potable water use (and utility bills) once they are installed.



Plumbing for greywater use indoors entails ganging waste lines from showers, bathroom sinks and clothes washers for diversion to a greywater tank, and supply lines from the greywater tank to toilets.

Image: PACE Greywater Systems **CONFIRM CREDIT**



#### Homeowner Benefit:

Greywater and rainwater harvest systems help reduce a home's water and wastewater bills by providing a secondary use for water that would otherwise be delivered to the sanitary sewer or the stormwater management system.

## Action Item 8-4

Install water heater inside the heated space (electric, direct vent, or sealed venting only)

### Points: 2

#### Responsible party:

Plumber

#### Intent:

Reduce energy use associated with water heating.



**what:** Installing the water heater within the heated space involves locating the unit within the home's thermal envelope.

**why:** Installing the water heater inside the heated space allows for capture of the waste heat from the heater for use with space heating. Additionally, since the temperature differential between the water heater and the conditioned air inside a home is lower than the difference between the water heater and outside air, less heat from the water heater is lost.

Direct vent water heaters help protect indoor air quality by venting combustion byproducts outside. They also draw combustion air from outside instead of using treated indoor air.

**how:** Combustion water heaters located inside the living area must be sealed combustion, with outside combustion air ducted to the firebox. They also must be directly vented to the outside to eliminate possibility of combustion products mixing with indoor air.

**considerations:** Installing the water heater near the point of highest use (see Action Item 8-14), insulating hot water pipes (Action Item 8-19) and installing high efficiency electric or gas water heaters (Action Items 8-22, 8-23) also helps save energy.

**resources:** ENERGY STAR program information on high efficiency water heaters: [www.energystar.gov](http://www.energystar.gov) (click on Products).

EPA Indoor Air Quality in Homes: Preventing Problems with Combustion Equipment: [www.epa.gov/iaq/homes/hip-combustion.html](http://www.epa.gov/iaq/homes/hip-combustion.html)

Building Science Corporation Info Sheet 601: "Sealed Combustion" describes the importance of sealed combustion equipment: [www.buildingscience.com](http://www.buildingscience.com) (search for Info-601).



**what:** A home run water pipe configuration dedicates a plumbing line for each fixture in a home, by using a manifold at the main water distribution point. Most manifold systems use cross-linked polyethylene (PEX) pipe to deliver water to fixtures.

**why:** Beyond the water savings potential and convenience of a home run configuration, PEX systems can be installed much more rapidly than copper and other rigid pipe systems. This can reduce construction time dedicated to plumbing activities. Home run PEX systems often confer additional water and energy savings by using smaller interior diameter pipe, which again delivers hot water more rapidly to fixtures (see Additional Considerations).

**how:** Select a plumber with experience installing PEX plumbing in a home run configuration.

**considerations:** Consider installing the smallest diameter pipe needed for the requirements of the fixture. PEX pipe has a smaller interior diameter for a given pipe size compared to copper, meaning it gets hot water to the fixture faster. As with any plumbing system, consideration should be given to end-use demands to determine the optimal layout. See Action Item 8-14 regarding placing the water heater within 20 feet of the point of heaviest use.

**resources:** ToolBase offers information on PEX plumbing and home run manifold configurations for building professionals: [www.toolbase.org](http://www.toolbase.org) (click on Building Systems, then Plumbing, then Cross-Linked Polyethylene (PEX) Water Supply Piping).

## Action Item 8-5

Use a "home run" manifold water pipe configuration

### Points: 2

#### Responsible party:

Plumber

#### Intent:

Conserve water by reducing wait time for water to reach fixtures.



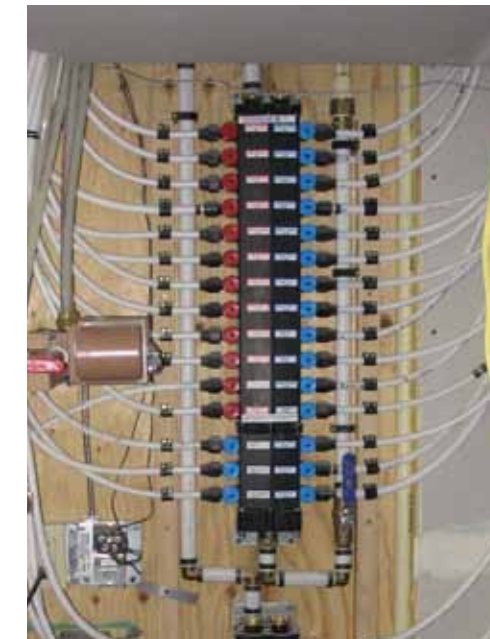
#### Homeowner Benefit:

Locating the water heater within conditioned space in the home reduces energy use by minimizing heat loss from the unit and capturing any heat that does escape for use in the home. This results in lower energy bills.



#### Homeowner Benefit:

Home run plumbing configurations increase the speed at which water reaches the use—saving on water use and energy related to water heating by reducing wait times. Additionally, these systems equalize pressure in the plumbing system, allowing for simultaneous water use without a drop in water pressure.



Home run systems dedicate a single line to each fixture, reducing line length and wait times for hot water.

Image: Jon Alexander, Sunshine Construction

## Action Item 8-6

Remove existing under-sink garbage disposal

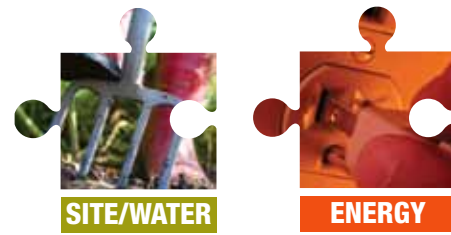
### Points: 1

#### Responsible party:

Plumber

#### Intent:

Reduce water use and demand on municipal wastewater treatment facilities.



**what:** Many existing homes have under-sink garbage disposals for grinding food waste. Removing such a system entails physically disconnecting the device.

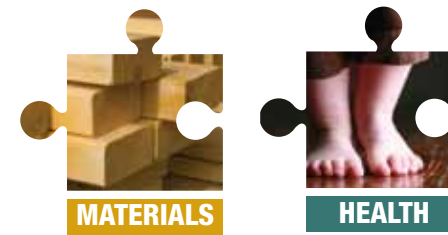
**why:** Under-sink garbage disposals introduce large amounts of nutrients and biological material into the sewer system, increasing the wastewater treatment needs of a jurisdiction. Wastewater treatment has a substantial energy and environmental impact. Methane, a common byproduct of anaerobic biological material decomposition, is 21 times more powerful per unit as a greenhouse gas than carbon dioxide.

**how:** Removing an under-sink garbage disposal entails capping off the power supply, removing the unit, and providing a replacement drain pipe if needed. Projects that do not have an existing under-sink garbage disposal are not eligible to earn a point for this Action Item.

**considerations:** Consider including other design elements that facilitate kitchen composting, including dedicated space in the kitchen for recyclable and compostable materials, building in a compost chute, and providing on-site composting in the form of a worm bin or Green Cone. This eases the transition from garbage disposal to composting.

**resources:** King County's page on composting: [www.your.kingcounty.gov/solidwaste/naturalyardcare/compost.asp](http://www.your.kingcounty.gov/solidwaste/naturalyardcare/compost.asp)

*Composting at Home*, a guide to on-site composting, is available for free download from the Saving Water Partnership: [www.savingwater.org/outside.htm](http://www.savingwater.org/outside.htm) (scroll down to *Resources*).



**what:** A catch basin (also called a drain pan or drip pan) is placed under a water heater and/or clothes washer to capture and divert any leaks that may develop.

**why:** This measure helps to avoid additional moisture problems within the dwelling if either the washing machine or water heater flooded. In some jurisdictions, drain pans are required on second floor laundry installations.

**how:** This Action Item is worth 1 or 2 points:

- Washing machine: 1 point
- Washing machine and water heater: 2 points

Drain pans are low cost and available from most home improvement retailers and building materials suppliers. Look for heavy-duty drain pans for placement under clothes washers: the ongoing movement and vibration from these appliances can eventually crack or degrade a low quality drain pan, rendering it useless. Drain pan overflow should be attached to a drain connected to the sanitary sewer.

**considerations:** Water alarms (Action Item 13-50) provide added protection and early warning of developing leaks. Consider adding insulation to the water heater if the current model is not being replaced (Action Item 8-20); insulating and adding a pan simultaneously will be less costly than doing them separately.

## Action Item 8-7

Install floor drain or catch basin with drain under washing machine and/or water heater

### Points: 1-2

#### Responsible party:

Plumbing, Concrete Pour

#### Intent:

Protect building durability and indoor air quality by avoiding moisture damage and flooding from water heaters and clothes washers.



#### Homeowner Benefit:

Decommissioning a garbage disposal can save water, along with energy use associated with operating the unit.



#### Homeowner Benefit:

Drain pans are a low-cost preventive device that can avoid costly water damage repairs down the road. Pans and drains to capture and divert leaks or flooding from faulty water heaters and clothes washers can also help protect indoor air quality by avoiding mold and moisture growth. Many insurance companies will also provide a discount on policies for homeowners who include this measure since claims are common for these types of failures.

## Action Item 8-8

Reuse plumbing fixtures that meet or can be modified to meet code

### Points: 1

#### Responsible party:

Contractor, Plumber

#### Intent:

Reduce raw material use and attendant environmental impacts by reusing materials.



MATERIALS

**what:** Plumbing fixtures include kitchen and bath faucets, shower and tub fixtures, sinks, tubs, and toilets.

**why:** Materials reuse is beneficial in that it saves energy and material resources related to creating new products.

**how:** This credit is available if salvaged fixtures are purchased from salvage and reuse operations, re-used from other jobsites, or reclaimed in demolition. Many fixtures can provide an architectural element that can be incorporated into new designs. Certain fixtures are more easily modified than others. It is not recommended to modify toilets that do not meet current efficiency standards; often the flushing action of old toilets relies on multiple gallon flows; by reducing the toilet tank capacity (e.g., with a filled bottle or other device to displace water in the tank), the resulting flush volume is usually insufficient to clear the toilet bowl. Sink fixtures with threaded heads can usually be adapted using a flow restrictor. Older, non-threaded sink and kitchen faucets most likely cannot be modified to meet this credit. Tub faucets do not have a flow requirement, and are readily reused. Due to flow requirements, showerheads are also difficult to retrofit to higher efficiency.

**considerations:** Also consider water quality when reusing fixtures. Some kitchen and lavatory faucets contain lead. If in doubt, test the fixture with a lead test kit, available from most home improvement centers.

See Action Items 8-9 (lavatory faucets), 8-10 (kitchen faucets), 8-11 (showerheads) and 8-12 (toilets) for more information on water-saving plumbing fixtures.

**resources:** The Building Materials Reuse Association provides a directory of used building materials retailers and salvage consultants:  
[www.bmra.org](http://www.bmra.org)

The Green Home Remodel Salvage and Reuse guide provides general information on building materials salvage and reuse:  
[www.greentools.us](http://www.greentools.us) (click on Residential Buildings, then Residential Remodeling Guides).

Learn about indoor and outdoor water conservation at the Saving Water Partnership website:  
[www.savingwater.org](http://www.savingwater.org)



SITE/WATER

ENERGY

**what:** Federal law requires that faucets have flow rates no greater than 2.5 gallons per minute (GPM). Low flow bathroom lavatory faucets can function well with flow rates as low as 0.5 GPM.

**why:** Faucets typically account for 11.4 gallons of water use per person per day. Selecting low flow faucets helps reduce overall water usage, helping relieve pressures on local water supplies and lowering environmental and energy impacts related to water treatment and distribution. It also reduces wastewater flows, consequently reducing water treatment needs.

**how:** Most lavatory faucets come with a standard aerator that delivers the maximum flow rate allowed (2.5 GPM). Replacement aerators are available that deliver 20% of the flow and are sufficient for virtually all bathroom tasks, unless a sink is commonly used for hair washing or other activities that require a high water flow rate. Not all brands are created equal, so talk to your supplier. The added cost of high performance, low flow heads is minimal, generally less than \$25 per house. Aerators that achieve 0.5 GPM may be available from your local water utility, either free or for a greatly reduced price. Look for low-flow aerators that deliver water in small individual streams rather than those that introduce air into the flow stream; the former keeps water warmer.

Another water-saving opportunity for bathroom lavatories are “toilet-to-tank” systems where water from hand washing is collected under the sink, which is then used for toilet flushing. Popular in Japan, these systems are available for special order in the United States and can earn a project innovation points.

User behavior is a key element in water conservation. Including information in the Homeowner Operations and Maintenance Manual on water-wise behaviors can help homeowners become even more efficient.

**considerations:** Remote lavatory faucets can take some time to receive hot water. Consider a “home run” plumbing configuration (Action Item 8-5) with small diameter piping (Action Item 8-26), or a small point of use instant water heater (Action Item 8-28).

Whole-house tankless water heaters (Action Item 8-24) may require a minimum flow rate greater than 0.5 GPM to activate. Check heater specifications when selecting ultra-efficient fixtures.

**resources:** The EPA WaterSense program includes bathroom sink faucets in its “Find a Product” section:  
[www.epa.gov/watersense/](http://www.epa.gov/watersense/)

The Saving Water Partnership provides information on efficient bathroom fixtures:  
[www.savingwater.org/inside\\_bathroom.htm](http://www.savingwater.org/inside_bathroom.htm)

## Action Item 8-9

Select bathroom faucets with GPM less than code

### Points: 1

#### Responsible party:

Plumber

#### Intent:

Reduce potable water use.



#### Homeowner Benefit:

This Action Item may save the homeowner money, by allowing the reuse of existing plumbing fixtures on the project, or low-cost fixtures from used building materials retailers. Modifying the fixtures to meet efficiency requirements results in water savings over time, reducing utility bills.



#### Homeowner Benefit:

Reducing water use related to lavatory faucets equates to lower water and wastewater bills.

## Action Item 8-10

Select kitchen faucets with GPM less than code

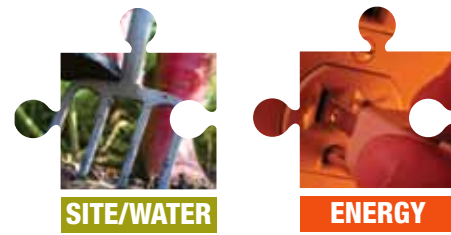
### Points: 1

#### Responsible party:

Plumber

#### Intent:

Reduce potable water use.



**what:** By federal standards, new kitchen faucets may not have a flow rate exceeding 2.5 gallons per minute (GPM). Low-flow kitchen faucets usually have aerators that restrict flow to 2.0 GPM.

**why:** The typical occupant uses more than 11 gallons of water per day via faucets throughout the home. Selecting low flow faucets helps reduce overall water usage. According to the California Urban Water Conservation Council, a family of four can save 1,700 gallons of water per year by installing water-conserving faucet aerators; 1,300 of these gallons are hot water, meaning substantial energy savings accrue over time as well.

**how:** Similar to lavatory faucets, kitchen aerators can be found at home improvement stores and online. Additionally, kitchen faucets can be outfitted with an aerator that is also a diverter, a toggle or button switch to restrict flow to a drip without turning off the tap. This allows for water savings along with the convenience of not needing to readjust the mixer to attain the right water temperature. It is not advised to restrict a kitchen tap's flow to less than 2.0 GPM, to avoid creating a dissatisfying experience for the user in terms of time required to fill a pot with water.

**resources:** The Saving Water Partnership provides information on efficient kitchen fixtures: [www.savingwater.org/inside\\_kitchen.htm](http://www.savingwater.org/inside_kitchen.htm)



#### Homeowner Benefit:

Conserving water related to kitchen faucets reduces both water and wastewater bills, and saves energy associated with water heating.



**what:** Standard showerheads available today consume 2.5 gallons per minute (GPM). Old showerheads can use 5 GPM or more. Low flow showerheads are available that perform well at rates of 1.75 GPM or less.

**why:** According to US EPA, showering represents 17% of America's indoor water use, and results in the use of 1.2 trillion gallons of water and an equivalent amount of wastewater created. Household water use places demands on local water supplies, and results in energy use related to water purification and pumping and wastewater treatment.

**how:** This Action Item is worth 2-5 points.

- Showerhead in primary bathroom: 3 points
- 2 showerheads: 4 points
- 3+ showerheads: 5 points

(Note: one showerhead per shower allowed.)

The GPM rating of a showerhead is usually noted in the center of the spray head. It may be necessary to search online for 1.6 GPM or better showerheads; they may not be available from many home improvement centers and plumbing suppliers. Inquire with the local water utility to see if low-flow showerheads are available at no cost or a discount from the utility.

Occupants with long hair may find fixtures with less than 1.6 GPM flow insufficient for rinsing purposes. 1.75 GPM showerheads may be more appropriate in this circumstance. Discuss water needs with the homeowner prior to specifying products.

**resources:** The EPA WaterSense program includes showerheads in its list of qualified products. Use the "Find a Product" locator to identify manufacturers and models. Additionally, the program offers a savings calculator to help determine the return on investment of water-saving purchases:

[www.epa.gov/watersense](http://www.epa.gov/watersense)

The Saving Water Partnership includes information on the benefits of efficient showerheads: [www.savingwater.org](http://www.savingwater.org) (click on *Conserve Inside*).

## Action Item 8-11

Select low flow showerheads (1.6 GPM or better) for primary bathroom

### Points: 2-5

#### Responsible party:

Plumber

#### Intent:

Reduce potable water use by selecting efficient fixtures.



#### Homeowner Benefit:

Conserving water related to showering reduces both water and wastewater bills, and saves energy associated with water heating.

## Action Item 8-12

Install dual flush or WaterSense qualified toilet

### Points: 2-8

#### Responsible party:

Plumber

#### Intent:

Reduce potable water use for non-potable indoor uses, extending capacity of water resources; reduce environmental impacts related to wastewater treatment.



**what:** Dual flush toilets offer the user a choice between a standard flush and a half flush (usually 0.8 gallons per flush [GPF]).

WaterSense is a program administered by the US EPA, similar to the ENERGY STAR program. It establishes water savings and performance criteria for products, including toilets, helping ensure that water efficiency per flush isn't traded off for performance. WaterSense toilets use 1.28 GPF or less, or are dual flush models, and are independently tested for performance.

**why:** According to the WaterSense program, toilets are the primary user of water in the average home, accounting for 30% of indoor water use. Replacing older toilets in an existing home with WaterSense models that use 20% less water than conventional toilets available today can save 4,000 gallons of water per year.

**how:** This Action Item is worth 2-8 points.

- 2 points per toilet
- Maximum 8 points.

Find WaterSense qualified toilet models by looking for the WaterSense label, or by using the "Find a Product" locator on the WaterSense website (see Resources).

**considerations:** Using rainwater or greywater for toilet flushing can dramatically reduce a home's indoor water use. See Action Item 8-3.

**resources:** EPA WaterSense program:  
[www.epa.gov/watersense/](http://www.epa.gov/watersense/)

The Saving Water Partnership provides information on the benefits of efficient toilets:  
[www.savingwater.org/inside\\_bathroom.htm](http://www.savingwater.org/inside_bathroom.htm)



**what:** Composting toilets convert human waste into nutrient-rich fertilizer for non-food plants rather than mixing the waste with potable water and flushing it down the drain. Some composting chambers use small amounts of water ("microflush toilets") or foam to deliver waste to the composting chamber; most are non flush (waterless) units.

**why:** Municipal wastewater treatment is a significant user of energy, and human waste adds unwanted nutrients to local water bodies. The advantages of composting toilets include dramatic reductions in water use, reduced groundwater pollution or sewage treatment impacts, and a recycling of nutrients. One toilet can accommodate up to five persons. While composting toilets can require an upfront investment, the payback period is typically about 10 years.

**how:** Check local building code and health department regulations concerning regulations for alternative onsite sewage systems prior to installation. Where composting toilets are used, greywater from sinks, showers, and laundry must still be addressed either with traditional sewer connections or on-site with septic or greywater reuse systems.

**resources:** Washington State Dept. of Health List of Registered On-site Treatment and Distribution Products:  
[www.doh.wa.gov/ehp/ts/WW/registered-list.pdf](http://www.doh.wa.gov/ehp/ts/WW/registered-list.pdf)

Washington State Guidelines for Composting Toilets:  
[www.doh.wa.gov/ehp/ts/WW/Water\\_Conservation\\_8-29-07.pdf](http://www.doh.wa.gov/ehp/ts/WW/Water_Conservation_8-29-07.pdf)

The Oikos Green Building Source maintains an information page on composting toilet technology:  
[www.oikos.com/library/compostingtoilet/](http://www.oikos.com/library/compostingtoilet/)

## Action Item 8-13

Install composting toilets

### Points: 10

#### Responsible party:

Plumber, Expert

#### Intent:

Reduce potable water use for non-potable indoor uses, extending capacity of water resources; reduce environmental impacts related to wastewater treatment.



#### Homeowner Benefit:

Dual flush and WaterSense qualified toilets reduce water use in a home; for example, replacing existing toilets with WaterSense models can save \$90 annually in water utility bills, and \$2,000 over the life of the toilet, according to US EPA. On average, dual flush toilets can save up to 26% more water than equivalent single flush models.



#### Homeowner Benefit:

Composting toilets dramatically reduce (by 95% or more) or completely eliminate the use of water for managing human waste. Since toilet flushing consumes 30% of an average home's indoor water, savings on water and wastewater utility bills can be substantial.

## Action Item 8-14

Locate water heater within 20 pipe feet of highest use

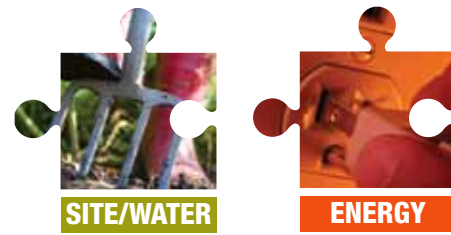
### Points: 2

#### Responsible party:

Architect, Plumber

#### Intent:

Reduce energy use associated with hot water distribution losses.



**what:** Plumbing systems, especially in older houses, can be complicated affairs. The aim of this Action item is to simplify a system, with special attention paid to the locations of highest demand in a home. According to the Saving Water Partnership, the end points of highest hot water use are showering and bathing, clothes washing, and dishwashing.

**why:** Hot water distribution results in energy loss when warmed water remaining in pipes cools. This cooled water must be flushed, resulting in a wait time for newly heated water to reach the fixture.

**how:** Locating the water heater near the point of highest use helps minimize pipeline energy loss. Typically, the point of highest demand is the shower. However, an evaluation of a home's water use via a water audit (Action Item 1-2) can precisely identify the largest hot water demand (in some homes with super efficient bathroom fixtures and water conserving behaviors, it may be the laundry or kitchen).

**considerations:** Stacking plumbing (arranging the plumbing system so that it is organized around a centralized location in the home, with each floor's services similarly configured) also helps in this regard.

Re-plumbing from copper or iron pipe on existing homes to PEX is an ideal time to reevaluate a plumbing system's design. Consider "home run" (Action Item 8-5) and other efficient distribution designs. A comprehensive water assessment (Action Item 1-2) helps provide information on water use in the home, which in turn can inform water heater placement.

**resources:** The NAHB's ToolBase program offers a Tech Set on resource efficient plumbing: [www.toolbase.org](http://www.toolbase.org) (click on Tech Sets).



**what:** Whole house water filtration systems (also called point-of-entry systems) filter all water entering a house, in contrast to point-of-use filters at a particular fixture. Whole house systems remove chlorine and other chemicals as they enter a home's plumbing system.

**why:** Removing chemicals and contaminants before the water is distributed through the home's plumbing system keeps these substances from being released into the air. Like other fixture-fixed water filters, these systems provide a higher quality drinking water, but they also alleviate the effects of asthma and allergies by ultimately providing cleaner air.

**how:** Work with the plumbing contractor to identify a whole-house water filtration system that meets the homeowner's needs. Look for filtration systems that meet the NSF/ANSI Standard 53 for home water filtration systems. Generally, no one single whole house water filter can filter chemicals, microorganisms, and sediments. Find a dual-purpose "effective" product or design a multi-filter system to capture all contaminants.

Include information on the filtration system's care and maintenance in the Homeowner Operations and Maintenance Manual.

## Action Item 8-15

Install a whole house water filter system

### Points: 3

#### Responsible party:

Plumber

#### Intent:

Protect occupant health by providing cleaner water for domestic uses.



#### Homeowner Benefit:

Quickly getting hot water to where it's needed reduces energy use associated with water heating, and also reduces water and sewer bills related to flushing cooled water through the hot water pipes. Another major benefit to homeowners is the reduced wait time—less time waiting for the hot water to reach the tap.



#### Homeowner Benefit:

A properly selected whole-house filtration system helps protect occupant health not only by filtering water of contaminants, but removing chlorine and other substances from water that can be released into the indoor air and become lung irritants.



## Action Item 8-16

Install showerhead filter

### Points: 1

#### Responsible party:

Contractor, Owner

#### Intent:

Protect occupant health by reducing chlorine inhalation related to showering.



**what:** Showerhead filters are installed above the showerhead, removing chlorine either through filtration or a chemical reaction. Showerhead filters can effectively remove 90% or more of chlorine from shower water.

**why:** Studies indicate that exposure to chlorine, absorbed through the skin and lung tissue during showering, can contribute to increased risk of health problems.

**how:** Showerhead filters are available through health-oriented building materials suppliers and online. Look for products with pop-in replaceable cartridges that install quickly, are long lasting (at least nine to twelve months) and do not require back flushing. Easy maintenance increases the likelihood of proper operation by the homeowner.

Include information on replacement frequency and unit maintenance needs in the Homeowner Operations and Maintenance Manual.

This Action Item is unnecessary if the home has installed a whole-house filtration system that removes chlorine (Action Item 8-15).



**what:** Home water filters use a variety of filtration media. Carbon filtration media can be composted at end of life, in contrast to many other media that must be disposed.

**why:** A goal of green building is to reduce waste—both during construction and during the operational phase of the building's life-cycle. By specifying materials that are easily composted or recycled at the end of life, material is kept out of the landfill.

**how:** Specify carbon filters that can be easily disassembled to remove the carbon for composting. It may be cost-effective to install a whole-house filtration system. This provides filtration at all taps and eliminates the need for multiple point-of-use filter changes.

**resources:** US EPA: "Drinking Water and Health: What you need to know:" [www.epa.gov/safewater/dwh/](http://www.epa.gov/safewater/dwh/) includes the consumer fact sheet "Filtration Facts," which includes information on "point of entry devices" (whole house and sink filtration devices).

## Action Item 8-17

If installing water filter at sink or whole house water filtration system, select one with biodegradable carbon filter

### Points: 1

#### Responsible party:

Contractor, Owner

#### Intent:

Reduce waste related to water filtration.



#### Homeowner Benefit:

Showerhead filters reduce occupant exposure to chlorine, helping protect health and providing additional benefits by being gentler on skin and helping soaps and shampoos lather better.



#### Homeowner Benefit:

Selecting biodegradable carbon filters helps reduce waste by allowing the filtration media to be composted.

## Action Item 8-18

Use no PVC piping for plumbing

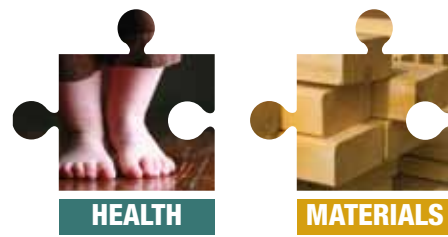
### Points: 3

#### Responsible party:

Plumber

#### Intent:

Protect human health and the environment by reducing polyvinyl chloride building materials manufacture.



**what:** PVC, or polyvinyl chloride, is a polymer used for a wide variety of building products, including most drainage and wastewater pipe.

**why:** Vinyl chloride, the building block for PVC, is a known human carcinogen. Also, in the event of a fire, PVC can release toxic smoke containing sulfuric acid and dioxins—some of the most potent toxins known to humanity. PVC is also very energy intensive to produce.

**how:** For potable water distribution, a variety of non-chlorinated alternatives exist. Cross-linked polyethylene, or PEX, is one such alternative. Polyethylene pipe is also available for site drainage. In general, polyethylene is considered a very benign plastic throughout its life cycle, and a good alternative to PVC.

**considerations:** Some replacements for PVC are not much better in terms of their environmental profile. ABS pipe, often used for wastewater conveyance, is one such material. High Density Polyethylene (HDPE) is considered one of the most benign plastic polymers, and a good alternative to PVC and ABS.

**resources:** The Washington Toxics Coalition maintains a fact sheet on PVC: [www.watoxics.org](http://www.watoxics.org) (click on *Healthy Homes and Gardens*, then *Home Repair and Building Materials*).

See the ToolBase resource for information on cross-linked polyethylene (PEX) pipe: [www.toolbase.org](http://www.toolbase.org) (click on *Design and Construction Guides*, then *Plumbing*).



**what:** A hot water tank continuously heats the pipe and the water in the water heater even when no water is being used. They act as “cooling rods.” Heat traps are one-way valves installed on the water heater’s inlet and outlet pipes to avoid these convective heat losses. Additional losses are incurred by distributing hot water through uninsulated pipes. Heat traps are unnecessary on tankless water heaters, as their purpose is to reduce standby losses. However, insulating hot water pipes is advisable on both tank and tankless water heating systems.

**why:** Insulation reduces the rate of heat loss, increasing the efficiency of the overall water heating and distribution system. This reduces the homeowner’s ongoing energy bills, and also reduces a home’s overall carbon footprint.

**how:** Off-the-shelf pipe insulation is readily available and readily installed if pipes are easily accessible. Polyethylene “pipe sleeves” are an easy-to-use insulation option; purchase sleeves with an inside diameter matching the outside diameter of the pipe to be insulated.

Install insulation on all pipes (hot and cold) within three feet of the water heater. On combustion water heaters, keep insulation at least 6” away from the flue.

**considerations:** Further increase the efficiency of hot water distribution by installing smaller diameter PEX water pipe (Action Item 8-26), and locating the water heater within 20 pipe feet of the highest hot water use (Action Item 8-14).

**resources:** The Department of Energy’s Energy Savers program offers information on insulating water heaters: [www.energysavers.gov](http://www.energysavers.gov) (click on *Appliances and Electronics*, then *Water Heaters*, then *Energy Efficient Water Heating*).

## Action Item 8-19

Insulate all hot water pipes and install cold inlet heat traps on water heater

### Points: 1

#### Responsible party:

Plumber

#### Intent:

Reduce energy use associated with domestic hot water standby losses and distribution losses.



#### Homeowner Benefit:

Avoiding vinyl windows reduces a home’s upstream and downstream environmental burden related to the manufacture and disposal of polyvinyl chloride.



#### Homeowner Benefit:

Reducing a water heater’s “standby losses” (energy used to keep the water in the tank hot) saves on energy bills.

## Action Item 8-20

If not replacing, inspect and insulate existing water heater

### Points: 1

#### Responsible party:

Plumber

#### Intent:

Reduce energy use by optimizing operational efficiency of existing water heater.



**what:** Insulating an existing water heater involves wrapping the unit in an insulating blanket.

**why:** Water heaters with tanks to store hot water (i.e., all water heaters other than instantaneous systems) lose heat over time even when the unit is not in use (this is called “standby loss”). According to the US Department of Energy, insulating an existing water heater can reduce standby losses by 25-45% and save 4-9% in water heating expenses.

**how:** If the current water heater is warm to the touch, it’s insufficiently insulated and can benefit from an insulating blanket. Water heater insulating blankets are readily available from home improvement retailers. With electric water heaters, a “bottom board” (rigid insulation placed between the bottom of the tank and the floor) can save another 4-9% of water heating energy, according to the Department of Energy.

Insulating gas water heaters is trickier, requiring careful attention to avoid blocking airflow to the burner, covering the thermostat, or creating a fire hazard by insulating the top of the unit. Read and follow all blanket installation instructions carefully.

**considerations:** Locating the water heater within the conditioned space, rather than a garage or attic, helps reduce standby losses as well (see Action Item 8-4). Also consider plumbing layout (Action Item 8-5) and pipe diameter (Action Item 8-26) when upgrading or replacing a home’s plumbing.

**resources:** The Department of Energy’s Energy Savers program offers information on insulating water heaters: [www.energysavers.gov](http://www.energysavers.gov) (click on *Appliances and Electronics*, then *Water Heaters*, then *Energy Efficient Water Heating*).



**what:** Air-to-water heat pumps extract latent heat from the air and convert it to hot water. Such systems are normally used for hydronic space heating systems, and can be modified to provide domestic hot water as well. A de-superheater captures otherwise wasted heat from the compression process in heat pumps and uses it to heat water. De-superheaters are typically added to geothermal heat pumps, but are also available for tankless water heaters.

**why:** The exhaust air heat pump is a good option for families who require lots of hot water. A unit with an EF (Energy Factor) of 1.9 will yield 50% savings in energy use compared to a conventional system.

**how:** Look for qualified professionals to specify and install these systems. The International Ground Source Heat Pump Association (see Resources) maintains a list of certified ground source heat pump system designers and accredited installers.

**considerations:** Energy efficiency experts are undecided on the true efficiency of heat pump water heaters in heating-dominated climates like the Pacific Northwest. During the heating season, if the heat pump water heater is located within the thermal envelope of the home, it is effectively robbing heat from the conditioned space to use for the hot water system, requiring the furnace to work harder. However, such systems are most efficient in the warm months, when they can serve an additional benefit of cooling the home (potentially avoiding the need for air conditioning).

**resources:** The Department of Energy’s Energy Savers program offers information on heat pump water heaters: [www.energysavers.gov](http://www.energysavers.gov) (click on *Heating and Cooling*, then on *Water Heating*)

International Ground Source Heat Pump Association:  
[www.igshpa.okstate.edu/](http://www.igshpa.okstate.edu/)

## Action Item 8-21

Upgrade electric water heater to air to water heat pump or de-superheater on central pump system with an EF of 10.9 or greater

### Points: 2

#### Responsible party:

Plumber

#### Intent:

Reduce energy use associated with domestic hot water.



#### Homeowner Benefit:

Reducing heat loss from the existing water heater via an insulating blanket reduces energy used to maintain hot water—saving on utility bills.



#### Homeowner Benefit:

Heat pump technology is an extremely efficient way to generate heat from electricity—often 3-5 times as efficient as electric resistance heat sources. Well-designed systems can cut water heating related energy bills in half or more.

## Action Item 8-22

Replace electric water heater with ENERGY STAR rated water heating equipment

### Points: 2

#### Responsible party:

Plumber

#### Intent:

Reduce energy use associated with domestic hot water.



**what:** ENERGY STAR water heaters comprise a group of water heating technologies including high efficiency gas storage, gas condensing, gas tankless, solar and heat pump water heaters.

**why:** According to the US EPA, the average household spends \$400-600 on water heating annually, making it the second largest energy expenditure after space heating.

**how:** Find ENERGY STAR qualified water heaters and look into potential local and federal rebates associated with high-efficiency water heaters on the ENERGY STAR website.

**considerations:** Coupling high-efficiency water heating with good plumbing design (Action Items 8-5 and 8-26) and ENERGY STAR clothes washers (Action Item 13-42), faucets (Action Items 8-9 and 8-10) and showerheads (Action Item 8-11) further enhances a home's water heating energy savings, as well as reducing water use and wastewater generation.

**resources:** The ENERGY STAR program sets performance criteria for qualified products: [www.energystar.gov](http://www.energystar.gov) (click on *Products*).



**what:** A heater's efficiency is determined by calculating the Energy Factor (EF), which is based on recovery efficiency (i.e., how efficiently the heat from the energy source is transferred to the water), standby losses (i.e., the percentage of heat lost per hour from the stored water compared to the heat content of the water), and cycling losses. The higher the EF, the more efficient the water heater. Gas storage tank water heaters have an EF between 0.55 and 0.67; 0.58 is typical. Gas tankless systems range from 0.69 to .92, with 0.84 typical. Some high-efficiency models are designed to use propane, which may be up to 30 percent less expensive to operate than electric heaters.

**why:** According to US Department of Energy, water heaters are available that are barely more efficient than ones made 20 years ago. However, technology has advanced dramatically, creating wide variability in the marketplace. Upgrading gas water heater efficiency from an EF of .55 to .60, for instance, will save 18 therms per year. At 1998 national averages for natural gas, this equates to an annual savings of about \$20.

Typical household operational savings will support an additional cost of about \$38. Upgrading a propane water heater from an EF of .55 to .60 will save 16 gallons of propane per year and operational savings will support an additional cost of about \$50.

**how:** This Action Item is worth 2, 4 or 7 points, based on efficiency of the heater.

- EF 0.62 2 points
- EF 0.83 4 points
- EF 0.90 7 points

Find water heaters with the highest EF by visiting the ENERGY STAR website. Water heaters are listed by various specifications, including size and energy factor.

**considerations:** Avoid heat loss by installing "heat traps" when installing a hot water tank on lower floors feeding upper stories. A heat trap is a device that prevents convective heat loss through the pipes leading into and out of a tank. Some new water heaters have factory-installed heat traps.

**resources:** The ENERGY STAR program sets performance criteria for qualified products: [www.energystar.gov](http://www.energystar.gov) (click on *Products*).

The Department of Energy's Energy Savers program describes efficient water heating options for a home: [www.energysavers.gov](http://www.energysavers.gov) (click on *Heating and Cooling*, then on *Water Heating*).

EPA Indoor Air Quality in Homes: Preventing Problems with Combustion Equipment: [www.epa.gov/iaq/homes/hip-combustion.html](http://www.epa.gov/iaq/homes/hip-combustion.html)

## Action Item 8-23

Upgrade gas or propane water heater efficiency to EF 0.62, 0.83, or 0.90

### Points: 2-7

#### Responsible party:

Plumber

#### Intent:

Reduce energy use associated with domestic hot water.



#### Homeowner Benefit:

Advanced water heating technologies can reduce the energy required to heat water by 50% or more, resulting in year-round, ongoing utility bill savings.



#### Homeowner Benefit:

Upgrading to a new, high efficiency gas water heater can substantially reduce water heating-related energy use, typically the second biggest energy user in a household. Depending on the efficiency of the model selected, a high-efficiency gas unit can reduce a home's water heating-related energy use by 30%.

## Action Item 8-24

Install tankless water heater that meets an Energy Factor of 0.83 or better

### Points: 4

#### Responsible party:

Plumber

#### Intent:

Reduce energy use associated with domestic hot water.



**what:** Tankless (also called demand or instantaneous) systems heat the water as it passes through, producing hot water on demand. Heating is activated when water begins to flow through the unit. This saves water at the tap and can save energy that would otherwise be used to store hot water until needed.

**why:** Tankless water heaters can substantially reduce energy use related to heating domestic water. According to the US Department of Energy, households that use 41 gallons of hot water or less daily can realize savings of 24-34% over a conventional storage tank system; homes using large amounts of hot water (86 gallons per day) can realize savings of 8-14%.

**how:** Tankless water heaters are readily available through most home improvement retailers and plumbing suppliers. Be sure to investigate incentives and tax credits available to homeowners that install high efficiency units.

Tankless heaters are limited to their capacity—be sure to size the system to the demand (reducing demand through hot water conservation strategies first). While most tankless gas water heaters now have electronic ignitions, models with pilot lights may still be available. Avoid these units; the gas used to maintain the pilot light essentially negates the energy savings created by eliminating standby losses.

These systems are activated by water flowing through the system, and require a minimum flow rate. With very low flow fixtures, e.g., lavatory faucets with 0.5 GPM aerators, the flow can be too weak to activate the water heater. In such

cases (especially with lavatories far away from the water heater) it may be preferable to install a small on-demand, point-of-use water heater (see Action Item 8-28).

As the potential savings numbers indicate, homes with lower hot water use realize larger savings from switching to tankless systems. Consider all hot water conservation strategies prior to installing a tankless system in order to capture the added savings and to properly size the tankless system.

**considerations:** Efficient distribution of hot water also saves energy. See Action Items 8-26 (install small diameter PEX pipe), and 8-14 (locate water heater within 20 feet of greatest use).

**resources:** The ENERGY STAR program offers information on whole-home tankless water heaters: [www.energystar.gov](http://www.energystar.gov) (click on *Products*, then *Water Heaters*).

The Department of Energy's Energy Savers website includes information for consumers on tankless water heaters: [www.energysavers.gov](http://www.energysavers.gov) (click on *Heating and Cooling*, then on *Water Heating*).

Database of State Incentives for Renewables and Efficiency: [www.dsireusa.org](http://www.dsireusa.org) (click on *Washington State* for information on federal, state and local incentives).



**what:** A timer on an electric water heater turns off the heating element at night or during sleeping hours, depending on occupant schedules, and/or during peak demand times.

**why:** A timer on an electric water heater can save an additional 5-12% of energy used to heat domestic hot water. According to the US Department of Energy, timers cost about \$60, but will pay for themselves in about one year.

**how:** This Action Item is not available to projects using tankless water heaters. According to the Department of Energy, timers on gas-fired tank water heaters do not realize the same energy savings as timers on electric water heaters, due to the pilot light.

Contact your utility to see if they provide a demand management program that reduces your rate during "off-peak" times. If such programs exist make that information part of the Homeowner Operations & Maintenance Kit.

**resources:** The Department of Energy's Energy Savers website includes information for consumers on efficient water heating, including installing timers: [www.energysavers.gov](http://www.energysavers.gov) (click on *Heating and Cooling*, then on *Water Heating*, then on *Energy Efficient Water Heating*)

## Action Item 8-25

Install a timer to regulate standby energy losses in water heater

### Points: 1

#### Responsible party:

Plumber

#### Intent:

Reduce energy use associated with water heater standby losses.



#### Homeowner Benefit:

Depending on water use volumes, tankless water heaters can substantially reduce energy use related to water heating—reducing related energy bills by one-third.



#### Homeowner Benefit:

Electric water heater timers reduce energy use related to "standby losses" resulting from maintaining hot water at all times. Installing a timer can save a household about \$60 in energy bills annually—paying for themselves in about a year.

## Action Item 8-26

Install small diameter PEX pipe

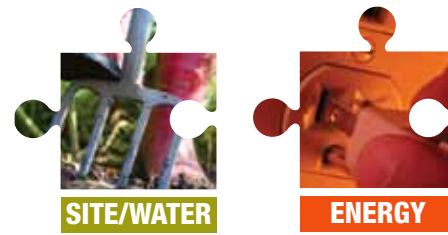
### Points: 1

#### Responsible party:

Plumber

#### Intent:

Reduce energy and water use associated with hot water distribution.



**what:** Due to fact that the walls of PEX piping are thicker than those of copper piping, the inner diameter of similarly sized copper and PEX pipe is smaller. This smaller diameter means there is a smaller volume of water in a length of PEX pipe compared to copper pipe and the PEX pipe delivers water to the fixture faster.

**why:** According to the NAHB Research Center, installing 3/8" diameter PEX piping can reduce hot water delivery time by 18% compared to 1/2" copper pipe.

**how:** Specify the smallest diameter piping that can deliver the flow needed at the fixture. Work with plumbing contractors to communicate the water conservation goals of the remodel.

**resources:** *Design Guide: Residential PEX Water Supply Plumbing Systems* (PATH, 2006) offers design guidance for PEX plumbing systems: [www.toolbase.org](http://www.toolbase.org) (click on *Plumbing* in the *Design & Construction Guides* section).



**what:** Drainwater heat recovery (DHR) devices capture waste heat present in wastewater and transfer it to incoming potable water, usually as a preheat for the hot water tank. DHR systems can be non-storage or storage type. Non-storage systems immediately feed warmed water back to the water heater (or to the shower's cold water line), thereby reducing water heating needs. Storage DHR systems include a storage tank.

**why:** A significant amount of heat remains in wastewater. Capturing this waste heat reduces the energy needed to heat water and can increase the capacity of water heaters.

**how:** Not including installation, non-storage style DHR systems cost between \$300-500. For DHR systems to work, the drain and water heater needs to be under the primary shower, and the hot water demand and drain use need to occur simultaneously.

**considerations:** Installing a DHR system in an existing home can be challenging as it requires a substantial length of unobstructed wastewater pipe and the right pipe configuration. For additions, waste pipes can be designed to work optimally with a DHR unit. Using stacked floor plans (Action Item 1-48) can make drainwater heat recovery more effective, by allowing for a single stack for wastewater and easier installation of a DHR unit.

**resources:** ToolBase describes the drainwater heat recovery technology for builders: [www.toolbase.org](http://www.toolbase.org) (click on *Technology Inventory*, then browse for *Drainwater Heat Recovery*)

The Department of Energy's Energy Savers website includes information for consumers on drainwater heat recovery: [www.energysavers.gov](http://www.energysavers.gov) (click on *Heating and Cooling*, then on *Water Heating*)

## Action Item 8-27

Drainwater heat recovery system

### Points: 1

#### Responsible party:

Plumber, Architect

#### Intent:

Reduce home energy use by capturing waste heat from drainwater.



#### Homeowner Benefit:

Small diameter PEX pipe delivers water to fixtures more quickly, saving water and energy by reducing the wait time for hot water and reducing heat loss as water travels from the heater to the fixture.



#### Homeowner Benefit:

Drainwater heat recovery systems help reduce water heating-related energy bills by capturing residual heat in wastewater and transferring it to incoming cold water. This reduces the amount of water heating energy required, saving on energy bills. These systems function with no moving parts, meaning no maintenance over the life of the unit.

## Action Item 8-28

Install on-demand point-of-use hot water supply

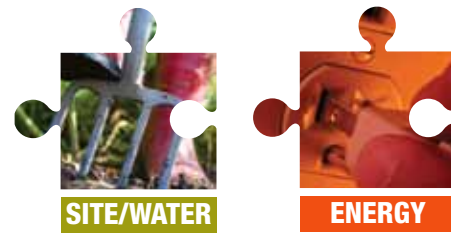
### Points: 2

#### Responsible party:

Plumber

#### Intent:

Reduce energy use related to hot water distribution.



**what:** On demand, or instantaneous hot water systems heat water as needed, either at a point of use or for an entire house. Triggered by water flow when a tap or other hot water draw is turned on, these systems heat the water as it passes through.

**why:** The benefit of demand hot water systems is the avoidance of standby losses. Point-of-use heaters also save water at the tap, by eliminating the need to run the tap until hot water arrives. This is especially true in homes with high efficiency faucet aerators, which by definition extend the time it takes water to reach the tap from the main heater.

**how:** This Action Item applies to point-of-use on-demand water heaters. For whole-house demand (tankless) systems, see Action Item 8-24). Since a limited amount of water can be drawn off at any one time, this option should be considered for intermittent and low volume demand needs.

These systems deliver the largest energy payback when installed on fixtures that are the greatest distance from the hot water source, and the fixture(s) hot water lines are disconnected. When remote lavatory faucets are outfitted with high efficiency aerators, e.g., 0.5GPM (see Action Item 8-9), they become good candidates for small-capacity point of use water heaters.

**considerations:** Electric on demand systems draw substantial amounts of power when activated. Some electric utilities do not advocate the use of electric on demand water heating (especially for whole-house use) due to the potential for the installation of large numbers of such systems in a service territory to cause system overloads.



**what:** If installing a solar water heating system (see Action Item 1-26) is not a part of the homeowner's current remodeling plans, it is still possible to pre-plumb the house during construction to allow for solar water installation at a later date.

**why:** As energy prices rise and fuel availability becomes uncertain, pre-piping the house for solar water heating makes retrofitting this system into a remodeling project so much easier—a real selling point to potential future homebuyers.

**how:** Work with a plumber with experience installing solar hot water systems to identify optimal locations for plumbing lines. The Department of Energy's *Homebuilder's Guide to Going Solar* (p. 7; see Resources) offers the following tips for pre-plumbing:

- Install 3/4" copper pipe (both cold and hot lines) from the roof to the storage tank location, capped and accessible from the top, and dead ended from the bottom.
- Insulate pipe.
- Run sensor wires parallel to the pipe, depending on the expected system.
- Install electric cable for future pump.
- Leave space near water heater for storage tanks, expansion tanks, heat exchangers etc.
- Provide literature for the recommended system, installers information etc. in the Homeowner Operations and Maintenance Manual.

This Action Item is easiest and most economical to accomplish when incorporated into other plumbing activities. Additionally, it is facilitated by having unobstructed access to wall cavities where plumbing chases will run (e.g., during insulation or ventilation system upgrades).

**considerations:** Be sure to consider the shading and orientation of future solar hot water panels when designing roof angles and dormer details, as well as landscape features such as trees. Additionally, consider the placement of future photovoltaic panels (see Action Item 1-27) and their space needs simultaneously.

**resources:** The Department of Energy's Energy Savers website includes information for consumers on solar hot water: [www.energysavers.gov](http://www.energysavers.gov) (click on *Heating and Cooling*, then on *Water Heating*)

*A Homebuilder's Guide to Going Solar* by the US Dept. of Energy's Office of Energy Efficiency and Renewable Energy (2008). Available as a free PDF download from: [www.eere.energy.gov/](http://www.eere.energy.gov/) (click on *Find Publications and Products*).

This guide provides an overview of the design, construction and marketing considerations when adding solar electric and solar hot water features to a home.

## Action Item 8-29

Pre-plumb for solar water heater

### Points: 2

#### Responsible party:

Plumber, Expert

#### Intent:

Facilitate the retrofit of a home for solar water heating.



#### Homeowner Benefit:

Properly sized and placed point of use on-demand water heating can help reduce energy use related to heating and delivering water to remote fixtures. While this energy benefit can be small compared to other energy conservation techniques, these units provide a substantial water conservation benefit by eliminating wait time for hot water to reach a fixture.



#### Homeowner Benefit:

Prepping a home for future solar hot water installation creates a double benefit: for the current homeowner, it makes it less costly and disruptive to install a system down the road; for prospective home buyers it becomes a talking and selling point, making the home more marketable.

## ELECTRICAL

A home's electrical system involves elements related to lighting controls, ventilation, and suitability for renewable energy technologies such as photovoltaics. Designing flexibility into the system is central to creating a high performance home.



## Action Item 9-1

Install thermostat with on/off-switch or smart timer for furnace fan to circulate air

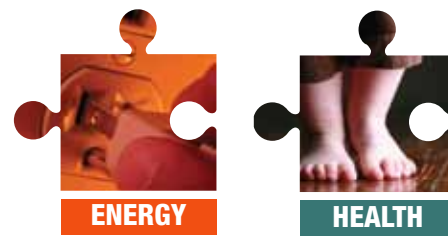
### Points: 1-2

#### Responsible party:

Electrician

#### Intent:

Reduce heating and cooling energy use by allowing the furnace fan to act as supplemental heating and cooling unit.



**what:** A thermostat with an air circulation switch allows an occupant to use the furnace fan to circulate air that has stratified while the furnace is not running, and to circulate air on warm days to produce a cooling effect without using air conditioning. Smart recovery (also called adaptive recovery) features sense the time it takes to reach a programmed temperature and adjust the furnace function accordingly.

**why:** Mixing air can help warm or cool a space, depending on the season. This can create energy savings in the form of getting heat or cooling to the place it's desired.

**how:** This Action Item is worth 1 or 2 points.

- Thermostat with on/off switch: 1 point
- Smart recovery and thermostat with on/off switch: 2 points

Look for thermostats with a “fan” option; many ENERGY STAR programmable thermostats have this feature. Communicate the project goals to the HVAC contractor.

**resources:** The ENERGY STAR program provides information on selecting and purchasing programmable thermostats: [www.energystar.gov](http://www.energystar.gov)



#### Homeowner Benefit:

The added control offered by thermostats that include fan on/off switches and smart timers result in increased comfort, reduced heating and cooling expenses, and a smaller carbon footprint.



**what:** EPA estimates that ENERGY STAR qualified programmable thermostats, when programmed properly, can save a household \$180 per year in heating costs.

Most of the latest generation programmable thermostats perform one or more of the following energy control functions:

- Store and repeat multiple daily settings, which can be manually overridden without affecting the rest of the daily or weekly program.
- Store four or more temperature settings a day.
- Adjust heating or air conditioning turn-on times as the outside temperatures change.

Pre-programming thermostats entails interviewing the homeowner to determine the optimal heating/cooling schedule for the home, and then entering those parameters into the thermostat's program function.

**why:** Programmable thermostats reduce energy use by providing heat only when and where required. By having a professional pre-program the thermostat, a project can help ensure the device is properly set to optimize energy use based on occupants' comfort parameters and lifestyle.

**how:** ENERGY STAR programmable thermostats are readily available at home improvement centers and building materials retailers. Visit the ENERGY STAR website to identify models with features that meet the needs of the household.

**considerations:** If de-commissioning an existing thermostat, be aware that many older thermostats contain large amounts of mercury in the tilt-switch mechanism. Look for HVAC contractors that are partners with the Thermostat Recycling Corporation, which manages mercury-containing thermostats at no charge and communicate the homeowner's desire for environmental stewardship on the remodel, or contact the local hazardous waste management program for information on where to recycle mercury thermostats.

#### resources:

ENERGY STAR recommendations for programming thermostats: [www.energystar.gov](http://www.energystar.gov) (click on *Products*, then *Heating and Cooling*, then *Programmable Thermostats*).

Mercury-containing thermostat disposal via the Thermostat Recycling Corporation: [www.thermostat-recycle.org](http://www.thermostat-recycle.org)

## Action Item 9-2

Install programmable thermostats and pre-program

### Points: 2

#### Responsible party:

Electrician, HVAC

#### Intent:

Reduce household energy use by optimizing operation of HVAC equipment.



#### Homeowner Benefit:

Increase the energy efficiency of the home heating/cooling system, reducing energy use and the home's carbon footprint.

## Action Item 9-3

Install timer control integrated with thermostat on continually running HRV

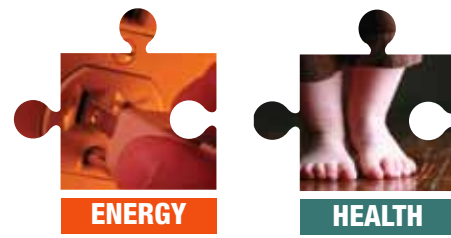
### Points: 3

#### Responsible party:

Electrician

#### Intent:

Reduce energy use related to ventilation by optimizing operation.



**what:** New programmable ventilation timers integrated with the thermostat for whole house central fan supply ventilation systems allow for monitoring the air handler to meet the fresh air requirements of the house. The timer works by taking advantage of the free distribution of ventilation air during thermostat driven heating or cooling operations, and provides periodic whole house ventilation during periods when the thermostat-driven heating or cooling is not in operation.

**why:** Controls help reduce energy demand of a system by allowing them to operate when needed, rather than continuously.

**how:** Specify a timer control system when selecting an HRV system from the HVAC contractor. Programmable ventilation controls can also measure humidity and indoor contaminants to activate systems based on these criteria as well.

This credit is for adding a timer control. See Action Item 1-42 for information on providing balanced or slightly positive air pressure in the home.



**what:** Mercury is a highly persistent, bioaccumulative toxic substance (PBT) that historically been used for a wide variety of purposes in commerce. In electrical equipment, it has been used to create tilt-switches and other controls for turning equipment off and on. While manufacturers of building equipment have made substantial progress in reducing or eliminating mercury in building system control devices, some HVAC and building equipment on the market today still contain mercury components. PBTs are a class of substances that have been targeted for phase-out due to their public health and environmental risk. (See Resources for more on PBTs.)

**why:** Mercury's toxicity and bioaccumulative nature makes it a priority element for elimination in building materials. Mercury-free alternatives are readily available, and eliminate the need to manage toxic building components down the road, as well as removing the risk of toxic exposures.

**how:** Specify mercury-free components for system controls. Manufacturers now regularly advertise their mercury-free products, and nonprofit organizations produce lists of mercury-free HVAC components, including thermostats (see Resources).

Old thermostats often contain large amounts of mercury. Make sure the HVAC contractor properly recycles old thermostats through the Thermostat Recycling Corporation, an organization funded by thermostat manufacturers to manage mercury-containing thermostats.

**resources:** Washington State Department of Ecology has organized a PBT Initiative to identify and eliminate these substances: [www.ecy.wa.gov/programs/swfa/pbt/](http://www.ecy.wa.gov/programs/swfa/pbt/)

Inform, a New York based environmental nonprofit, maintains information on mercury and HVAC equipment: [www.informinc.org/fact\\_P3hvac.php](http://www.informinc.org/fact_P3hvac.php)

## Action Item 9-4

Use heating system controls that are free of mercury

### Points: 1

#### Responsible party:

Electrician, HVAC

#### Intent:

Reduce the overall environmental and health impact of mercury by avoiding it in new products.



#### Homeowner Benefit:

Timer controls save energy on ventilation system operation, reducing energy bills.



#### Homeowner Benefit:

Eliminating toxics in the first place eliminates the risk of later toxic exposures to occupants, and it eliminates the need for complicated disposal methods at the end of a product's service life.

## Action Item 9-5

Install 60-minute timer switches or humidistat for bath exhaust and laundry fans or HRV override switch

### Points: 1

#### Responsible party:

Electrician

#### Intent:

Protect indoor air quality, occupant health and building durability by managing indoor moisture levels.



**what:** Timer switches for bath and laundry rooms provide a time-based ventilation assist to rooms when moisture levels dictate additional ventilation.

Humidistats automatically engage additional ventilation when humidity levels reach a certain level.

Boost controllers work with whole-house ventilation systems where the fan is running continuously at low speed. The controllers allow the system to be temporarily boosted to a higher speed when an occupant wants spot ventilation.

**why:** Such systems provide homeowners the option for manual and/or automatic controls. Occupants are more likely to use an exhaust fan with a crank timer switch, avoiding moisture buildup and eventual mildew problems in bathrooms, kitchens, or laundry rooms.

**how:** Specify timers or humidistats when installing bath and laundry ventilation fans, and include space for controls (usually an additional space on the switch plate or a separate plate) on the electrical plans.

Timers designed to work with Heat Recovery Ventilators (see Action Item 7-14 for more on HRVs) are also available, to serve as an override switch to turn the HRV on high speed for 15 minutes.

Timers can be installed in all areas of the house that require periodic or spot ventilation. The override switch can also be used with systems designed with remote sensors tracking relative humidity. The occupant can use the manual switch to turn on the system.

**considerations:** Fan timers should be coupled with efficient, quiet fans. Look for ENERGY STAR qualified fans (see Action Item 9-11) with a sone (noise measure) rating of 1 or less.

**resources:** The National Association of Home Inspectors has written an informative article, "Bathroom Ventilation Ducts and Fans:" [www.nachi.org](http://www.nachi.org) (click on *Inspection Articles*, under *Articles and Links*).



**what:** A garage exhaust fan helps exhaust automobile fumes from the garage space. An exhaust fan on a timer will engage on a regular cycle; a fan wired to the garage door opener will activate only when the garage door is operated.

**why:** Studies have shown that carbon monoxide and other toxic compounds and particulate materials in automobile exhaust can enter the home from the attached garage. Frequently, the leaky forced air heating system serves as a conduit between the garage and living space of the home.

**how:** The first step in reducing occupant exposure to car exhaust and garage contaminants is to eliminate air transmission routes between the garage and the living space. See Additional Considerations for more information.

To achieve points for this Action Item, install an exhaust fan, operated by timer or wired to the garage door opener. This Action Item cannot be taken in conjunction with Action Item 1-33.

**considerations:** The best way to minimize potential exposures is to eliminate the garage altogether, build a detached garage, or air seal the garage from the house and equip it with an automatic exhaust fan. See Action Item 1-33 for more on this approach. Sealing the ductwork and HVAC equipment can also significantly reduce this air movement from the garage to the living space.

See Action Item 1-33 for resources related to garages and indoor air quality.



#### Homeowner Benefit:

Ventilation timers and humidistats make it easy to provide adequate ventilation without having to remember to return later to turn off the fan. This, in turn, enhances indoor air quality and building durability by reducing mold, mildew and rot.

## Action Item 9-6

Install exhaust fan in attached garage on timer or wired to door opener

### Points: 2

#### Responsible party:

Electrician

#### Intent:

Protect indoor air quality and occupant health.



#### Homeowner Benefit:

Keeping polluted garage air out of the house helps protect against the intrusion of contaminants into the house, compromising, indoor air quality and occupant health.

## Action Item 9-7

Install photo cells, timers, and/or motion detectors (interior)

### Points: 3

#### Responsible party:

Electrician

#### Intent:

Reduce a home's energy use related to lighting.



**what:** Photo Cells are thin-film devices that work by generating a current when exposed to light and are used as a light sensor for lighting devices.

Timers can be located at a light switch, a plug, or in a socket, and are available as both mechanical and solid state. Some offer the option of a manual override. In addition, some screw base compact fluorescent bulbs cannot be used with timers; check manufacturer's recommendations.

**why:** Motion detectors or occupancy sensors can result in significant energy savings, especially in bathrooms and bedrooms where lights are frequently left on. Sensors can have manual on/off switches or can operate entirely automatically.

**how:** There are several choices of wall-mounted dimmers: toggle, rotary, sliding, solid-state touch, and new integrated systems with remote controls that can recall previous lighting levels. If several high-wattage incandescent lamps are to be controlled at one point, add a hard-wired dimmer.

Consider motion detectors and photosensors for energy efficiency. Dimmers allow one light to serve many purposes; also, most incandescent bulbs use less energy and last longer when used at lower levels. Look for full-range dimmers that vary the light continuously from off to full brightness. Dimmers can be used with incandescent lights, including low voltage systems, and with some compact fluorescents (be sure to install dimmable CFLs if using dimmer switches).

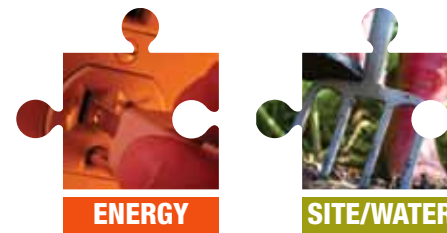
Motion detectors should not be used with some compact fluorescents, or with high intensity discharge lights because of their inability to relight quickly. Some models feature dimmers that reduce light to a preset level; others come with photosensors that turn lights on only when the light level is below a preset point and motion is detected.

Photo cells, timers, occupancy and vacancy sensors, and dimmers all have different qualities that make them more or less suited to a particular application. Consult with your lighting supplier and/or an interior design professional with experience in lighting design for an optimal lighting design and hardware selection strategy, and communicate lighting design goals, and any formal lighting designs, to the electrician.

**considerations:** Light sensing controls are increasingly used to control outdoor lights along driveways and walkways (see Action Item 9-8). Be sure to consider daylighting strategies, including light tubes (Action Item 1-21) and clerestories (Action Item 1-20), as well as the general passive solar design approach (Action Item 1-22) when determining the most appropriate lighting controls.

**resources:** The Green Home Remodel *Lighting* guide provides efficient lighting information for homeowners: [www.seattle.gov/dpd/greenbuilding/](http://www.seattle.gov/dpd/greenbuilding/) (click on *Green Remodel Guides*).

*The Lighting Pattern Book for Homes* by Russell Leslie and Kathryn Conway.  
[www.lrc.rpi.edu/patternBook.asp?id=13306](http://www.lrc.rpi.edu/patternBook.asp?id=13306)



**what:** See Action Item 9-7

**why:** See Action Item 9-7

**how:** See Action Item 9-7

In addition to lighting efficiency outdoors, it's important to consider two other factors: safety, and light pollution. Outdoor lighting should highlight any trip hazards present, and provide a low, even light that avoids bright and dark spots (the dark adapted eye will focus on the light areas, making it difficult to see dangers lurking in the shadows). Also, couple the outdoor lighting strategy with the indoor lighting controls—see Action Item 9-7 for information on these technologies for use in interior applications.

**considerations:** See also Action Item 9-14 for additional credit available for installing energy efficient outdoor lighting.

#### resources:

The Efficient Lighting Fixtures List provides room-by-room advice on efficient lighting:  
[www.elflist.com](http://www.elflist.com)

The *Green Home Remodel* Lighting guide provides efficient lighting information for homeowners: [www.seattle.gov/dpd/greenbuilding/](http://www.seattle.gov/dpd/greenbuilding/) (click on *Green Remodel Guides*).

*The Lighting Pattern Book for Homes* by Russell Leslie and Kathryn Conway. Available for free download from the Lighting Research Center:  
[www.lrc.rpi.edu/patternBook.asp?id=13306](http://www.lrc.rpi.edu/patternBook.asp?id=13306)

The International Dark Sky Association "Practical Guide 3: Residential Lighting" describes how to minimize residential light pollution: [www.darksky.org](http://www.darksky.org) (click on *Quality Lighting*, then *Homeowner's Guide*).



#### Homeowner Benefit:

Technologies that automatically switch lights on and off depending on natural light levels, occupancy, time of day or other factors help reduce energy by avoiding reliance on humans to remember to be energy efficient. Reduced energy use translates into lower electricity bills.

## Action Item 9-8

Install photo cells, timers, motion detectors (exterior)

### Points: 2

#### Responsible party:

Electrician, Lighting Designer

#### Intent:

Reduce a home's energy use related to lighting.



#### Homeowner Benefit:

Technologies that automatically switch lights on and off depending on natural light levels, occupancy, time of day or other factors help reduce energy by avoiding reliance on humans to remember to be energy efficient. Reduced energy use translates into lower electricity bills.

## Action Item 9-9

Install whole house fan beyond code requirements

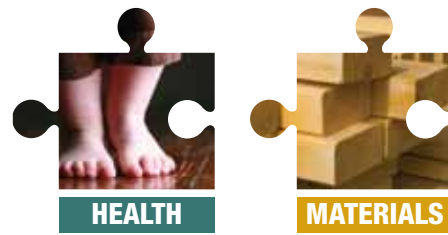
### Points: 2

#### Responsible party:

Electrician

#### Intent:

Protect occupant health and comfort by providing proper levels of ventilation to the home.



**what:** Whole house fans can be set up either to exhaust air from the home or to supply fresh air to the interior of the home. When set up and operated properly, whole house fans provide consistent fresh airflow to occupied spaces. They are an especially critical component in a tight house, one with infiltration at or below .35 air changes per hour measured at 50 Pascals pressure using a blower door test (see Action Item 10-11).

**why:** Installing a ventilation system that performs beyond code provides an added level of certainty that occupants are receiving sufficient fresh air.

**how:** If a whole house fan is set up to exhaust, the system must provide outside make up air to maintain balanced air pressure and prevent backdrafting from fuel burning devices. If set up as a supply fan, the system must include either passive or mechanical venting so that air pressure in the home is only slightly positive. If too high, the air pressure in the home will force moisture into the walls of the home, creating moisture issues (see Action Item 1-42 for information on providing balanced or slightly positive air pressure in a home).

Whole house fans work best when ducted to at least four locations in the house.

Beyond code elements include:

- Using only smooth, 4" diameter minimum ducting for bath fans operating at less than 80 CFM.

- Minimizing the length of ductwork for bath fans of 50-80CFM to less than 10 feet, and ideally six feet or less.
- Kitchen fans (maximum: 300 CFM) use less than 50' of ductwork (see Action Item 7-33 for more on kitchen ventilation)
- Installing a timer control integrated with the thermostat with balanced or positive pressure.

Homeowners must understand how to properly operate and maintain their whole house ventilation system. This information should be clearly explained to them and be provided as part of the Homeowner's Operations and Maintenance Manual.

**considerations:** Consider including a Heat Recovery Ventilator to reduce the energy penalty associated with increased ventilation (Action Item 7-14).

**resources:** The US Department of Energy Building Technologies Program Technology Fact Sheet: "Whole House Ventilation Systems: Improved control of air quality" describes the types of whole house ventilation systems, controls, design and installation criteria. Available through the DOE Building America program: [www1.eere.energy.gov/buildings/building\\_america/](http://www1.eere.energy.gov/buildings/building_america/) (search using the keywords *Whole House Ventilation*).



**what:** High efficiency ventilating fans are those that carry the ENERGY STAR logo (see Action Item 9-11).

A sone rating identifies the noise level created by a fan.

Smooth ductwork is usually formed from galvanized steel or aluminum, and is free from corrugations and other surface irregularities.

**why:** High efficiency fans use less electricity for operation and quiet fans will be used more readily, promoting indoor air quality and reducing energy consumption.

**how:** Look for ENERGY STAR ventilation fans, properly sized for the application.

Additionally, this Action Item requires the replacement of any flexible, corrugated ductwork to smooth ductwork with a minimum diameter of 4".

**resources:** The ENERGY STAR program: [www.energystar.gov](http://www.energystar.gov) (click on *Products*).

## Action Item 9-10

Replace all existing vent fans with higher efficiency units (quiet and rated to 1.5 sones or less), with smooth ducting (minimum of 4 inches) or other quiet ventilation strategy

### Points: 3

#### Responsible party:

Electrician

#### Intent:

Protect occupant health and indoor air quality by ensuring proper ventilation.



#### Homeowner Benefit:

Whole house fans provide fresh air to occupants, expelling stale air and any accumulated contaminants. This helps protect indoor air quality and human health.



#### Homeowner Benefit:

Higher efficiency, low-sone fans and smooth ductwork will be quieter and use less electricity, reducing ventilation-related energy expenses and helping protect indoor air quality and reduce the risk of moisture damage.

## Action Item 9-11

Install ENERGY STAR exhaust fan

### Points: 2

#### Responsible party:

Electrician

#### Intent:

Reduce energy use related to home ventilation.



**what:** ENERGY STAR ventilation fans are identified by the ENERGY STAR logo, which lets the consumer know that the product is a top performer in its product category.

**why:** ENERGY STAR ventilation fans can be up to 70% more energy efficient than industry averages, and can save substantially on operating costs, especially for continuously or frequently running units.

**how:** Check the ENERGY STAR website for qualified units.

Make sure ventilation fans are properly sized for the job to avoid creating backdrafting hazards in the home (see Action Item 7-33 for information on properly sizing kitchen fans). In addition, properly size and design exhaust ductwork; undersized and complicated or long duct runs decrease the efficiency of the fan. Make sure all fan ductwork terminates outside the home; it is a common problem to have existing fan ducts terminate in the attic, where they can create major moisture problems. Avoid roof penetrations (and the opportunity for leaks) by exhausting fans through the home's exterior walls.

**resources:** The ENERGY STAR program provides information on selecting efficient ventilation fans (click on *Products*, then *Heating and Cooling*): [www.energystar.gov](http://www.energystar.gov)

Building Science Corporation  
Building Science Primer 042: "Read This Before You Ventilate" provides practical information on proper ventilation for a home: [www.buildingscience.com](http://www.buildingscience.com) (click on *Information*, then search for *042*).



**what:** ENERGY STAR ceiling fans are rated by the US EPA and Department of Energy for energy efficiency. Certified fans are, on average, 50 percent more energy efficient than the industry average.

**why:** Ceiling fans provide a cooling effect by moving air past the skin. The effect can help an occupant remain comfortable at higher ambient temperatures, reducing the need for mechanical cooling.

**how:** Provide wiring and switching needed for one or more ceiling fans in the electrical plan, and install fan(s). Find ENERGY STAR rated ceiling fans on the ENERGY STAR website (see Resources).

**considerations:** Coupling ceiling fans with other low-energy ventilation strategies, such as strategically placed windows that allow for cross ventilation (Action Item 1-43) and landscaping that reduces energy consumption naturally (Action Item 1-25) helps create a mutually reinforcing set of approaches to indoor comfort, and can eliminate the need to provide mechanical air conditioning to a Pacific Northwest home.

#### resources:

The ENERGY STAR program provides information on selecting efficient ceiling fans: [www.energystar.gov](http://www.energystar.gov) (click on *Products*, then *Heating and Cooling*).



#### Homeowner Benefit:

ENERGY STAR exhaust fans can save considerable amounts of energy over the lifetime of the unit, especially fans used for continuous ventilation. Along with reduced energy bills related to these energy savings, a homeowner often will experience a quieter, more trouble-free fan due to performance requirements related to these factors as well.

## Action Item 9-12

Properly install one or more ENERGY STAR ceiling fan(s)

### Points: 1

#### Responsible party:

Electrician, Architect

#### Intent:

Reduce energy use related to home cooling and ventilation.



#### Homeowner Benefit:

A ceiling fan can be used as a low-energy alternative to mechanical air conditioning to provide cooling on hot summer days.

## Action Item 9-13

Reuse electrical fixtures that meet or can be modified to meet code

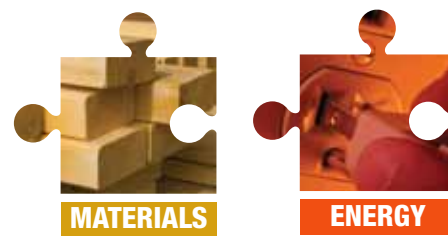
### Points: 1

#### Responsible party:

Contractor, Electrician

#### Intent:

Reduce raw material extraction and energy use related to manufacturing and distributing new building products.



**what:** Electrical fixtures that can be reused in a remodel include electrical outlets, light switches, and light fixtures. Many lighting fixtures can be modified to accept compact fluorescent or LED (light emitting diode) lighting technology.

**why:** Upgrading lighting fixtures to accept more efficient light sources helps reduce a home's energy bills and its carbon footprint. In the summertime, more efficient lighting also helps keep a home cool by reducing the waste heat associated with incandescent lighting, which wastes 90% of the energy used by the bulb, emitting it as heat rather than light.

**how:** Consult with electrical subcontractors about modifying existing electrical fixtures to ensure it can be done safely and effectively. In many cases, simple screw-in compact fluorescent bulbs can fit most fixtures designed for incandescent bulbs. Cove lighting installations can be retrofitted with LED strip lights or linear fluorescent lighting.

**considerations:** Be sure to balance the benefits of reuse with energy efficiency and safety. Lighting designed for incandescent may not work well with other light sources (especially LED lighting, which tends to offer bright, direct light very different from an incandescent bulb). Additionally, some old electrical fixtures may contain lead-based paints, asbestos components, or, in the case of old fluorescent lighting, PCB-containing ballasts. Some older light switches (specifically "silent" switches) can contain mercury. Any fixtures containing hazardous materials should be properly disposed.

See Action Items 9-14, 9-15 and 9-16 to learn more about ENERGY STAR lighting options.

**resources:** The Building Materials Reuse Association provides a directory of used building materials retailers and salvage consultants: [www.bmra.org](http://www.bmra.org)

The *Green Home Remodel Salvage and Reuse* guide provides general information on building materials salvage and reuse: [www.greentools.us](http://www.greentools.us) (click on *Residential Buildings*, then *Residential Remodeling Guides*).

The ENERGY STAR program provides information on efficient lighting options: [www.energystar.gov](http://www.energystar.gov) (click on *Products*, then *Lighting*).



**what:** A lighting intensity of 1.1 Watts per square foot is ample for low-light areas. Watts per square foot is determined by dividing the total wattage of the lighting fixtures in an area by the total area.

**why:** Matching light levels to lighting needs helps conserve energy and can actually increase safety and comfort, by avoiding eyestrain and (in exterior lighting applications) allowing the dark-adapted eye to function properly.

**how:** Specify lighting with the proper lumen level to achieve 1.1 Watts per square foot at the distance from the floor, work surface or ground above which the lighting will be placed.

In outdoor lighting situations, take care to focus light where it's needed and avoid "light trespass" either into adjoining properties or into the night sky. Often, outdoor lighting (e.g., patios and pathways) are sufficiently lit with considerably less than 1.1 Watts per square foot. Work closely with the homeowner to determine optimal light levels, which vary with a person's age and visual acuity. Using light colored, more reflective landscape materials can help reduce the light level needs outside while also reducing unwanted summer heat gain.

**resources:** The ENERGY STAR program lists qualified fluorescent and LED lighting fixtures: [www.energystar.gov](http://www.energystar.gov) (click on *Products*, then *Lighting*, then *Light Fixtures*).

The Efficient Lighting Fixtures List provides room-by-room advice on efficient lighting: [www.elflist.com](http://www.elflist.com)

The *Green Home Remodel* Lighting guide provides efficient lighting information for homeowners: [www.seattle.gov/dpd/greenbuilding/](http://www.seattle.gov/dpd/greenbuilding/) (click on *Green Remodel Guides*).

*The Lighting Pattern Book for Homes* by Russell Leslie and Kathryn Conway. Available for free download from the Lighting Research Center: [www.lrc.rpi.edu/patternBook.asp?id=13306](http://www.lrc.rpi.edu/patternBook.asp?id=13306)



#### Homeowner Benefit:

Reusing existing electrical fixtures helps reduce the cost of a remodel by eliminating the need to purchase a new product. It also can help maintain historic continuity in the home by tying existing and new elements together.

## Action Item 9-14

Lighting average is 1.1 Watts/sq. ft. with all exterior, garage, closet, utility room and under counter lighting are CFLs or LEDs.

### Points: 4

#### Responsible party:

Electrician, Lighting Designer, Architect

#### Intent:

Reduce a home's energy use related to lighting.



#### Homeowner Benefit:

Providing reduced lighting levels where lower light is sufficient for tasks lowers lighting-related energy bills without compromising comfort or safety.

## Action Item 9-15

Install hard-wired fluorescent or LED fixtures, with 1 point for each 10% of Lighting

### Points: 1-10

#### Responsible party:

Electrician

#### Intent:

Reduce a home's energy use related to lighting.



**what:** Hardwired fluorescent fixtures are fixtures with integrated fluorescent ballasts, dedicating the fixture to fluorescent use and making it impossible to replace the fluorescent bulb with an incandescent bulb. Such fixtures have either pin or twist-lock sockets as opposed to conventional screw-in incandescent style sockets.

**why:** High-efficiency fluorescent lighting fixtures use a quarter of the energy of their incandescent ancestors. The purpose of hard-wiring fluorescent fixtures is to guarantee they will stay as dedicated fluorescent fixtures without the possibility of reverting to incandescent bulbs that do not offer the same energy efficiencies. New systems are available with a twist-lock ballast (GU-24), which makes it very compact and easily replaceable, as well as making it easy to change the wattage of the bulb.

**how:** This Action Item is worth 1-10 points.

- 1 point per 10% of lighting
- Maximum of 10 points.

Percentage is determined as a fraction of the total number of lighting units inside the home (See Action Item 9-14 for exterior fixtures). Look for ENERGY STAR qualified fluorescent lighting fixtures and bulbs, as it meets standards for bulb longevity, rapid warm up, and lumen output and color rendering. Pick a color rendering that meets the needs of the space (warmer colors for ambient lighting, and cooler colors for task lighting).

**considerations:** All fluorescent bulbs contain a small amount of mercury. Be sure to provide information on spent mercury bulb recycling to the homeowner in the Operations and Maintenance Manual (see Resources).

**resources:** The ENERGY STAR program lists qualified fluorescent and LED lighting fixtures: [www.energystar.gov](http://www.energystar.gov) (click on *Products*, then *Lighting*, then *Light Fixtures*).

The Green Home Remodel Lighting guide provides homeowners with information on efficient lighting strategies throughout the home: [www.seattle.gov/dpd/greenbuilding/](http://www.seattle.gov/dpd/greenbuilding/) (click on *Green Remodel Guides*).

*The Lighting Pattern Book for Homes* by Russell Leslie and Kathryn Conway. Available for free download from the Lighting Research Center: [www.lrc.rpi.edu/patternBook.asp?id=13306](http://www.lrc.rpi.edu/patternBook.asp?id=13306)



**what:** According to a Tacoma Power study, the fixtures most likely to be on more than three hours per day in the winter months were in the kitchen, followed by the porch, living room, and other outdoor lighting.

Lighting represents 20 percent of a typical home's electric bill, according to the US EPA.

**why:** Fluorescent lighting uses about 1/3 the electrical energy as incandescent lighting. Lamps that are on three hours per day can provide a simple payback to the homeowner in less than 3 years if the upgrade cost is less than \$15. Look for rebates offered by local electric utility programs. Fluorescent lamps are expected to last 10,000 hours.

Due to higher up-front cost, LED lighting has longer payback periods than fluorescent, but avoids mercury issues and is substantially more energy efficient than fluorescent. Additionally, LEDs can last 30,000 hours or longer, making them ideal for lighting in difficult to reach areas.

**how:** This Action Item is worth 2 or 5 points

- Compact fluorescent or linear fluorescent: 2 points
- LED: 5 points

Both fluorescent and LED lighting come in screw-in varieties, which allow for installation in existing incandescent bulb sockets. However, such bulbs can be easily removed by occupants. Dedicated fixtures ensure the original high efficiency lighting remains in place.

Consult with the homeowner to determine the locations likely to be highest use in the home. Look for ENERGY STAR qualified compact fluorescent bulbs, as well as qualified fluorescent and LED fixtures as they are rated not only for energy efficiency but also for service life, color rendering, and the speed at which they reach full brightness. Many cut-rate fluorescent bulbs and LED lighting do not meet ENERGY STAR performance criteria, and may not perform as advertised.

**considerations:** See Action Item 9-15 for additional points for hard-wired fluorescent lighting, and Action Item 9-17, for points available for providing replacement bulbs to homeowners.

**resources:** The ENERGY STAR program lists qualified fluorescent and LED lighting fixtures, and fluorescent bulbs: [www.energystar.gov](http://www.energystar.gov) (click on *Products*, then *Lighting*).

The Efficient Lighting Fixtures List offers advice on efficient lighting solutions for every room in the house, and lists of efficient lighting retailers in King County: [www.elflist.com](http://www.elflist.com)

The Lighting Pattern Book for Homes by Russell Leslie and Kathryn Conway. Available for free download from the Lighting Research Center: [www.lrc.rpi.edu/patternBook.asp?id=13306](http://www.lrc.rpi.edu/patternBook.asp?id=13306)

## Action Item 9-16

Use compact fluorescent bulbs, ballast, or fixtures; or LEDs in three high-use locations

### Points: 2-5

#### Responsible party:

Electrician, Lighting Designer

#### Intent:

Reduce a home's energy use related to lighting.



#### Homeowner Benefit:

High efficiency lighting helps reduce a home's overall energy use, which in turn results in lower electric bills. In the summertime, highly efficient lighting produces less unwanted heat, keeping a home more comfortable and reducing the need for mechanical air conditioning.



#### Homeowner Benefit:

High-efficiency fluorescent lighting provides high-quality light with low energy use.



## Action Item 9-17

Furnish four compact fluorescent light or LED bulbs to owners

### Points: 1

#### Responsible party:

Contractor

#### Intent:

Reduce a home's energy use related to lighting.



**what:** Compact fluorescent lights (CFLs) produce light by using an electrical current to excite molecules in a tube coated with special substances that emit light (fluoresce) when struck by the molecules in the bulb. The process is much more efficient than incandescent bulbs, which use electrical resistance to create light (and heat). Fluorescent lighting comes in three primary configurations: linear fluorescent (tubes), integrated ballast CFLs, and GU-24 CFLs.

Light Emitting Diode (LED) technology uses a solid-state technology to create light.

**why:** CFLs cost more initially, but advanced technology enables CFLs to use 75% less energy than a standard incandescent bulb and last up to 10 times longer. Beyond the inherent energy savings of LEDs and CFLs, they also reduce unwanted heat gain caused by incandescent lighting.

**how:** Modular compact fluorescent lights can save the customer even more, because as lamps (bulbs) fail, only the lamp itself, and not the ballast, has to be replaced. Newer, higher quality bulbs produce a warm light with good color rendering, while electronic ballasts eliminate the hum, flicker, and delayed illumination time common with older models.

LEDs are even more energy efficient, often using 1/5th the energy used by incandescent bulbs, and having extremely long service life.

(This Action Item is required for credit in the program if installing screw-in compact fluorescent lighting; see Action Item 9-16.)

Fluorescent bulbs that meet ISO 9000 standards are lower mercury in content. Look for ENERGY STAR qualified lamps, which are evaluated not only for energy efficiency but lamp life, color rendering, and time to full brightness. GU-24 lamps allow for replacement of the lamp without discarding the ballast. Include information in the Homeowner Operations and Maintenance Manual regarding proper recycling of spent mercury-containing fluorescent bulbs.

The quick growth of the LED lighting industry has resulted in a wide disparity in quality among products. The ENERGY STAR program has established performance criteria for LED light fixtures related to flicker, light quality over time, and power draw when off.

The growing buzz about LED lighting has some experts saying the technology may be soon replacing fluorescent lighting as the preferred energy-efficient lighting source. Consider designs that will allow for easy change-out of fluorescent fixtures to LEDs to facilitate this shift.

**resources:** The ENERGY STAR program lists qualified fluorescent and LED lighting fixtures, and fluorescent bulbs: [www.energystar.gov](http://www.energystar.gov) (click on *Products*, then *Lighting*).

Mercury-containing fluorescent lighting must be properly recycled. The King County Local Hazardous Waste Management Program provides information on fluorescent light disposal: [www.govlink.org/hazwaste/mercury/LampsWithHg.html](http://www.govlink.org/hazwaste/mercury/LampsWithHg.html)



**what:** Recessed can lights, also known as recessed fixtures or “downlights,” place the lighting fixture above the ceiling height, often in attic space. Washington State Energy Code requires recessed can lights to be IC (insulation contact) rated, to meet standards for airtightness, and to be installed with a gasket or caulk to between the fixture and ceiling to prevent air leaks.

**why:** Even “airtight” recessed can lights and IC (insulation contact) rated fixtures, if installed improperly, waste energy through leaks around the can itself or by not allowing sufficient insulation near the fixture. Additionally, improperly insulating around a fixture can result in a fire hazard or overheating in the can, reducing bulb life. Various lighting designs avoid the need for recessed lighting, including track lighting, surface mount lighting, wall sconces and fluorescent light coves and light shelves.

**how:** Choose surface mounted lighting options, including track lighting and wall sconces. Recessed can lights placed completely within the thermal envelope of the home (e.g., between a first and second floor) are allowed, as they do not suffer the same energy penalty as cans placed in unconditioned space.

**resources:** The Pennsylvania Housing Research Center Builder Brief 0502: “Air Leakage in Recessed Lighting” discusses this common problem with recessed can lights: [www.engr.psu.edu/phrc](http://www.engr.psu.edu/phrc) (click on *Publications*, then *Builder Briefs*).

ENERGY STAR Qualified Homes: Thermal Bypass Checklist (ENERGY STAR, 2008). This document provides detailed best practice information on construction and insulation installation for optimal thermal performance. A PDF of this document is available for download at: [www.energystar.gov](http://www.energystar.gov) (search for *Thermal Bypass Checklist*)

## Action Item 9-18

No recessed can lights

### Points: 3

#### Responsible party:

Electrician, Architect

#### Intent:

Reduce a home's energy use related to heating.



#### Homeowner Benefit:

Over the life of one CFL, a consumer can avoid replacing up to 13 incandescent bulbs. The super efficient performance of CFLs also means a consumer can save at least \$25.00 in energy costs over the life of each CFL that replaces an incandescent bulb.



#### Homeowner Benefit:

Avoiding recessed can lights helps keep a home's thermal envelope tight by reducing the incidence of air leakage and heat transfer from conditioned space to unconditioned space—reducing heating-related energy bills.

## Action Item 9-19

Install CO detector

### Points: Req

#### Responsible party:

Electrician

#### Intent:

Protect occupants against hazards associated with carbon monoxide exposure.



**what:** Carbon monoxide (CO) is produced by incomplete combustion of materials such as natural gas, wood, coal, oil, kerosene, gasoline, and even tobacco. Sources include wood or gas burning stoves and fireplaces, automobile exhaust from attached garages, and contamination from furnace flue leaks and backdrafting. At low levels, CO causes fatigue in healthy people and chest pains in those with heart disease. At higher levels, symptoms range from impaired vision and coordination, to headaches, dizziness, nausea, and death. A carbon monoxide detector measures the amount of CO in the living space, and sounds an alarm when concentrations get above a certain level (usually 400 parts per million) for a few minutes. CO monitors can be plug-in or hard-wired.

**why:** Home detectors warn occupants of unsafe CO levels and are relatively inexpensive and easy to install.

**how:** CO detectors are available from home improvement retailers. Include hardwiring for CO detectors on the electrical plan.

A CO detector should be installed wherever there is a fuel burning device and near the bedrooms. Check consumer test results before buying. Hardwired models are preferred, as they are less likely to be disabled by occupants or rendered inoperable by dead batteries.

**considerations:** A carbon monoxide detector is a last line of defense against CO poisoning. Make sure a home's ventilation system is properly balanced (Action Item 1-42) and that ventilation fans (especially range hoods) are properly sized (Action Item 7-33). Avoiding combustion appliances (Action Item 1-41) helps dramatically reduce the risk of CO poisoning, as does providing direct venting equipment (Action Item 7-29) and providing a complete separation of the home from the garage (Action Item 1-33). However, occupant behavior also plays a role; for example, indoor use of barbecue equipment or kerosene heaters. Consider providing CO poisoning information in the Homeowner Operations and Maintenance Manual (see Resources).

**resources:** The Consumer Product Safety Committee provides a fact sheet on combustion appliances, useful for inclusion in the Homeowner Operations and Maintenance Manual:  
[www.cpsc.gov/cpsc/pub/pubs/452.html](http://www.cpsc.gov/cpsc/pub/pubs/452.html)

US EPA information on carbon monoxide:  
[www.epa.gov/iaq/co.html](http://www.epa.gov/iaq/co.html)



**what:** Photovoltaic systems consist of a solar array, most often installed on the roof, and an inverter that converts the DC electricity produced by the panels into AC for use in the home or for export to the electrical grid. Wiring must be run between the solar array and the inverter, and then between the inverter and the home's breaker panel. This Action Item provides a route for future installation of a PV system by running wiring or conduit between the attic and the future location of the inverter, near the breaker panel.

**why:** A remodel often creates opportunity for future upgrades. With walls open and subcontractors on site, adding conduit for future PV installation is a minimal expense, and is a value-add to services provided.

**how:** Install conduit or wiring from a space close to the home's electrical service panel (where a future inverter will be located) to the attic, and between the main service panel and the future inverter. This is best accomplished when the walls are open for other upgrades, such as insulation or plumbing.

Conduit is preferred to wiring, to allow flexibility in the gauge of wiring that can be pulled through the conduit, and therefore flexibility in the size of photovoltaic system that can be placed on the roof.

Beyond installing wire or conduit, the Department of Energy's *Homebuilder's Guide to Going Solar* (p. 7; see Resources) provides the following tips for making a home solar ready:

- Provide space near the main service panel for inverters and disconnects.
- Leave space in the panel itself for a power input breaker, and for a 30 amp, double pole breaker (solar feed).
- Minimize the wire run between the service panel and the future photovoltaic array.
- Install an electric disconnect switch for the future solar electric system.
- Leave a copy of the wiring notes and diagram in the service panel.
- Post a sign on the panel door stating that the home is "solar ready."
- Include system schematics and other pertinent details on the recommended system in the Homeowner's Operations and Maintenance Manual.

**considerations:** Consider the placement of a future photovoltaic array in conjunction with panels related to potential future solar hot water systems (see Action Item 8-29). Additionally, locate conduit in response to existing roof orientation and slope, dormers, and any shading from trees or other landscape elements.

#### resources:

*A Homebuilder's Guide to Going Solar* by the US Dept. of Energy's Office of Energy Efficiency and Renewable Energy (2008). Available as a free PDF download from: [www.eere.energy.gov/](http://www.eere.energy.gov/) (click on *Find Publications and Products*).

This guide provides an overview of the design, construction and marketing considerations when adding solar electric and solar hot water features to a home.

## Action Item 9-20

Pre-wire or pre-install conduit for future photovoltaic use

### Points: 2

#### Responsible party:

Electrician, Expert

#### Intent:

Encourage the future installation of renewable energy systems on the home.



#### Homeowner Benefit:

A carbon monoxide detector warns occupants of dangerous levels of the potentially deadly gas, reducing the risk of injury or death related to exposure.



#### Homeowner Benefit:

Running conduit or wire for a future photovoltaic system becomes a selling point down the road, as the home can be marketed as "solar ready" with little up-front cost.

## Action Item 9-21

Provide infrastructure for electric/hybrid vehicle charging

**Points: 2-3**

**Responsible party:**

Electrician

**Intent:**

Reduce a household's transportation-related carbon footprint by encouraging the use of alternative fuel vehicles.



**what:** Infrastructure for vehicle charging consists of access to electricity near the parking space. In most cases, this is a standard 120 volt electrical outlet.

**why:** Alternative transportation helps reduce a household's transportation-related carbon footprint. Providing infrastructure to conveniently charge electric/hybrid vehicles enables homeowners to choose more environmentally-preferable vehicle options.

**how:** This Action Item is worth 2 or 5 points:

- Rough-in an outlet and provide a dedicated circuit:  
2 points
- Install an outlet on a dedicated circuit:  
3 points

The outlet should be located to allow for charging both inside the garage and in the driveway.



### Homeowner Benefit:

Adding the option of electric/hybrid vehicle charging increases the flexibility of a home's parking, for current and future occupants.

## INSULATION

Insulation, the critical component of a home's "thermal envelope," is a major determinant of not only overall energy use but also the comfort of a home. Proper levels of insulation, coupled with air sealing and best installation practices, help ensure a home stays efficient and comfortable.

## Action Item 10-1

Add wall insulation

### Points: 3

#### Responsible party:

Contractor, Insulation

#### Intent:

Reduce a home's energy use related to heating and cooling.



**what:** Insulation comes in a variety of forms, including loose-fill cellulose, rock wool, and fiberglass, fiberglass, denim batts or wool batts, and expanding spray foam. In existing walls where drywall or plaster will be retained, blown-in insulation products are the most feasible. Blown-in insulation products, including cellulose or open cell spray foam, provide the added benefit of air sealing. Cellulose insulation is made from 100% post consumer recycled paper and is usually combined with boric acid or sodium borate as a fire retardant (and carpenter ant and termite repellent).

**why:** Home energy use is a substantial contributor to the US carbon footprint. Reducing energy use through increasing wall insulation helps reduce the home's energy bills, and helps future-proof the home against rising energy prices.

**how:** The type of insulation chosen will determine the installation method. Follow manufacturer's instructions. Blown insulation must be carefully installed to prevent "overblowing," which can affect R-value.

Cellulose insulation can be dry-blown or poured loose-fill into cavities. With exposed studs, it is most commonly damp-sprayed or blown in behind netting. When sprayed or blown in nets, the product leaves few voids, reducing air infiltration and settling. All vertical insulation should be installed with a six-sided air barrier (i.e., each stud bay should have a continuous air barrier). See Resources for details on insulation best practices.

Adding wall insulation in existing homes can be tricky; previously

empty stud bays may have been obscuring water intrusion issues. If the home is having siding replaced, consider re-siding with a "rain screen" siding approach.

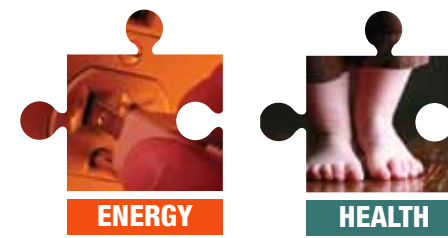
An additional consideration on existing homes is wiring; if the home has old knob-and-tube wiring, it will likely need to be replaced with insulated wiring prior to adding insulation to avoid a fire hazard.

Focus on air sealing the home prior to adding insulation. A home performance test (Action Item 1-16) is invaluable in finding and sealing air leaks.

**considerations:** Evaluate adding insulation to the ceiling, attic, or floors (Action Items 10-2 and 10-3) as well. Adding exterior or interior rigid insulation (Action Item 10-8) in addition to insulation in existing stud bays can dramatically increase a wall's thermal performance, by reducing the thermal bridging that occurs with framing. Beyond the R-value of the insulation options, consider other environmental attributes, including recycled content materials (Action Item 10-7) and materials free from toxins and ozone depleting substances (Action Item 10-9).

The ENERGY STAR program provides consumer information on insulation and air sealing: [www.energystar.gov](http://www.energystar.gov) (click on *Home Improvement*).

ENERGY STAR Qualified Homes: *Thermal Bypass Checklist* provides detailed best practice information on construction and insulation installation for optimal thermal performance: [www.energystar.gov](http://www.energystar.gov) (search for *Thermal Bypass Checklist*).



**what:** Floor insulation usually takes the form of batts installed between floor joists in a crawl space or unheated basement.

**why:** Floor insulation can substantially increase a home's comfort, by reducing the conductive heat loss that occurs through the feet on a cold floor. A warm floor makes a room feel warmer in general, allowing the air temperature in the room to be lowered, potentially saving on heating bills.

**how:** Be sure to air seal the floor prior to adding insulation, paying special attention to plumbing, electrical and ductwork penetrations. (A large hole is usually cut for tub plumbing and left open after tub installation; gaskets to seal this hole are available from home improvement retailers.) Increased levels of insulation can be installed between joists by adding furring to extend the depth of the joists.

Note: insulation must be in full contact with the building shell. Air gaps between insulation and the floor dramatically reduce the insulating value of the assembly, and such gaps are a very common occurrence with floor insulation installations.

**considerations:** Stand-alone improvements in floor insulation can in some instances actually lead to increases in crawl space moisture, and cause frozen water pipes. Insulation and mechanical improvements in the crawl space should be comprehensive (see Action Item 3-21).

#### resources:

The ENERGY STAR program provides consumer information on insulation and air sealing at: [www.energystar.gov](http://www.energystar.gov) (click on *Home Improvement*)

ENERGY STAR Qualified Homes: *Thermal Bypass Checklist*. This document provides detailed best practice information on construction and insulation installation for optimal thermal performance. A PDF of this document is available for download at: [www.energystar.gov](http://www.energystar.gov) (search for *Thermal Bypass Checklist*)

The Department of Energy's Energy Savers resource for consumers includes information on floor insulation: [www.energysavers.gov](http://www.energysavers.gov) (click on *Insulation and Air Sealing*)

## Action Item 10-2

Add floor insulation

### Points: 2

#### Responsible party:

Contractor, Insulation

#### Intent:

Reduce a home's energy use related to heating and cooling.



#### Homeowner Benefit:

Adding floor insulation increases comfort by reducing cold floors, and can reduce energy bills related to home heating.



#### Homeowner Benefit:

Wall insulation reduces energy use and associated energy bills, and increases comfort.

## Action Item 10-3

Insulate entire accessible attic

### Points: 1-3

#### Responsible party:

Contractor, Insulation

#### Intent:

Reduce a home's energy use related to heating and cooling.



**what:** Attic insulation can take the form of blown in products (cellulose, rock wool or fiberglass), batts, or expanding foam. See Action Item 10-1 for descriptions of these materials.

**why:** Attics tend to be a low-cost insulation opportunity, due to their easy accessibility. Many existing attics already have some insulation but it's likely less than current recommended levels.

**how:** Perform a comprehensive air sealing of the attic space prior to adding insulation, including caulking penetrations for wiring and ductwork. Careful attention must be paid to recessed can lights, fireplace and furnace flues, and other elements that can present a fire hazard if improperly insulated. See Resources for an ENERGY STAR guide to safely air sealing and insulating an attic. Care must also be taken to avoid blocking air vents when adding insulation to an attic; use baffles to avoid this.

Blown-in insulation products, including cellulose or open cell spray foam, have an advantage over batt products like fiberglass in that they provide better penetration and filling of cavities and are made from non-toxic materials.

Expanding spray foam insulation can either be open-celled or closed-cell. Closed-cell foam is more dense, offering a higher R-value, greater resistance to air leakage and water vapor and therefore more resistant to mold and moisture damage in comparison to open-cell products. For homes with shallow roof rafters, closed cell foam offers better R-value per inch. Open cell foam products are typically less expensive as they are less dense and

require less material. Additionally, some open cell products are made from low toxic or rapidly renewable materials.

This Action Item is worth 1 or 3 points.

- Add any insulation: 1 point
- Add insulation to provide a total value of R-38 or more: 3 points

Careful installation of blown insulation in attics assures even coverage, avoiding high and low areas with varying R-values, and avoids blocking ventilation paths. Ask how the insulation contractor controls for the proper amount of insulation material and depth.

Some old attics will contain asbestos, either in previous applications of vermiculite insulation, or in fire-proof material surrounding heating ducts. Do not disturb this material, or consult with an asbestos abatement contractor.

**considerations:** Performing a whole-house insulation project will reduce the likelihood of discomfort caused by partial insulation jobs—eliminating cold spots. See Action Items 10-1 and 10-2 above, for information on insulating walls and floors/crawl spaces.

**resources:** ENERGY STAR consumer information: [www.energystar.gov](http://www.energystar.gov) (click on *Home Improvement*).

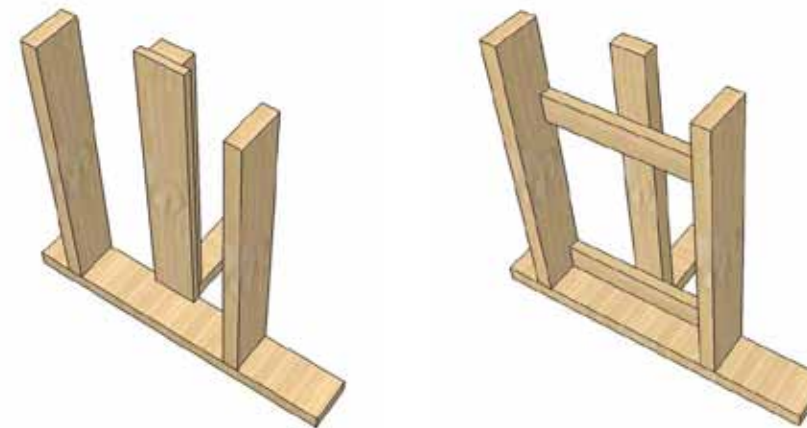
ENERGY STAR Qualified Homes: Thermal Bypass Checklist is best practice information on construction and insulation installation [www.energystar.gov](http://www.energystar.gov) (search for *Thermal Bypass Checklist*).



**what:** Conventional framing at interior/exterior wall intersections places additional framing members in the wall space that could instead be dedicated to insulation, increasing the overall thermal efficiency of the wall assembly.

**why:** Energy-efficient framing practices maintain structural integrity while freeing up space for insulation.

Alternative framing details provide for easy placement of insulation; for example, a “ladder blocked intersection,” as described in the Washington State Energy Code *Builder's Field Guide* (see Resources).



Backing an interior framed wall with 1x6 material (left) or with ladder blocking (right) allows for contiguous insulation in the stud bay, increasing the thermal efficiency of the wall assembly.

Image: David Vandervort Architects, courtesy of the City Green Building, Seattle Department of Planning and Development.

## Action Item 10-4

Fully insulate at interior/exterior wall intersection in addition/remodel structures

### Points: 1

#### Responsible party:

Contractor, Insulation

#### Intent:

Reduce a home's energy use related to heating.



#### Homeowner Benefit:

Fully insulating exterior walls helps increase the building's overall energy efficiency, reducing heating and cooling bills. Additionally, evenly insulating a home's thermal envelope reduces cold spots and temperature differentials, which can lead to condensation, mold growth and even structural damage to the home.

## Action Item 10-5

If using fiberglass insulation, use formaldehyde-free fiberglass insulation or Greenguard certified product

### Points: 3

#### Responsible party:

Contractor, Insulation

#### Intent:

Protect indoor air quality and occupant health by reducing exposure to volatile organic compounds.



HEALTH

**what:** Urea formaldehyde is used as a binder in certain building materials, primarily engineered wood products and fiberglass insulation. Urea formaldehyde releases large amounts of formaldehyde over long periods of time. Formaldehyde is a volatile organic compound that, according to the International Agency for Research on Cancer, is a known human carcinogen (cancer-causing agent). Additionally, it is an irritant even at very low concentrations. Although insulation is usually separated from the living space after construction is complete, air leaks and improper construction practices can lead to occupant exposure.

**why:** Given the ready availability of formaldehyde-free alternatives to standard fiberglass insulation, risking occupant exposure is unnecessary. Featuring healthier building products, such as formaldehyde-free insulation, is also a way to position a remodeling firm as proactive on occupant health issues.

**how:** Formaldehyde-free insulation is available as an alternative to standard fiberglass insulation, as are products certified through Greenguard Environmental Institute, an organization that sets standards and testing protocols for the indoor air quality performance of a wide variety of products.

Formaldehyde-free insulation products prominently display their status and are available through insulation suppliers and home improvement retailers. For Greenguard certified insulation products, search the Greenguard website (see Resources).

**considerations:** Glass fiber insulation itself requires personal protective equipment for installation, due to the hazardous nature of airborne glass fibers if inhaled. Opting for more benign insulation products, such as recycled content cellulose, avoids this issue. See Action Item 10-6.

**resources:** Greenguard Environmental Institute:  
[www.greenguard.org](http://www.greenguard.org)  
(click on *Find Products*).

US EPA information on formaldehyde:  
[www.epa.gov/iaq/formalde.html](http://www.epa.gov/iaq/formalde.html)



HEALTH

MATERIALS

**what:** A wide variety of alternatives to fiberglass insulation exist; see Action Item 10-1 for a list and descriptions.

**why:** Standard fiberglass insulation contains urea formaldehyde, a known human carcinogen (see Action Item 10-5 for more on formaldehyde). In addition, glass fibers themselves are dangerous if inhaled. Avoiding these hazards by using more benign alternatives (including alternatives that are cost-competitive) makes for an easy shift from standard practice.

**how:** Consult with the insulation subcontractor to determine which material will work best for the project. Alternatives to fiberglass insulation are readily available. Select a material that meets the energy efficiency, recycled content, and health and safety goals of the project.

In general, batt insulations are inferior to blown-in insulation in terms of uniformity of coverage and ability to reduce air infiltration—but materials and application methods of even blown-in materials alter their insulation and air sealing abilities.

**considerations:** See Action Item 10-7 for information on choosing recycled content insulation products.

## Action Item 10-6

Insulate with alternatives to fiberglass insulation

### Points: 4

#### Responsible party:

Contractor, Insulation

#### Intent:

Reduce hazards to workers and occupants related to inhalation of glass fiber and exposure to formaldehyde.



#### Homeowner Benefit:

Formaldehyde is an irritant and cancer-causing agent. Eliminating formaldehyde from building materials helps protect occupant health.



#### Homeowner Benefit:

Cost-competitive, energy-efficient alternatives to fiberglass insulation exist that eliminate the inhalation hazards related to the glass fibers that make up the material. Additionally, batt insulation products rely heavily on expert installation to achieve rated efficiency levels—something that is rarely done in the field. Using blown-in non-fiberglass insulating materials can simultaneously reduce health hazards and increase energy efficiency due to better air sealing—resulting in a healthier home and lower heating and cooling bills.

## Action Item 10-7

Use recycled-content insulation (all insulation to have a minimum of 40% recycled-content)

### Points: 2

#### Responsible party:

Contractor, Insulation

#### Intent:

Increase market demand for recycled-content building materials; reduce demand on virgin and non-renewable resources; reduce embodied energy in building products.



**what:** There are three commonly available types of recycled content insulation.

Cellulose insulation is made from 100% post consumer recycled newspapers or telephone books. The insulation can be dry blown or poured loose fill into enclosed cavities, dry blown into netting, or damp sprayed into open stud bays.

Several brands of fiberglass insulation batts are manufactured using recycled glass, including post consumer glass collected in curbside recycling programs.

Mineral wool insulation is another option and is available in loose fill or batts. It has, on average, 75% post-industrial recycled content.

**why:** Specifying recycled content building materials for a project helps reduce a home's environmental footprint by more efficiently using resources. Recycled-content insulation products have a good track record at this point, reducing uncertainty of product performance that can concern some homeowners and builders. Additionally, recycled content insulation products are competitively priced.

**how:** This Action Item requires insulation products to contain at least 40% recycled content. This is easily attained with some products, such as recycled cellulose. With others, it will be important to inquire of the supplier or manufacturer to determine the recycled content.

**considerations:** Be sure to compare the energy efficiency of different insulation materials as well as their recycled content. Batt insulation tends to be unforgiving in terms of installation, requiring careful attention to avoid air pockets and crushing, both of which reduce the effective R-value of the wall.

**resources:** The California Integrated Waste Management Board maintains a Recycled Product Directory: [www.ciwmb.ca.gov/rcp/](http://www.ciwmb.ca.gov/rcp/) (click on *Construction*).



**what:** Continuous rigid insulation entails installing panels of expanded polystyrene or other foamed insulation either on the interior of the home, to be then covered with drywall or plaster, or on the exterior, to be covered with siding.

**why:** Conventional stick framing allows only a limited amount of space for insulation, and the studs act as a "thermal bridge" allowing heat to be lost to the outside in the heating season and allowing additional heat to enter the home in the summertime. The R-value of wood is approximately R-1 per inch, meaning existing 2x4s have an R-value of approximately 3.5.

The use of insulated exterior sheathing reduces the thermal bridging created by framing. Insulated exterior sheathing can reduce condensation in walls because the wall stays warmer. When properly detailed, it can also provide a superior exterior water management system; however, if improperly detailed, the rigid insulation can actually keep moisture that does enter the assembly from evaporating, leading to water damage.

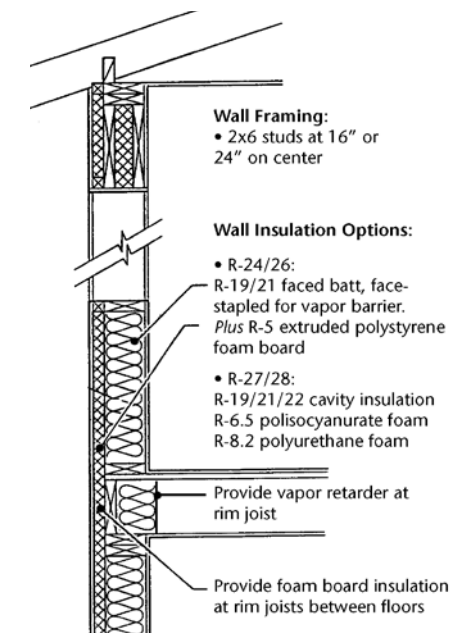
**how:** New modular exterior insulation systems combine insulation and a drainage plane with quick installation in the form of plastic clips that hold the system to the sheathing.

Insulated exterior sheathing can reduce condensation in walls because the wall stays warmer, and when properly detailed can provide a superior exterior water management system.

However, proper installation takes education and experience. Look for subcontractors with demonstrated experience, and learn more about effective installation methods. See Resources.

**resources:** Building Science Corporation Research Report 0501: "Guide to Insulating Sheathing." This report describes best practices for installing exterior rigid insulation, including flashing and taping details: [www.buildingscience.com](http://www.buildingscience.com) (search for 0501)

The Washington State Energy Code *Builder's Field Guide* includes details for installing both interior and exterior rigid insulation: [www.energy.wsu.edu/code/](http://www.energy.wsu.edu/code/) (see *Chapter 4: Insulation*)



Exterior or interior rigid insulation reduces thermal bridging caused by framing members.

Image: Washington State Energy Code *Builder's Field Guide*, courtesy of WSU Energy Extension.

## Action Item 10-8

Use continuous rigid insulation on interior or as exterior sheathing

### Points: 3

#### Responsible party:

Architect, Contractor

#### Intent:

Reduce a home's energy use related to heating and cooling; reduce the likelihood of mold and structural damage related to in-wall condensation.



#### Homeowner Benefit:

Installing a continuous layer of rigid insulation on a home can dramatically increase a home's energy efficiency, reducing heating and cooling bills. It also reduces the likelihood of temperature differentials causing condensation within the wall assembly, which can reduce insulation efficiency and cause mold and structural damage.

## Action Item 10-9

Use environmentally friendly foam building products (formaldehyde-free, CFC-free, HCFC-free, brominated flame retardant-free)

### Points: 3

Responsible party:

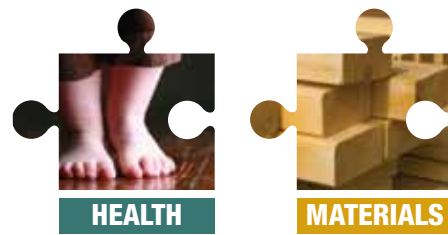
Contractor, Insulation

Intent: Reduce ozone depletion and global warming by eliminating the use of CFCs and HCFCs; protect indoor air quality by reducing exposure to formaldehyde; protect global environmental health by reducing brominated fire retardants.



### Homeowner Benefit:

Avoiding CFCs, HCFCs and brominated fire retardants benefits the environment and all humans by reducing the ozone depletion, global warming and bioaccumulative toxic effects of these compounds. Additionally, excluding urea formaldehyde from a building directly benefits occupants by reducing exposure to this toxic volatile organic compound.



HEALTH

MATERIALS

**what:** Environmentally friendly foam products are free of the most concerning compounds found in these energy-conserving materials. This includes CFCs, HCFCs, formaldehyde, and brominated fire retardants.

**why:** Foam insulation products are excellent at improving the energy efficiency of a home, but many foam products harbor substantial environmental and health tradeoffs. Of primary concern are foam building materials that are manufactured using chlorofluorocarbons (CFCs) or hydrochlorofluorocarbons (HCFCs).

CFCs are known to contribute significantly to ozone depletion and global warming, two of our most serious environmental concerns. HCFCs are considerably less damaging than CFCs in terms of ozone depleting potential, but can be extremely potent greenhouse gases. In addition, avoid products that include formaldehyde, because indoor formaldehyde is gaining recognition as a severe health hazard causing reactions ranging from flu-like symptoms to death in individuals that become sensitized through exposure. And finally, many expanded foam products use brominated fire retardants, a class of halogenated compounds that have been shown to be bioaccumulative, meaning they magnify in concentration as they travel up the food chain. Brominated fire retardants are now found virtually everywhere on Earth, and in humans in alarmingly high concentrations.

Polystyrene has recently come to light as a material of concern due to the use of HBCD (hexabromocyclododecane), a brominated fire retardant. European regulators are considering banning HBCD and have listed it as a substance of “very high concern.”

**how:** This Action Item applies only to foam insulation products. Options to consider include:

- Polyurethane insulation (e.g. polyisocyanurate) with pentane instead of HCFCs as the blowing agent. Polyurethane insulation may also be treated with brominated fire retardants; inquire of the manufacturer.
- Soy- and other bio-based foam insulation products.

**resources:** The US EPA maintains a wide variety of information on ozone depleting substances and alternatives: [www.epa.gov/ozone/strathome.html](http://www.epa.gov/ozone/strathome.html)

Environmental Building News primer on brominated fire retardants: [www.buildinggreen.com](http://www.buildinggreen.com) (click on News, then Back Page Primers).



ENERGY

HEALTH

MATERIALS

**what:** Penetrations in a home’s thermal envelope, including doors, windows, plumbing and electrical penetrations, all create potential avenues for moisture and air leaks. Sealing these penetrations in a new construction home is required by code but often difficult to enforce; in existing homes, sealing may not exist at all.

**why:** Proper sealing of penetrations not only enhances energy efficiency by reducing air infiltration, it reduces the significant moisture transfer that occurs through air leaks into the home. This moisture can wet insulation, cause rot, and result in homeowner discomfort, complaints and callbacks.

**how:** An excellent way to identify air leaks is with a home performance evaluation including a blower door test (see Action Item 1-16), conducted prior to the initiation of construction. This evaluation can provide valuable information on the most cost effective measures for increasing a home’s energy performance and indoor air quality. Find qualified technicians for carrying out a home performance evaluation through Home Performance Washington (see Resources).

As part of quality control, ensure the construction crew seals all penetrations at doors, windows, plumbing and electrical penetrations. Pay special attention to plumbing stacks that run from the crawlspace to the attic, adjacent to baths and kitchen. Leaky pathways in these locations act as chimneys: continuously drawing

cool air from the crawlspace to the attic. During winter months especially, the cold air drawn through rooms with high relative humidity cools interior surfaces and promotes condensation and mold growth.

*Note:* electrical and plumbing penetrations that are completely within the conditioned space do not need to be sealed; this credit is specifically addressing air and moisture leakage to the outside of the home.

**considerations:** In existing homes, air sealing is an important first step, usually best accomplished prior to the installation of additional insulation. Address the benefits of air sealing early on with clients to gain support for doing this task early in the project.

Even better, use the Airtight Dry-wall Approach (ADA), an advanced sealing package that goes beyond basic practice (see Action Item 11-1).

**resources:** For homeowners, “Air Seal and Insulate with ENERGY STAR” is a useful publication for understanding the benefits and techniques of air sealing: [www.energystar.gov](http://www.energystar.gov) (click on *Home Improvement*)

Home Performance Washington provides a list of certified service providers, as well as training for energy auditors: [www.homeperformancewashington.org](http://www.homeperformancewashington.org)

## Action Item 10-10

Verify seals at doors, windows, and plumbing and electrical penetrations against moisture and air leaks

### Points: 2

Responsible party:

Performance Contractor

Intent:

Reduce energy use related to heating and cooling by enhancing a home’s airtightness; promote building durability and indoor environmental quality by reducing moisture related issues.



### Homeowner Benefit:

Air leaks can be responsible for 30% or more of a home’s energy use. Air leaks also can cause uncomfortable cold spots and drafts. Additionally, unsealed penetrations are routes of entry for moisture and bulk water, which can cause unseen rot and mold within building cavities. Sealing penetrations can therefore reduce energy bills, enhance comfort, protect indoor air quality, and add to the long-term durability of the home.



## Action Item 10-11

Perform a blower door test at the appropriate point in construction

### Points: 2

#### Responsible party:

Performance contractor

#### Intent:

Confirm the airtightness of a home; identify air leaks and correct them prior to the end of construction.



**what:** Blower door tests evaluate the integrity of a home's air barrier between conditioned and unconditioned space. Blower door tests use a fan to create a pressure differential between the inside and outside of the home in order to determine the amount of air leakage (measured in air changes per hour, or ACH, at a specific level of pressure—usually 50 Pascals). On existing homes, a blower door test is usually performed as part of a home performance evaluation (see Action Item 1-16), with a second test being performed at the end of the home improvement process. Tests performed before and after measures are taken to increase a home's tightness help set a baseline and estimate improved energy performance. For this Action Item, an additional blower door test is required, after framing, sheathing, windows and doors, and plumbing and electrical are installed, but prior to most insulation and drywall.

**why:** A pre-drywall blower door test helps confirm that a home is meeting airtightness goals, at a time in the construction process when corrective actions are relatively easy and inexpensive.

**how:** It is important to perform the blower door test at a point where the home is sufficiently complete to yield meaningful results, but also allows the ability to quickly identify and correct leaks. The actual airtightness of the home at this point in construction may be secondary to the usefulness of being able to identify the source of air leaks and fix them.

Blower door tests can be performed by an experienced (and preferably certified) contractor or subcontracted to a home energy performance specialist. Look for qualified technicians through Home Performance Washington (see Resources). Hiring an independent party to conduct the blower door test adds credibility to the process. Using the same contractor throughout the project helps create continuity.

**resources:** The Department of Energy's Energy Savers resource for consumers includes information on blower door testing: [www.energysavers.gov](http://www.energysavers.gov) (click on *Insulation and Air Sealing*, then *Energy Audits*).

Home Performance Washington: [www.homeperformancewashington.org](http://www.homeperformancewashington.org)

## DRYWALL

The drywall stage offers additional opportunity to create an airtight structure, reducing drafts and related energy expense. It also represents a chance to use healthier drywall compounds, protecting indoor air quality.



### Homeowner Benefit:

Performing an additional blower door test during construction allows a remodeler to identify and correct any overlooked or improperly detailed areas in the building's envelope.

## Action Item 11-1

Airtight Drywall Approach for framing structures

### Points: 3

#### Responsible party:

Contractor, Drywaller

#### Intent:

Reduce home energy use associated with air leakage.



**what:** The airtight drywall approach (ADA) for framed structures is an advanced air sealing strategy that goes beyond basic practice. Specifically, it includes drywall caulked or gasketed at the top and bottom plates installed on insulated walls, windows and doorframes; caulked or gasketed drywall installed on interior walls at intersections with exterior ceilings; and caulking or gasketing all electrical, plumbing or mechanical penetrations in the drywall.

**why:** Creating a continuous air barrier at the building envelope is key to effectively reducing unwanted air infiltration. Minimizing infiltration saves the homeowner money by reducing heating bills, and can reduce the risk of moisture damage in wall assemblies by inhibiting moist air migration.

**how:** This Action Item applies to home additions or areas of the home with a down-to-the-studs remodel.

ADA is a specialized skill; look for drywall installers with demonstrated experience with the process. Because the approach is more detail-oriented and time consuming than standard drywall installation, costs may be slightly higher.

However, selecting an installer that has experience will avoid the risk of the client paying for the installer to learn on the job, and increase the likelihood of a quality installation.

Proper attention should be given to the quality and durability of the sealing materials as well as matching the type of sealant to the size of the gap.

A green building adage: “built tight, ventilate right.” Building with airtight construction methods requires equal attention to providing sufficient ventilation. See Action Item 1-42 for additional information on balancing and controlling ventilation, and consider providing energy efficient ventilation by installing a Heat Recovery Ventilator (Action Item 7-14).

**considerations:** Tighter homes are more prone to back-drafting. Install quality, self-closing dampers on vents to prevent back-drafts on windy days and make sure the home’s ventilation system is pressure equalized. Requiring low-VOC caulks and sealants (see Action Item 4-3) also reduces indoor air quality issues down the road.

**resources:** The Department of Energy’s Energy Savers resource for consumers includes information on ADA: [www.energysavers.gov](http://www.energysavers.gov) (click on *Insulation and Air Sealing*, then *New Homes*, then *Airtight Drywall*, and *Simple Caulk and Seal*).



**what:** See Action Item 4-3 for a description of the terminology used in this Action Item.

**why:** Some joint compounds contain volatile organic compounds (VOCs) of concern, including formaldehyde, benzene, and various fungicides and preservatives.

**how:** Look for joint compounds that meet independent certifications for indoor air quality performance, such as Greenguard® certification.

In addition, clearly communicate with all subs the project’s indoor air quality goals, and provide them with product names to increase the likelihood of compliance with goals. (It is very easy for a subcontractor to simply use “extra” materials on hand, which may not meet a green project’s criteria for performance.)

**considerations:** Specify low toxic, low VOC products for other applications in the home, such as caulks and adhesives for framing (Action Item 4-3), tile and grout additives (Action Item 13-34) and paints and finishes (Action Item 13-35).

**resources:** Greenguard Environmental Institute: [www.greenguard.org](http://www.greenguard.org) (click on *Find Products*)

## Action Item 11-2

Inside the house, use only low-VOC, low-toxic, water-based, solvent-free adhesives, and additives for drywall and joint compound

### Points: 2

#### Responsible party:

Contractor, Drywall

#### Intent:

Protect indoor air quality and occupant health and comfort by using nontoxic or low-toxic materials.



#### Homeowner Benefit:

A tightly sealed house will save energy, and reduce heating bills. The Airtight Drywall Approach helps ensure a continuous air barrier between the indoors and outside, which keeps cold and/or moist air from entering the walls and living space, enhancing comfort, durability, and indoor air quality as well.



#### Homeowner Benefit:

Specifying healthier drywall and joint compound helps protect indoor air quality, resulting in a healthier, more comfortable home.

## EXTERIOR

Exterior finishes can be made more environmentally friendly by selecting salvaged, recycled content, sustainable harvest or otherwise environmentally preferable materials.

## Action Item 12-1

Reuse siding

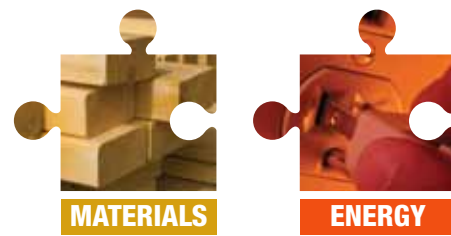
### Points:

#### Responsible party:

Contractor

#### Intent:

Conserve raw materials and reduce manufacturing-related energy use by reusing building materials.



**what:** Reusing siding entails either using existing siding material on a home or sourcing used siding materials from used building materials retailers or other jobsites.

**why:** Reusing existing building materials on a home can reduce materials purchase costs, although added labor in removing and preparing the material for reinstallation may likely erode these savings. More generally, materials reuse helps reduce raw material extraction and energy use associated with production.

Reusing from other projects or by purchasing materials from a used building materials retailer also avoids these environmental impacts.

**how:** The suitability of siding for reuse will depend on a variety of factors, mainly its condition and the ease of reinstallation. Projects planning on including exterior rigid insulation or a rain screen siding approach, for example, may find that certain types and styles of siding materials are difficult to work with. For example, shingle siding can be difficult to incorporate into a rain screen design, which tend to rely on horizontally applied siding materials.

Reused materials from homes built prior to 1980 may contain lead-based paint. Removing and working with such siding can create lead dust and leaded paint flakes, both an exposure hazard during the removal and installation and creating soil contamination after the fact. For information on working with lead-based paint in existing homes, see the Resources section.

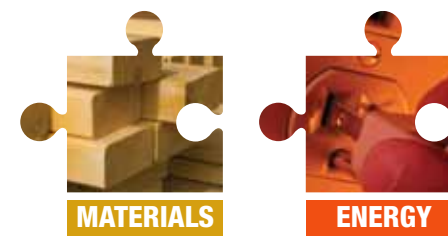
Reusing siding from the existing home requires careful removal using the proper tools, and storage for reuse.

**considerations:** Removing siding from a home opens up the opportunity to install exterior rigid insulation to increase the home's energy efficiency (see Action Item 10-8). However, this will change the outside dimensions of the home, and may complicate the process of reusing existing siding. Evaluate with the homeowner whether the resource efficiency benefit of reusing siding is worth more than the energy efficiency benefits of increased insulation to make a decision if one precludes the other.

**resources:** The Building Materials Reuse Association provides a directory of used building materials retailers and salvage consultants: [www.bmra.org](http://www.bmra.org)

The *Green Home Remodel Salvage and Reuse* guide provides general information on building materials salvage and reuse: [www.greentools.us](http://www.greentools.us) (click on *Residential Buildings*, then *Residential Remodeling Guides*).

EPA information on avoiding lead based paint hazards: [www.epa.gov/lead](http://www.epa.gov/lead)  
Homeowners should read the EPA document: "Renovate Right: Important Lead Hazard Information for Families, Child Care Providers and Schools."



**what:** Reusing decking entails either using decking siding material on a home or sourcing used decking materials from used building materials retailers or other jobsites.

**why:** See Action Item 12-1 for the rationale behind reusing building materials.

**how:** The suitability of decking for reuse will depend on a variety of factors, mainly its condition and the ease of reinstallation. Reusing decking from the existing home requires careful removal using the proper tools, and storage for reuse.

**resources:** The Building Materials Reuse Association provides a directory of used building materials retailers and salvage consultants: [www.bmra.org](http://www.bmra.org)

The *Green Home Remodel Salvage and Reuse* guide provides general information on building materials salvage and reuse: [www.greentools.us](http://www.greentools.us) (click on *Residential Buildings*, then *Residential Remodeling Guides*).

EPA information on avoiding lead based paint hazards: [www.epa.gov/lead](http://www.epa.gov/lead).  
Homeowners should read the EPA document: "Renovate Right: Important Lead Hazard Information for Families, Child Care Providers and Schools."

## Action Item 12-2

Reuse decking

### Points: 1

#### Responsible party:

Contractor

#### Intent:

Conserve raw materials and reduce manufacturing-related energy use by reusing building materials.



#### Homeowner Benefit:

Reusing siding can reduce materials purchase costs and reduce disposal fees related to disposing of existing siding on a home.



#### Homeowner Benefit:

Reusing siding can reduce materials purchase costs and reduce disposal fees related to disposing of existing decking on a home.

## Action Item 12-3

Use siding with reclaimed, or recycled material on at least 20% of solid wall surface

### Points: 3

#### Responsible party:

Contractor

#### Intent:

Reduce raw material extraction and energy use related to manufacturing new building products.



MATERIALS

**what:** Recycled materials take two forms: post-consumer recycled and post-industrial recycled. Post-consumer recycled materials are manufactured from materials sourced from curbside recycling programs or otherwise diverted from the municipal solid waste stream. Post-industrial recycled materials are manufactured from manufacturer's waste-scrap left over from the manufacturing process itself. Post-consumer recycling truly "closes the loop" by taking materials that have lived their useful lives and cycles them back as inputs. Post-industrial recycling, while very beneficial, is often primarily an efficiency measure (since a manufacturer will have to otherwise deal with the scraps as waste). Promoting efficiency in manufacturing and a "cradle to cradle" approach for materials are the two objectives post-industrial and post-consumer recycling, respectively.

**why:** See Action Item 4-16 for the rationale behind encouraging the use of post-consumer and post-industrial waste.

**how:** Aluminum or steel siding products contain high percentages of recycled metal-up to 100%. The scrap is also recyclable.

Vinyl siding can include a small percentage of post-industrial scrap in the manufacturing process. However, PVC is difficult to recycle, and there are no vinyl siding products with post consumer vinyl at this time.

Fiber cement composites are also resource efficient, and in addition to durability and low maintenance, offer a very good fire rating when compared to wood or metal siding. The wood fiber in these products

is reclaimed from wood processing waste, meaning it is post-industrial rather than post-consumer recycled content. It can also be harvested from small diameter fast growing tree species.

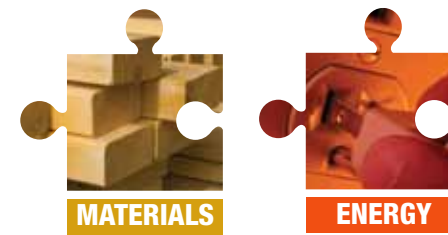
The regional manufacturer Paperstone, known for their solid-surface countertop material, also offers a panelized rain screen siding product made from 100% post-consumer recycled paper with a resin binder. The paper is certified by the Forest Stewardship Council. While marketed primarily to commercial projects, the material is suitable for contemporary residential buildings as well.

To calculate compliance with this credit, subtract the window and door areas from the total exterior wall surface area, and determine the percentage of remaining wall area supplied by the recycled or reclaimed material.

**considerations:** Recycled content is but one environmental attribute to look for in a green material or product. Be sure to consider any recycled content product's environmental health and energy efficiency profile as well as its materials efficiency profile.

**resources:** The California Integrated Waste Management Board maintains a Recycled Product Directory: [www.ciwmb.ca.gov/rcp/](http://www.ciwmb.ca.gov/rcp/) (click on *Construction*).

Scientific Certification Systems maintains a database of certified products, including those certified for recycled and reclaimed content: [www.scscertified.com/products/](http://www.scscertified.com/products/)



MATERIALS

ENERGY

**what:** Siding warranted for 50 years is eligible for this Action Item. Common siding materials warranted for extended periods include metal siding and fiber cement products.

**why:** Extended warranty products mean benefits for the homeowner, the environment, and the contractor. The durability and quality of long-lasting products is likely to mean fewer callbacks related to quality issues or product failure. Additionally, long-lasting products have more time over which to amortize their environmental costs, meaning a smaller environmental footprint.

**how:** Many of the fiber-cement composites offer a 50-year warranty; commercial-grade metal siding may have similar warranties.

When installing long-life products, be aware of aesthetic trends in materials choices and applications. Often, materials are discarded long before they are worn out, for aesthetic reasons. Aim for enduring design.

Also, given the long lasting nature of the siding for this credit, it makes sense to select an equally durable material for a substrate. Using a rain screen drainage plane siding approach (Action Item 4-18) can help ensure the durability of the underlying sheathing and framing.

**resources:** *Durability by Design*, a resource for designing long-lasting buildings is available through the PATH website: [www.pathnet.org/sp.asp?id=984](http://www.pathnet.org/sp.asp?id=984)

## Action Item 12-4

Use 50-year siding product for new or replaced siding

### Points: 2

#### Responsible party:

Architect, Contractor

#### Intent:

Reduce materials-related energy and resource use by extending the service life of building materials.



#### Homeowner Benefit:

Recycled content building materials can be durable, cost-effective alternatives to building with virgin materials.



#### Homeowner Benefit:

Durable materials translate into lower operating and maintenance costs for a home, by reducing replacement costs related to both materials and labor.

## Action Item 12-5

Use regionally produced stone or brick

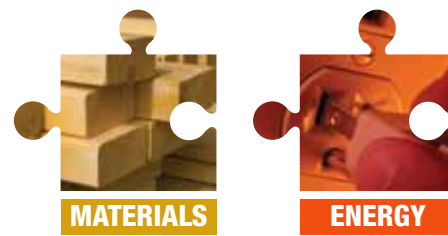
### Points: 1

#### Responsible party:

Architect, Landscape Architect

#### Intent:

Reduce transportation related energy use and pollution; support local economies.



**what:** "Regionally produced" materials are considered to be produced within 500 miles of the job site, excluding Canada.

**why:** Use of regional materials helps keep material transport costs down, reinforces a regional aesthetic, and supports the local economy.

**how:** Use locally quarried, cut and polished stone. Regionally run and operated stone and landscape suppliers are more likely to stock regional products than big-box retailers and national building materials suppliers.



#### Homeowner Benefit:

Using locally produced stone and brick and help enhance the regional aesthetic of the home, helping it integrate more with its surroundings and work with the local vernacular architecture.



**what:** Third party certification entails an independent entity confirming that a set of agreed upon standards have been followed in the growth, harvest and distribution of forest products. Definitions of sustainable harvest vary depending on the certification body (see "how" below for details).

**why:** Many of the world's forests are in serious decline due to overharvesting and other poor forestry practices. Purchasing certified sustainable harvest wood sends a market signal to producers that responsibly managed forests and the products that come from them have value. In addition, some certification programs require worker safety and compensation standards be met as well, helping fulfill social sustainability goals in addition to environmental sustainability. Certified sustainable harvest lumber is available from regional producers, meaning that economic sustainability and regional economic development can be a third benefit of purchasing certified wood.

**how:** This Action Item is worth 1 or 5 points.

- Use siding meeting Tier 2 requirements: 1 point
- Use siding meeting Tier 1 requirements: 5 points

See Action Item 4-14 for descriptions of Tier 1 and Tier 2 requirements, and for resources to help find sustainable harvest wood products.

## Action Item 12-7

Use wood siding that is third-party certified sustainably harvested wood, on at least 20% of solid wall surface that meets:

### Points: 1-5

#### Responsible party:

Contractor

#### Intent:

See Action Item 4-14.

## Action Item 12-6

If replacing siding and/or exterior trim no vinyl siding or exterior trim

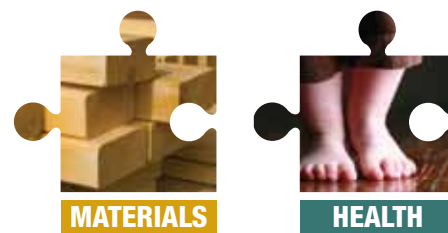
### Points: 4

#### Responsible party:

Contractor

#### Intent:

Protect environmental and human health by reducing toxic exposures during a product's lifecycle.



**what:** Vinyl is the common name given polyvinyl chloride, or PVC products. It is not environmentally preferred due to its toxic manufacturing process and limited potential for recycling. In the event of a fire, PVC can release toxic smoke containing dioxins—some of the most potent toxins known to humanity.

**how:** Many alternatives to vinyl siding exist. Work with the homeowner to identify siding materials that meet their aesthetic, environmental, and functional needs.

See Action Item 12-4 for more information on long service life siding products.



#### Homeowner Benefit:

While vinyl siding and trim often has a low up-front cost in terms of purchase price, it is problematic from the environmental and health perspective. Avoiding PVC products can reduce life cycle toxic emissions and provide more options for reuse and recycling.



#### Homeowner Benefit:

Using third party certified sustainable harvest wood products helps protect forest ecosystems and resources. Additionally, sustainable harvest wood can be superior in quality when compared to wood produced using standard forestry practices.

## FINISHES/INDOOR AIR QUALITY

Careful selection of interior finishes can help ensure a project's indoor air quality goals are fulfilled. Additionally, finishes can be selected for a variety of environmental traits, including sustainable harvest, local or regional production, durability, and more.

## Action Item 13-1

Provide an outdoor clothesline or drying rack

### Points: 1

#### Responsible party:

Contractor, Architect

#### Intent:

Reduce the carbon footprint of the home by reducing the energy use associated with mechanical clothes drying.



ENERGY

**what:** Clotheslines and drying racks take a variety of forms, including pulley versions, retractable lines, and wooden or coated wire racks.

**why:** A permanent clothesline can save energy and help reduce air pollution by reducing use of the clothes dryer, especially during the summer months. Using only a clothesline, instead of electric or gas dryer saves an average of 1,000 kWh of electricity a year.

**how:** Installing the clothesline in an outdoor location avoids moisture problems in the home. If installing indoors, collocating machinery including boilers and water heaters in the same room as the laundry can put waste heat from these machines to work. (Additionally, installing in a laundry room is more convenient, and allows use of the laundry ventilation system to remove excess moisture caused by clothes drying.) Wall-hung drying racks and retractable lines can be quickly stored when not in use, freeing up space for other uses. Low-cost models are available from home improvement retailers and online. Sufficient length of line is key to providing a practical clothesline or rack.

**considerations:** High-efficiency front-loading clothes washers (see Action Item 13-42) extract more water from clothing during the spin cycle, making clothes dry faster.



#### Homeowner Benefit:

A clothesline is a simple, low-tech way to reduce energy bills, and it also helps clothes last longer.



MATERIALS

**what:** Rapidly renewable materials are those that reach maturity or harvest within ten years or less. Examples of rapidly renewable materials include bamboo, cork, linseed oil, agricultural waste fibers such as wheat and sorghum stalks and sunflower seed hulls, and some rapidly growing tree species, including some types of poplar.

**why:** Rapidly renewable materials can create more raw materials per acre compared to slower growing species, meaning less pressure on agricultural lands.

**how:** Rapidly renewable materials are often used for flooring and panel products, Products contain-

ing rapidly renewable materials often publicize their status, making them relatively easy to find.

**considerations:** While a material's rapidly renewable status is important, so is the way it is cultivated and processed. Inquire as to the cultivation practices associated with the rapidly renewable materials being considered. Bamboo can now be certified under the Forest Stewardship Council, an independent third-party certification program. Agricultural fibers can be organically grown. And in composite materials featuring rapidly renewable elements, be sure to inquire as to the resins that comprise the remainder of the product, and whether they contain toxins or volatile organic compounds.



#### Homeowner Benefit:

Rapidly renewable materials often have interesting textures and patterns, adding unique elements to a home's design, and a more environmentally friendly option than standard wood or other finish material.



MATERIALS

**what:** See Action Item 13-2.

**how:** See Action Item 13-2. For this Action Item, select three applications of materials meeting the definition of "rapidly renewable."



#### Homeowner Benefit:

See Action Item 13-2.

## Action Item 13-2

Use any amount of rapidly renewable building materials and products made from plants harvested within a ten-year cycle or shorter

### Points: 1

#### Responsible party:

Architect

#### Intent:

Encourage the use of rapidly renewable materials; reduce demand for non-renewable and long-cycle renewable products.

## Action Item 13-3

In three applications, use rapidly renewable building materials and products made from plants harvested within a ten-year cycle or shorter

### Points: 3



## Action Item 13-4

Reuse flooring

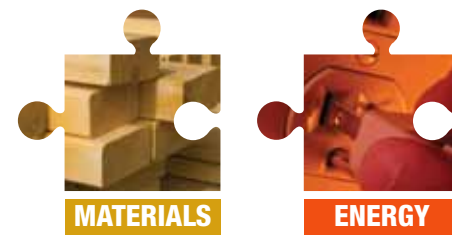
**Points: 2**

**Responsible party:**

Contractor

**Intent:**

Reduce raw material extraction and energy use related to manufacturing and distributing new building products.



**what:** Flooring can be reused on site, from other projects, or purchased from used building materials retailers.

**why:** See Action Item 12-1 for the rationale behind reusing building materials.

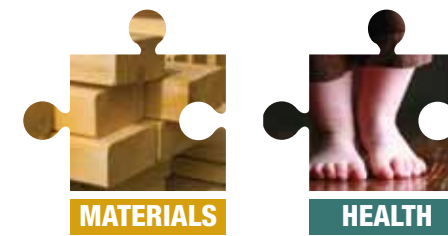
**how:** Solid wood flooring is the easiest type of flooring to reuse. Reuse can happen on site on a project (with careful removal and storage), or materials can be purchased from used building materials retailers or brought in from other jobs. Oak, fir and occasionally maple flooring are commonly available used in the Pacific Northwest.

**considerations:** Evaluate hiring a professional salvage company to remove existing flooring for reuse; specialized tools and experience help a professional crew recover more usable flooring in a short amount of time.

**resources:** The Northwest Building Salvage Network provides links to used building materials retailers and resources on building salvage: [www.nbsnonline.org](http://www.nbsnonline.org). The site also includes a fact sheet on reusing flooring (click on *Downloads*).

The Green Home Remodel Salvage and Reuse guide provides general information on building materials salvage and reuse: [www.greentools.us](http://www.greentools.us) (click on *Residential Buildings*, then *Residential Remodeling Guides*).

EPA information on avoiding lead based paint hazards: [www.epa.gov/lead](http://www.epa.gov/lead). Homeowners should read the EPA document: "Renovate Right: Important Lead Hazard Information for Families, Child Care Providers and Schools."



**what:** Vinyl is the common name given polyvinyl chloride, or PVC products. Vinyl siding or exterior trim is a commonly used material due to its relatively low purchase price. It is not environmentally preferred, however, due to the toxic manufacturing process required and limited potential for recycling the material at the end of its service life.

**why:** Vinyl chloride, the building block for PVC, is a known human carcinogen. Also, in the event of a fire, PVC can release toxic smoke containing sulfuric acid and dioxins—some of the most potent toxins known to humanity. PVC is also very energy intensive to produce. Vinyl flooring materials often contain phthalates (plasticizers that can mimic human and animal hormones, disrupting the endocrine system) that can offgas into the living environment.

**how:** Many alternatives to vinyl flooring exist, including natural linoleum, tile, wood, cork, bamboo and non-vinyl resilient plastic.

**considerations:** If using wood flooring, consider sustainable harvest wood (see Action Item 13-18), or used wood flooring (Action Item 13-4).

**resources:** The Washington Toxics Coalition maintains a fact sheet on PVC: [www.watoxics.org](http://www.watoxics.org) (click on *Healthy Homes and Gardens*, then *Home Repair and Building Materials*).

## Action Item 13-5

No vinyl flooring

**Points: 4**

**Responsible party:**

Contractor, Owner

**Intent:**

Protect environmental and human health by reducing toxic exposures during a product's lifecycle.



### Homeowner Benefit:

Reusing flooring can save on materials purchase costs, reducing the total cost of the remodel. Additionally, used flooring is often made from higher quality wood than new flooring available today.



### Homeowner Benefit:

While vinyl flooring often has a low up-front cost in terms of purchase price, it is problematic from the environmental and health perspective. Disposal at the end of life is also an issue; currently no facilities exist to recycle the material.

## Action Item 13-6

Use any amount of rapidly renewable flooring products with a ten-year harvest cycle or shorter (excluding carpet)

### Points: 1

#### Responsible party:

Contractor, Architect, Owner

#### Intent:

Encourage the use of rapidly renewable materials; reduce demand for non-renewable and long-cycle renewable products.



MATERIALS

**what:** Rapidly renewable flooring products include bamboo, cork, and potentially agricultural fibers.

**why:** Rapidly renewable materials can create more raw materials per acre compared to slower growing species, meaning less pressure on agricultural lands.

**how:** To achieve points for this Action Item, the project must use any amount of rapidly renewable materials. For more on rapidly renewable materials, see Action Item 13-2.



#### Homeowner Benefit:

Rapidly renewable materials often have interesting textures and patterns, adding unique elements to a home's design, and a more environmentally friendly option than standard wood or other finish material.

## Action Item 13-7

On more than 250 square feet, use rapidly renewable flooring products with a ten-year harvest cycle or shorter (excluding carpet)

### Points: 3

#### Responsible party:

Contractor, Architect, Owner

#### Intent:

Encourage the use of rapidly renewable materials; reduce demand for non-renewable and long-cycle renewable products.



MATERIALS

**what:** Rapidly renewable flooring products include bamboo, cork, and potentially agricultural fibers.

**why:** Rapidly renewable materials can create more raw materials per acre compared to slower growing species, meaning less pressure on agricultural lands.

**how:** To achieve points for this Action Item, the project must use 250 square feet of rapidly renewable materials. For more on rapidly renewable materials, see Action Item 13-2.



#### Homeowner Benefit:

Rapidly renewable materials often have interesting textures and patterns, adding unique elements to a home's design, and a more environmentally friendly option than standard wood or other finish material.



HEALTH

**what:** Pre-finished flooring takes many forms, including traditional solid wood tongue-and-groove and click together laminate "floating floor" products.

**why:** Pre-finished flooring leaves most volatile emissions associated with floor finishing at the factory, away from the indoor environment and occupants. Additionally, floor finish techniques used by manufacturers (e.g., UV curing) are more durable, providing a longer-lasting product. Finishing a floor on site also introduces fine wood dust into the home, which has been shown to cause nasal cancer in laboratory animals.

**how:** Pre-finished flooring is available from a wide variety of manufacturers. Look for products that can achieve other BUILT GREEN points, such as rapidly renewable materials (e.g., cork, bamboo), salvaged materials, and responsibly harvested wood. Be sure to consider potential downsides of some pre-finished flooring products; e.g., some types of laminate flooring use urea formaldehyde resins.

**considerations:** If installing pre-finished flooring on a concrete slab, perform a calcium chloride test to ensure moisture levels are within manufacturer's tolerances (see Action Item 3-20).

## Action Item 13-8

Use pre-finished flooring

### Points: 1

#### Responsible party:

Architect, Interior Designer

#### Intent:

Protect indoor air quality by reducing VOC emissions and wood dust within the occupied space.



#### Homeowner Benefit:

Pre-finished flooring obviates the need for on-site finishing, reducing installation time and protecting indoor air quality by eliminating emissions related to floor finishing on site.

## Action Item 13-9

Add no new carpet in addition/remodel, or eliminate carpet

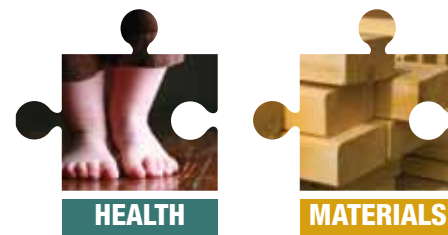
**Points: 5-15**

**Responsible party:**

Interior Designer

**Intent:**

Protect indoor air quality by reducing toxin “sinks” such as carpeting.



**what:** For the purposes of this Action Item, carpet refers to all types of carpet, whether of natural or synthetic fiber.

**why:** A study by the Washington Toxics Coalition found that carpet can harbor 400 times more toxic lead dust than adjacent hard surfaces, exceeding the action levels set for cleanup at Superfund toxic waste sites. In general, carpet is a “sink” for toxins, accumulating heavy metals, pesticides and biological contaminants over time.

**how:** The healthiest floor choices are smooth surfaces, such as tile, linoleum, and wood, which do not harbor dust and other allergy-causing particles. Solid surfaces are easier to clean than carpet and they keep vacuuming to a minimum. (Vacuuming stirs up dust, even under ideal conditions.) Wood and tile floors are also more durable than carpet, so they cost less per year of use.

This Action Item is worth 5 or 15 points.

- No new carpet: 5 points
- Eliminate all carpet: 15 points

For the purposes of this Action Item, “no new carpet in home” is defined as adding carpet in existing space, adding carpet in a home addition, or replacing existing carpet. Specify alternatives to carpet for flooring in parts of the home where flooring materials are being replaced. A wide variety of wood and resilient flooring materials can replace carpet. For example, cork’s naturally insulating qualities and slight “give” make it good for upstairs areas where sound transmission and the desire to go barefoot dictate a warmer, softer surface; natural linoleum’s continuous surface and naturally antibacterial surface makes it ideal for the kitchen.

Work with the homeowner to identify materials with the qualities they desire for each application.

**resources:** The Washington Toxics Coalition fact sheet “Carpeting and Children’s Health: How Flooring Decisions can Affect Your Home’s Indoor Air Quality:” [www.watoxics.org](http://www.watoxics.org) (click on *Healthy Homes & Gardens*, then *Home Repair and Building Products*).



**what:** Third-party product certification provides independent verification of a product’s performance. In the case of carpeting, third party certification for air quality focuses on volatile organic compound (VOC) emissions levels.

**why:** Volatile emissions from carpeting can cause respiratory irritation. Selecting products that pass air quality tests can increase comfort and reduce complaints from homeowners.

**how:** Specify carpeting that has been certified via a third party (e.g., Greenguard Environmental Institute) for air quality. As of 2009, Scientific Certification Systems Indoor Advantage program and Greenguard Environmental Institute Indoor Air Quality Certified programs are both third party certified. Note that the Carpet and Rug Institute’s Green Label and Green Label Plus carpet certifications do not qualify, as they are a second party certification system (CRI does not conduct independent testing and standards development).

**resources:**

Scientific Certification Systems:  
[www.scscertified.com](http://www.scscertified.com)  
(click on *Green Building Products*)

Greenguard Environmental Institute:  
[www.greenguard.org](http://www.greenguard.org)  
(click on *Find Products*)



### Homeowner Benefit:

Limiting or eliminating carpet helps protect indoor air quality and occupant health by removing a common repository for toxins and irritants.

## Action Item 13-10

If using carpet, specify products certified by third-party for good indoor air quality

**Points: 1**

**Responsible party:**

Architect, Interior Designer

**Intent:**

Protect indoor air quality and the health of occupants by reducing VOC emissions from carpet products.



### Homeowner Benefit:

Carpet products certified for low emissions help protect occupant health.

## Action Item 13-11

Use recycled content carpet pad

### Points: 1

#### Responsible party:

Contractor, Interior Designer, Owner

#### Intent:

Reduce resource use by specifying recycled content products.



**what:** Carpet padding may be made from several recycled-content materials including nylon and polypropylene waste from carpet manufacturing; jute from burlap materials; and recycled tire rubber and rebound urethane, reprocessed from virgin prime urethane products.

**why:** In general, these products have been found to be very resilient and possess good performance characteristics.

**how:** A variety of options are available for cost-competitive, resource-efficient carpet padding. Communicate with the carpet installer the client's desire for recycled content carpet pad.

**considerations:** Consider potential indoor air quality impacts related to indoor applications of materials made from recycled tire rubber or rebound urethane.

See Action Item 13-9 for information on the benefits of limiting or eliminating carpet in the home.

**resources:** The California Integrated Waste Management Board maintains a Recycled Product Directory: [www.ciwmb.ca.gov/rcp/](http://www.ciwmb.ca.gov/rcp/) (click on *Construction*). Carpet pad is listed in the carpet category within the directory.



**what:** Natural fiber rugs include animal and plant fibers, such as wool, sisal, jute, and coir. Some rugs are a mix of these fibers and other natural fibers. Natural fiber rugs often are backed with latex.

Natural wool carpet padding is also available.

**why:** Today, 97% of all manufactured carpets consist of synthetic fibers. These synthetic components can off-gas volatile compounds and the glues that bind the fibers to the backing may contain chemical compounds, a number of which are known to be toxic.

**how:** Natural fiber rugs are becoming a strong niche market despite the overwhelming dominance of the carpeting market by synthetic products.

Even natural fiber carpets can be a source of noxious gases if treated with chemicals. For example, wool carpet is often moth-proofed, and can be extensively fumigated to kill potential pests if imported. (Most wool carpeting is imported.) Note also that some chemically sensitive individuals (Action Item 1-30) are allergic to natural latex, which is used as a backing on many natural fiber rugs.

**considerations:** Maintain the good indoor air quality profile of natural fibers by installing them using the dry-tack method (Action Item 13-14).

## Action Item 13-12

If installing and/or replacing carpeting, install natural fiber carpet (e.g. jute, sisal, wool)

### Points: 1

#### Responsible party:

Architect, Interior Designer

#### Intent:

Protect indoor air quality by avoiding synthetic carpeting.



#### Homeowner Benefit:

Recycled content carpet pad can cost less than virgin material, saving money on project costs.



#### Homeowner Benefit:

Installing natural fiber carpet can help protect indoor air quality by avoiding the introduction of volatile organic chemicals that can be emitted from synthetic carpeting.

## Action Item 13-13

Use recycled, renewed carpet or wool carpet

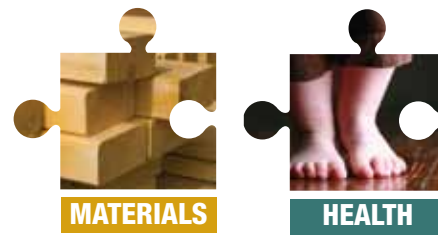
### Points: 1

#### Responsible party:

Contractor, Interior Designer, Owner

#### Intent:

Reduce resource use by specifying recycled content and renewable products; protect indoor air quality by specifying natural



**what:** Recycled-content carpets may include plastic yarns produced from recycled plastic bottles or recovered fibers from recycled textiles.

Renewed carpet is used carpet that has been cleaned and often overlaid with a new pattern.

Wool carpet is renewable, biodegradable, naturally fire and stain resistant, and colorfast; see Action Item 13-12 for more on natural fiber carpet.

**why:** In general, these products have been found to possess good performance characteristics and be cost-competitive with conventional carpeting.

**how:** A variety of attractive recycled and renewed styles are available through carpet suppliers and environmental building product retailers.

**resources:** The California Integrated Waste Management Board maintains a Recycled Product Directory: [www.ciwmb.ca.gov/rcp/](http://www.ciwmb.ca.gov/rcp/) (click on *Construction*). Carpet pad is listed in the Carpet category within the directory.



**what:** Dry methods of carpet installation include tacking and the use of carpet tiles that are joined together with self-adhesive stickers.

**why:** Carpet adhesives can contain a variety of volatile compounds, although most solvent-based adhesives have been phased out of production.

Additionally, dry methods of carpet installation increase the likelihood of reuse or recycling carpet, by facilitating removal without damaging the materials.

**how:** Specify a dry installation method with the project's carpet subcontractor.

**considerations:** Consider reducing or eliminating carpet altogether (Action Item 13-9).

## Action Item 13-14

If using carpet, install by dry method

### Points: 2

#### Responsible party:

Architect, Interior Designer

#### Intent:

Protect indoor air quality and occupant health by avoiding toxins and volatile compounds associated with carpet adhesives; reduce waste by facilitating carpet reuse.



#### Homeowner Benefit:

Renewed and recycled content carpet can be cost-competitive and high performance, saving on construction costs. Wool carpet is nontoxic, renewable and durable, helping protect indoor air quality and lowering the life cycle cost of a carpet installation.



#### Homeowner Benefit:

Installing a carpet by a dry method (such as tacking) helps protect occupant health by avoiding exposure to toxins found in carpet adhesives.

## Action Item 13-15

Use replaceable non-vinyl carpet tile and backer

### Points: 1

#### Responsible party:

Contractor, Interior Designer, Owner

#### Intent:

Reduce material use and attendant resource extraction and embodied energy.



**what:** Carpet tiles are an alternative to conventional broadloom carpet installed wall-to-wall. Modular squares of carpeting are laid on the floor, butted up against one another to create a continuous carpet. Carpeting can be arranged either wall-to-wall or rug-style where it's needed. Most carpet tile is laid without glue or tacking; instead, each tile is attached to its neighbor with self-adhesive tape, creating a single unit out of the modules.

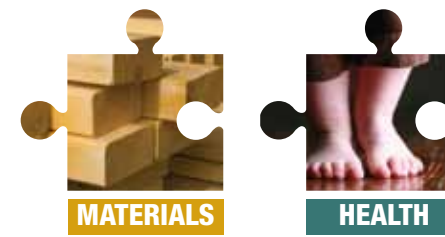
**why:** Carpet tiles reduce waste by allowing a user to replace only those tiles in need of replacement. They also allow for more even wear of a carpet by occasionally rotating tiles. Some carpet tile companies have recycling programs that will take back damaged or worn tiles. Carpet tiles are available in greener materials choices, including recycled content, bio-based materials and natural fibers. Look for Green Label Plus certification for indoor air quality through the Carpet and Rug Institute (CRI).

**how:** Major carpet manufacturers are now producing modular carpet tiles for residential use. Products are usually ordered online and can be delivered directly to the home.

**considerations:** As with standard carpet, carpet tiles serve as a sink for dust and contaminants. Hard surfaces are a superior option from the indoor air quality perspective. However, carpet tiles allow for strategic placement of carpet only where needed for comfort or effect. Look for natural fibers and/or low pile carpet to make this choice even greener.

**resources:** CRI Green Label Plus certifies carpet for indoor air quality: [www.carpet-rug.org](http://www.carpet-rug.org) (click on *Residential Customers*, then *Clearing the Air*). Includes a certified product finder.

The California Integrated Waste Management Board's Recycled Content Product Directory includes carpet tiles: [www.ciwmb.ca.gov/RCP](http://www.ciwmb.ca.gov/RCP) (click on *Product Search*, then use the search term "*Carpet Tile*").



**what:** Recycled content tile often contains post-industrial recycled content in the form of reground porcelain or tile scraps from the manufacturing process. Other tiles contain post-consumer recycled glass, or glass from other industries such as automobile production.

**why:** Purchasing recycled-content tile helps support the market for recyclable materials. It also can result in a superior product: adding recycled glass to a tile product can result in a more durable tile. Using salvaged tile is even more environmentally advantageous than using recycled tile, and often has the added benefit of supporting local used building materials retailers.

**how:** Find recycled content tile products by inquiring with tile and flooring companies or by searching databases including the California Recycled Content Product Directory (see Resources). Be sure to ask for verification of recycled content.

**resources:** The California Integrated Waste Management Board maintains a Recycled Product Directory: [www.ciwmb.ca.gov/rcp/](http://www.ciwmb.ca.gov/rcp/) (click on *Flooring*).

## Action Item 13-16

Use 40% recycled-content or salvaged hard surface tile, 75 square feet minimum

### Points: 3

#### Responsible party:

Contractor, Owner

#### Intent:

Increase demand and develop market for recycled content and salvaged materials.



#### Homeowner Benefit:

Carpet tiles allow for replacement of only the parts of carpet that are worn or damaged, reducing the cost of replacement over time.



#### Homeowner Benefit:

The natural benefits of tile's durability are enhanced with recycled content. Often recycled content further enhances the durability of tile, meaning less frequent replacement and longer service life, reducing the total cost of ownership.

## Action Item 13-17

Use natural linoleum

**Points: 3**

**Responsible party:**

Contractor, Owner

**Intent:**

Encourage the use of natural materials; reduce material extraction and energy use related to manufacturing by using longer service life materials.



**what:** Natural linoleum is a resilient sheet flooring material that is a mixture of wood flour, pine rosin, linseed oil and natural pigments applied to jute backing. The term “linoleum” is often used generically to refer to vinyl (PVC) flooring and other sheet goods. BUILT GREEN uses the term “natural linoleum” to distinguish true linoleum from other resilient sheet flooring. Only natural linoleum receives points under this Action Item.

**why:** Linoleum’s durability and health characteristics benefit the homeowner; its long life and durable nature benefit the installer by reducing the likelihood of callbacks and complaints.

**how:** Natural linoleum is available from a variety of retailers, and is sourced from two major manufacturers: Forbo and Armstrong. Similar to carpet, specific colors and styles are ordered from sample sets and specially delivered.



### Homeowner Benefit:

Natural linoleum is long lasting, hardwearing, and comprised of all natural ingredients. It is also naturally anti-static and antibacterial, making it a prime candidate for use in the kitchen, bath and laundry areas. These features translate into lower life-cycle cost (money savings over time) and a healthier indoor environment.



**what:** See Action Item 4-14.

**why:** See Action Item 4-14.

**how:** This Action Item is worth 1 or 4 points, depending on requirement level met:

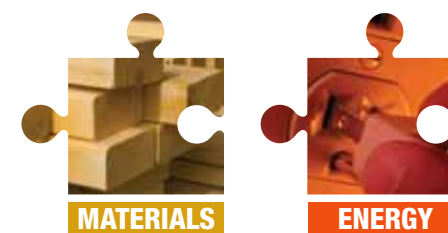
- Flooring meets Tier 1: 5 points
- Flooring meets Tier 2: 1 point

See Action Item 4-14 for Tier definitions.



### Homeowner Benefit:

Using third party certified sustainable harvest wood products helps protect forest ecosystems and resources. Additionally, sustainable harvest wood can be superior in quality when compared to wood produced using standard forestry practices.



**what:** See Action Item 12-1 for the rationale behind reusing building materials.

**how:** Find trim for reuse at local used building materials retailers, or source it from on site or other projects. Salvaging trim for reuse requires careful removal; often existing trim is adhered to walls or flooring by dried paint. Cut the trim free with a box cutter prior to removing.

**considerations:** Be aware of lead based paint issues when working with any old painted surfaces. Removing and reusing this material can expose workers and occupants to lead based paint dust. See Resources for information on working with surfaces suspected of containing lead based paint.

**resources:** See Action Item 12-1. For lead-based paint information, see [www.epa.gov/lead](http://www.epa.gov/lead).



### Homeowner Benefit:

Reusing trim materials can save on materials purchase costs, reducing the total cost of the remodel. Additionally, used trim is often made from higher quality wood than new trim available today.

## Action Item 13-18

Use flooring that is third-party certified sustainably harvested wood that meets Tier 1 or Tier 2 requirements.

**Points: 1-5**

**Responsible party:**

Architect

**Intent:**

See Action Item 4-14.

## Action Item 13-19

Reuse trim

**Points: 2**

**Responsible party:**

Architect, Contractor

**Intent:**

Reduce materials resource use and embodied energy by reusing building materials.

## Action Item 13-20

Use regional trim products, 50% minimum

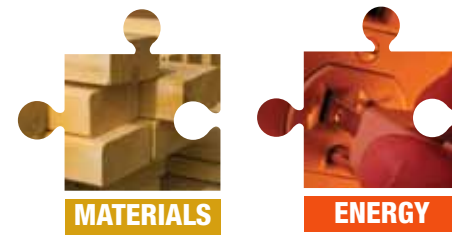
### Points: 1

#### Responsible party:

Contractor

#### Intent:

Support local economies and responsible natural resource use by purchasing regional products.



MATERIALS

ENERGY

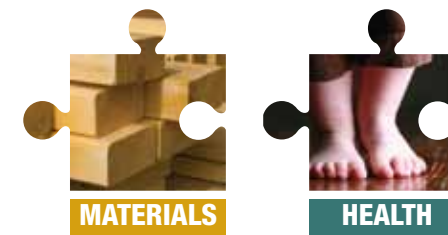
**what:** Regionally produced materials are sourced within 500 miles of the jobsite, not including Canada.

**why:** Use of regional materials helps keep material transport costs and energy use down, reinforces a regional aesthetic, and supports the local economy.

**how:** Find regional sources of wood through local lumberyards. Additionally, organizations such as the Northwest Natural Resource Group can help identify regional, sustainable harvest wood sources (see Resources).

**considerations:** See also Action Item 4-14 for information on sustainable harvest wood products.

**resources:** The Northwest Natural Resource Group is an association of small and midsize regional timberland owners and others that produce sustainable harvest wood to BUILT GREEN Tier 1 standards: [www.nnrg.org](http://www.nnrg.org). The website includes information on certified forestry and resources for finding products.



MATERIALS

HEALTH

**what:** Finger-jointed materials consist of shorter pieces of wood joined together to create usable materials. MDF, or medium density fiberboard, is a fine-ground wood product held together with a binder. As with many composite and engineered wood products, it is important to inquire as to the type of binder used, to avoid the introduction of formaldehyde and other toxic volatile organic chemicals into the home.

**why:** Formaldehyde is an irritant and known human carcinogen, according to the International Agency for Research on Cancer. The State of California classifies formaldehyde as a toxic air contaminant, with no safe level of exposure. Urea formaldehyde binders in particular are known to offgas, that is, release formaldehyde over long periods after the product is finished, compromising indoor air quality.

**how:** As awareness of the ill effects of formaldehyde grows, more manufacturers are modifying production practices to avoid the use of urea formaldehyde. Ask for urea formaldehyde free products, and look for independent certification of products to specific indoor air quality standards, such as GreenGuard Environmental Institute.

Strict California standards for formaldehyde emissions will likely dramatically reduce the formaldehyde levels in consumer products, especially composite wood products.

To receive points for this Action Item, the project must show evidence that 90% of the materials used for trim (by weight or purchase price) are free from added urea formaldehyde. Building products that meet this criterion often visibly display their formaldehyde-free status.

**resources:** Green Seal Choose Green Report: *Particle-board and Medium Density Fiberboard* describes issues with composite wood products and how to avoid them: [www.greenseal.org](http://www.greenseal.org) (click on *Publications and Resources*, then *Choose Green Reports*).



#### Homeowner Benefit:

Using regional products helps support local economies.

## Action Item 13-21

Use finger-jointed or MDF trim with no added urea formaldehyde, 90% minimum

### Points: 3

#### Responsible party:

Contractor

#### Intent:

Encourage the more efficient use of natural resources.



#### Homeowner Benefit:

Selecting materials with no added urea formaldehyde helps protect indoor air quality and occupant health.



## Action Item 13-22

Use only shelving, window trim, door trim, base molding etc., with no added urea formaldehyde

### Points: 4

#### Responsible party:

Contractor

#### Intent:

Protect occupant health by reducing exposure to formaldehyde.



HEALTH

**what:** Urea formaldehyde is a resin, primarily used to bind together composite wood products but also used as glue in some insulation products and in other building materials.

**why:** Formaldehyde is a known human carcinogen, according to the International Agency for Research on Cancer. Urea formaldehyde resins off-gas formaldehyde for many years after manufacture, introducing the volatile organic compound into the living space. Even at low concentrations, formaldehyde is a lung irritant and sensitizer, which is especially problematic for asthmatics and those with allergies.

**how:** Specify materials free from added urea formaldehyde. Alternatives to urea formaldehyde include solid wood products, phenolic resins (phenol formaldehyde), MDI, and soy-based resins. Products using these resins include exterior-grade plywood, exterior grade MDF, and agricultural board (wheat board or straw board).

**considerations:** Wheat board and straw board are also rapidly renewable materials (see Action Item 13-2).

**resources:** See Action Item 13-21 for information and resources related to formaldehyde.



MATERIALS

**what:** See Action Item 4-14.

**why:** See Action Item 4-14.

**how:** This Action Item is worth 1 or 3 points.

- Trim meets Tier 1 requirements: 3 points
- Trim meets Tier 2 requirements: 1 point

50% of purchased trim (by weight or purchase price) must meet Tier 1 or 2 criteria. See Action Item 4-14 for Tier definitions.



#### Homeowner Benefit:

Using third party certified sustainable harvest wood products helps protect forest ecosystems and resources. Additionally, sustainable harvest wood can be superior in quality when compared to wood produced using standard forestry practices.

## Action Item 13-23

Use trim that is third-party certified sustainably harvested wood, minimum of 50%

### Points: 1-3

#### Responsible party:

Architect

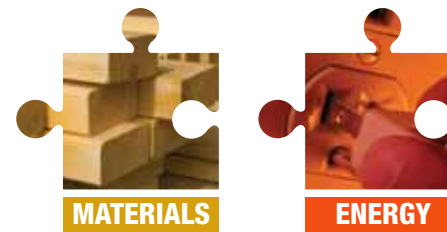
#### Intent:

See Action Item 4-14.



#### Homeowner Benefit:

Avoiding urea formaldehyde protects indoor air quality and enhances occupant comfort.



MATERIALS

ENERGY

**what:** Doors can be reused on site, from other projects, or purchased from used building materials retailers.

**how:** Find doors for reuse at local used building materials retailers, or source them from on site or other projects. Be sure to evaluate salvaged doors for presence of lead based paint.

**resources:** The Northwest Building Salvage Network provides links to used building materials retailers and resources on building salvage:

[www.nbsnonline.org](http://www.nbsnonline.org)  
The site also includes a fact sheet on reusing doors (click on *Downloads*).

## Action Item 13-24

Reuse doors

### Points: 2

#### Responsible party:

Architect, Contractor

#### Intent:

Reduce materials resource use and embodied energy by reusing building materials.



#### Homeowner Benefit:

Reusing doors can save on materials purchase costs, reducing the total cost of the remodel. Additionally, used doors are often higher quality and doors available today.

## Action Item 13-25

Use reconstituted or recycled-content doors

### Points: 1

#### Responsible party:

Contractor, Owner

#### Intent:

Support recycled content product markets and reduce extraction of virgin materials.



MATERIALS

**what:** Approximately 95% of hollow core doors are constructed with recycled corrugated cardboard. Most recycled content solid core doors use post-industrial or post-consumer wood waste and a wood binder to create a medium density fiberboard. Alternatively, some door cores are made from agricultural waste fiber (straw board or wheat board).

**why:** Specifying recycled-content products encourages the market for recyclable materials such as paper and wood waste.

**how:** Seek door manufacturers who use cores manufactured with this or other renewable or recycled materials.

Doors with composite wood cores (including recycled content materials) are often manufactured using urea formaldehyde binders. Inquire of retailers and manufacturers prior to purchasing doors in order to avoid introducing this toxin into the home.

Purchase ENERGY STAR qualified exterior doors (see Resources).

**resources:** The ENERGY STAR program establishes criteria for the thermal performance of exterior doors and many other products for the home: [www.energystar.gov](http://www.energystar.gov) (click on *Products*).

Green Seal Choose Green Report: Particleboard and Medium Density Fiberboard describes issues with composite wood products and how to avoid them: [www.greenseal.org](http://www.greenseal.org) (click on *Publications and Resources*, then *Choose Green Reports*).



MATERIALS



ENERGY

**what:** Cabinets can be reused on site, from other projects, or purchased from used building materials retailers.

**why:** See Action Item 12-1 for the rationale behind reusing building materials.

**how:** Find salvaged cabinets through retailer members of the Northwest Building Salvage Network (see Resources).

**considerations:** Used cabinets may have been manufactured using urea formaldehyde binders. If uncertain about a cabinet's formaldehyde content, consider sealing the wood surfaces with low-toxic paints formulated to block the transmission of VOCs. These paints are available through specialty environmental home retailers. Sealing used cabinets can also reduce exposure to any lead-based paints that may have been applied to the cabinetry in the past.

**resources:** The Northwest Building Salvage Network provides links to used building materials retailers and resources on building salvage: [www.nbsnonline.org](http://www.nbsnonline.org)

The Building Materials Reuse Association provides a directory of used building materials retailers and salvage consultants: [www.bmra.org](http://www.bmra.org)

The Green Home Remodel Salvage and Reuse guide provides general information on building materials salvage and reuse: [www.greentools.us](http://www.greentools.us) (click on *Residential Buildings*, then *Residential Remodeling Guides*)

EPA information on avoiding lead based paint hazards: [www.epa.gov/lead](http://www.epa.gov/lead)  
Homeowners should read the EPA document: "Renovate Right: Important Lead Hazard Information for Families, Child Care Providers and Schools."

## Action Item 13-26

Reuse cabinets

### Points: 1

#### Responsible party:

Architect, Contractor

#### Intent:

Reduce materials resource use by reusing building materials.



### Homeowner Benefit:

Reconstituted or recycled content doors can be less expensive and of similar quality to doors made from virgin materials, benefiting the environment and the project budget simultaneously.



### Homeowner Benefit:

Reusing cabinets can save on materials purchase costs, reducing the total cost of the remodel. Additionally, used cabinets are often higher quality and doors available today.

## Action Item 13-27

Install cabinets made with no added urea formaldehyde board and low-toxic finish

**Points: 4**

**Responsible party:**

Contract

**Intent:**

Protect occupant health by reducing exposure to formaldehyde.



HEALTH

**what:** Low toxic finishes for cabinets include low VOC paints and stains, and water-based sealants. For a description of no added urea formaldehyde products, see Action Item 13-22.

**why:** See Action Item 13-22.



**Homeowner Benefit:**

See Action Item 13-22.

**how:** A variety of cabinet manufacturers can supply product constructed of materials free from urea formaldehyde. See Action Item 13-22 for more information.

**resources:**  
See Action Item 13-22.



MATERIALS

**what:** See Action Item 4-14.

**why:** See Action Item 4-14.

**how:** This Action Item is worth 1 or 3 points.

- Use trim that meets Tier 1 requirements: 3 points
- Use trim that meets Tier 2 requirements: 1 point

50% of purchased cabinets (by weight or purchase price) must meet Tier 1 or 2 criteria. See Action Item 4-14 for Tier definitions.



**Homeowner Benefit:**

Using third party certified sustainable harvest wood products helps protect forest ecosystems and resources. Additionally, sustainable harvest wood can be superior in quality when compared to wood produced using standard forestry practices.

## Action Item 13-29

For cabinets use wood that is third party certified sustainably harvested wood, minimum of 50%

**Points: 1-3**

**Responsible party:**

Architect

**Intent:**

See Action Item 4-14.

## Action Item 13-28

For cabinets, use regional products, 90% minimum

**Points: 2**

**Responsible party:**

Interior Designer, Architect

**Intent:**

Support local economies and responsible natural resource use by purchasing regional products.



MATERIALS



ENERGY

**what:** Regionally produced materials are generally considered to be produced within the Pacific Northwest region, ideally in WA, OR, or ID.

**why:** Use of regional materials helps keep material transport costs down, reinforces a regional aesthetic, and supports the local economy.

**how:** To achieve points for this

Action Item, 90% or more of all cabinets (by weight or purchase price) purchased for the remodel must be regionally produced. A wide variety of cabinets are regionally produced.

**resources:** The Northwest Natural Resource Group is an association of regional timberland owners and others that produce sustainable harvest wood to BUILT GREEN Tier 1 standards: [www.nnrg.org](http://www.nnrg.org) Includes resources for finding products.



**Homeowner Benefit:**

Using regional products helps support local economies.



MATERIALS



HEALTH

**what:** See Action Item 13-21 for a description of urea formaldehyde. Agricultural fiber products include straw board, wheat board, and panels made from other agricultural waste, including sorghum stalks and sunflower seed hulls.

**how:** This Action Item is worth 2 or 3 points:

- 50%: 2 points
- 90%: 3 points

Percentage may be determined by weight or purchase price of new cabinetry (existing cabinetry is not included in calculations).

Most agricultural fiber panel products are manufactured using either phenolic or MDI resins, which contain no added urea formaldehyde. Check with the manufacturer.

**resources:** Green Seal: [www.greenseal.org](http://www.greenseal.org) (click on *Publications and Resources*, then *Choose Green Reports*) for a report on particleboard and MDF.



**Homeowner Benefit:**

Avoiding formaldehyde emissions from products helps protect occupant health.

## Action Item 13-30

Use cabinet casework and shelving constructed of agricultural fiber with no added urea formaldehyde

**Points: 2-3**

**Responsible party:**

Architect, Contractor

**Intent:**

Protect human health and indoor quality by avoiding exposure to formaldehyde.

## Action Item 13-31

Use wood veneers that are third-party certified sustainably harvested wood that meet Tier 1 requirements, 50% minimum

**Points: 1**

**Responsible party:**

Interior Designer, Architect

**Intent:**

See Action Item 4-14



MATERIALS

**what:** See Action Item 4-14.

**why:** See Action Item 4-14.

**how:** This Action Item is worth 1 point.

- Use veneers that meet Tier 1 or Tier 2 requirements: 1 point

50% of purchased veneers (by weight or purchase price) must meet Tier 1 or 2 criteria. See Action Item 4-14 for Tier definitions.



**Homeowner Benefit:**

Using third party certified sustainable harvest wood products helps protect forest ecosystems and resources. Additionally, sustainable harvest wood can be superior in quality when compared to wood produced using standard forestry practices.



MATERIALS



ENERGY

**what:** Hardware can be reused on site, from other projects, or purchased from used building materials retailers.

**why:** See Action Item 12-1.

**how:** Reusing hardware requires having all elements of the hardware on hand; often, vintage hardware is difficult to match with replacement parts. Be sure to consider safety and security when reusing hardware. See Action Item 12-1 for more on reusing materials.



**Homeowner Benefit:**

Reusing hardware can save on materials purchase costs, reducing the total cost of the remodel. Additionally, used hardware is often higher quality and doors available today.

## Action Item 13-33

Reuse hardware

**Points: 1**

**Responsible party:**

Architect

**Intent:**

Reduce materials resource use and embodied energy by reusing building materials.

## Action Item 13-32

Use countertops that are salvaged, recycled, or third-party certified sustainably harvested wood that meets Tier 1 requirements

**Points: 2**

**Responsible party:**

Interior Designer, Architect

**Intent:**

Reduce resource extraction and more responsibly manage resource use by specifying environmentally preferable countertop material.



MATERIALS



ENERGY



HEALTH

**what:** Salvaged countertops are reused from the existing home, other projects, or from used building materials retailers. Recycled content countertops contain material from post-consumer or post-industrial recycling processes. For sustainable harvest wood products, see Action Item 4-14.

**why:** Specifying environmentally preferable countertop materials helps reduce resource use.

**how:** Salvaging countertops or from other projects requires careful removal and storage. Specify recycled content or sustainable harvest wood content when sourcing new materials. A variety of recycled content and sustainable harvest wood countertop options exist, including certified solid wood and butcher block, recycled glass and concrete slabs, and paper-resin composite materials. See Action Item 4-14 for a description of Tier 1 requirements for certified sustainable harvest wood.



**Homeowner Benefit:**

Environmentally preferable countertop material helps protect renewable and/or nonrenewable resources.



HEALTH

**what:** See Action Item 4-3.

**why:** See Action Item 4-3.

**how:** See Action Item 4-3. In addition, clearly communicate with all subs the project's indoor air quality goals, and provide them with product names to increase the likelihood of compliance with goals. (It is very easy for a sub-contractor to simply use "extra"

materials on hand, which may not meet a green project's criteria for performance.)

**considerations:** Specify low toxic, low VOC products for other applications in the home, including caulks and adhesives for framing (Action Item 4-3); joint compound (Action Item 11-2); and paints and finishes (Action Item 13-35).



**Homeowner Benefit:**

Avoiding formaldehyde emissions from products helps protect occupant health.

## Action Item 13-34

Inside the house, use only low-VOC, low-toxic, water-based, solvent-free sealers, grouts, mortars, caulks, adhesives, stains, pigments, and additives for tile and grout

**Points: 2**

**Responsible party:**

Architect, Interior Designer

**Intent:**

Protect indoor air quality and occupant health and comfort by using nontoxic and low-toxic materials.

## Action Item 13-35

Use only low-VOC/low-toxic interior paints and finishes for all surface areas (including doors, windows, trim)

### Points: 5

#### Responsible party:

Contractor

#### Intent:

Protect indoor air quality and occupant health and comfort.



#### Homeowner Benefit:

Low-toxic, low-VOC paints protect indoor air quality, making a home healthier for occupants.



**what:** Volatile organic compounds, or VOCs, are substances that convert to gas at room temperature and pressure, allowing them to be inhaled by occupants.

Toxic compounds found in paints include cadmium, lead, mercury, and various fungicides and mildew inhibitors.

**why:** Some VOCs are toxic or irritating, and in the outdoor environment, VOCs are converted by sunlight into smog, creating a public health problem.

Toxics found historically and currently in paints cause a wide variety of adverse health effects, including acute poisoning, neurological damage, and cancer.

**how:** Specify products that meet the California Air Resources Board's limits for VOCs (see Resources) or choose paints certified by Green Seal (see Resources). Green Seal is an independent non-profit organization that sets environmental and health performance criteria for a variety of products.

**considerations:** Even when using low toxic, low VOC paints and finishes, practice healthy post-application ventilation procedures. See Action Item 13-38 for more information.

**resources:** Green Seal: [www.greenseal.org](http://www.greenseal.org) (click on *Find a Certified Product/Service*).

California EPA Air Resources Board "Architectural Coatings VOC limits" tables: [www.arb.ca.gov/coatings/arch/voclimits.htm](http://www.arb.ca.gov/coatings/arch/voclimits.htm)



**what:** See Action Item 13-35.

**why:** See Action Item 13-35.



#### Homeowner Benefit:

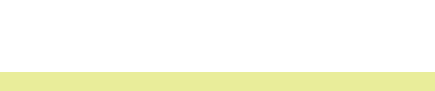
Low-toxic, low-VOC paints protect indoor air quality, making a home healthier for occupants.



**what:** Lead and cadmium are toxic elements: cadmium is a carcinogen and lead is a potent neurotoxin.

**why:** The toxic characteristics of lead and cadmium are well known. Requiring that paints and finishes are free from these substances helps reduce their prevalence not only in the home but also in the larger environment, and reduces worker exposure as well.

**how:** For the purposes of this Action Item, large surface areas are any walls or floors receiving a finish. (Excludes trim, doors and windows.) This Action Item cannot be taken in conjunction with Action Item 13-35.



#### Homeowner Benefit:

Low-toxic, low-VOC paints protect indoor air quality, making a home healthier for occupants.

**how:** The Green Seal paint standard (GS-11) requires paints certified under the standard to be free of cadmium, lead, mercury and other toxic substances. Specifying Green Seal certified paint is one way to ensure these toxins are not in paint. Specifying Green Seal qualified paints also achieves points for low-VOC, low toxic paint as well (see Action Items 13-35 and 13-36).

**resources:** See Action Item 13-35.



#### Homeowner Benefit:

Selecting paints and finishes free from cadmium and lead helps protect occupant health.

## Action Item 13-36

Use only low-VOC/low-toxic interior paints and finishes for large surface areas

### Points: 3

#### Responsible party:

Architect, Interior Designer

#### Intent:

See Action Item 13-35.

## Action Item 13-37

Use only paints and finishes without cadmium or lead

### Points: 1

#### Responsible party:

Architect, Interior Designer

#### Intent:

Reduce toxic materials in manufacturing and toxic exposures in the home.

## Action Item 13-38

Effective ventilation with approved method after each new finish is applied

### Points: 3

#### Responsible party:

Contractor

#### Intent:

Protect worker and occupant health by removing any toxins or irritants introduced by wet finish application.



**what:** Wet finishes evaporate a variety of substances as they cure. Depending on the composition of the finish, these can be benign or problematic.

New finishes (e.g., paints, stains, and floor finishes) will offgas for a time after application. Emissions are highest immediately after the finish is applied. This Action Item helps reduce the risk of unhealthy substances remaining in the home after wet finishes are applied, by requiring the spaces in which they are applied be properly ventilated during the curing process.

**why:** If the house is not properly ventilated during this phase, the emitted gases can absorb into surfaces, to later re-release into the indoor environment.

**how:** Ventilate the house with fans (several box fans placed in windows, blowing in with other windows open simultaneously, works best) so that gases will be exhausted outside. Ideally, the home's HVAC system should be inactivated during the course of the remodel. Alternatively, the existing duct system can be reverse pressurized to ventilate the home via existing ductwork. Venting out should continue for at least two and up to seven days after each application, depending on the amount of surface covered and the cure time and toxicity of the finish. (For toxic finishes applied over large areas, vent for seven days.) Use construction filters and change them out before occupancy.

If possible, ventilate the entire home after completion of the remodel and prior to occupancy.

**considerations:** Specify low-VOC, low toxic finishes (Action Items 13-35 and 13-36) to protect occupant health and reduce required ventilation time.

**resources:** US EPA information on painting and indoor air quality:  
[www.epa.gov/iaq/homes/hip-painting.html](http://www.epa.gov/iaq/homes/hip-painting.html)



**what:** Brominated flame retardants (BFRs) were introduced in 1978. Bromine is a halogen compound, in the same class as chlorine, and is known for being highly reactive. The low cost of brominated flame retardants has facilitated their broad use in a variety of consumer products. However, these substances have been shown to rapidly accumulate in the human body. In 2007, the Washington State Legislature passed a ban (ESHB 1024) on all forms of polybrominated diphenyl ether (PBDE), a brominated fire retardant that is accumulating especially rapidly. BFRs are found in many foam insulation products, especially polystyrene.

**why:** Some BFRs are considered persistent organic pollutants known to bioaccumulate through the food web, and pose a risk of adverse effects to human health and the environment.

**how:** Avoid materials, particularly insulation and carpet padding, with this class of flame retardants.

**resources:** See Action Item 10-9 for more information on environmentally friendly foam products.

US EPA information on PBDEs:  
[www.epa.gov/oppt/pbde/](http://www.epa.gov/oppt/pbde/)

"Brominated Fire Retardants: Rising Levels of Concern" by Sarah Jansen for Health Care Without Harm:  
[www.noharm.org](http://www.noharm.org)  
(click on *BFRs*).



#### Homeowner Benefit:

Properly ventilating a space after wet finishes have been applied helps remove any hazardous materials, volatile compounds or other irritants that may be present. This helps protect indoor air quality and occupant health.

## Action Item 13-39

Do not install products with brominated flame retardant

### Points: 1

#### Responsible party:

Architect, Interior Designer

#### Intent:

Encourage the transition to safer fire retardant compounds.



#### Homeowner Benefit:

Brominated fire retardants are quickly accumulating in the environment and in people. Avoiding these substances in a home helps reduce occupant exposure as well as overall environmental hazard.

## Action Item 13-40

Substitute products that require solvent-based cleaning methods with solvent-free or water-based methods

### Points: 1

#### Responsible party:

Contractor

#### Intent:

Reduce exposures to toxic compounds; protect occupant health and comfort, indoor air quality and reduce hazardous waste.



#### Homeowner Benefit:

Eliminating solvent-based cleaning products during construction (and later, by the homeowner as well), avoids toxic materials in the home, which in turn protects occupant health and indoor air quality.



**what:** Most solvent-based cleaning methods are required because of the use of oil-based paints, stains, caulks and other products. Solvent-based products include acetone, paint thinner, and other highly toxic compounds.

**why:** By replacing solvent-based products with water and other more benign cleaning compounds, a remodeler can reduce the amount of hazardous materials on the jobsite, in turn reducing the risk of toxic exposure to both workers and building occupants.

Also, reducing the amount of hazardous materials used by a firm can exempt it from costly hazardous waste management requirements. Similarly, since shifting away from solvent-based cleaning products will also likely mean a move away from using oil-based paints, stains and other products—again, reducing both toxic exposure risk and hazardous waste management issues.

**how:** Eliminating solvent-based cleaning products likely will mean a general examination of a project's paint, finish and adhesive choices to avoid solvent-based products. This should not be difficult—a wide variety of water-based products have been developed for virtually any application on a standard remodel.

One challenge to achieving this Action Item may be using plant oil-based paints and stains, which can require plant-based solvents for brush cleanup.

**resources:** King County Local Hazardous Waste Management Program includes information for homeowners on household hazardous materials and safer alternatives: [www.govlink.org/hazwaste](http://www.govlink.org/hazwaste) (click on *Household*, then *Alternatives*).



**what:** Gas dryers use the heat from combusting natural gas on site to dry clothing; by contrast, electric dryers use electricity generated at a remote power plant to heat an element in the dryer.

**why:** The direct application of natural gas-derived heat on site is a more efficient approach than burning fuel at the power plant to create electricity to, in turn, heat an element on site. Consumer benefits are approximately \$35 per year in western Washington (at 2009 natural gas and electricity rates). Cost for fuel piping when installed during construction is minimal: \$40 to \$75. Costs may be higher in a remodel application. Gas clothes dryers generally cost about \$40 more than electric clothes dryers.

**how:** Natural gas clothes dryers are widely available. The level of efficiency between dryers is relatively small, and dryers are not labeled for efficiency using either the Department of Energy's Energy-Guide labeling program or ENERGY STAR. Look for long warranties and comprehensive service agreements. Whether choosing a gas or electric dryer, choose one with a moisture sensor, which shuts off the dryer when the clothes are dry.

Be sure to examine the expected future cost of fuels when making appliance and heating decisions, as well as weighing the carbon impacts of electricity sources based on the project's electric utility fuel source.

**considerations:** Line drying (Action Item 13-1) is by far the most environmentally benign (and cost-effective) way of drying clothes. Consider installing an easy-to-use clothes line to reduce overall dryer use, and select a clothes washer that achieves high spin speeds (usually front loading models; see Action Item 13-42) to extract more water during the wash cycle, reducing drying time and making line drying more feasible.

**resources:** EPA Indoor Air Quality in Homes: Preventing Problems with Combustion Equipment: [www.epa.gov/iaq/homes/hip-combustion.html](http://www.epa.gov/iaq/homes/hip-combustion.html)

## Action Item 13-41

Install gas clothes dryer

### Points: 1

#### Responsible party:

Contractor, Owner

#### Intent:

Reduce greenhouse gas emissions by avoiding system losses associated with electricity generation and distribution, and the inefficiency of electric appliances.



#### Homeowner Benefit:

At current energy prices, natural gas is a cost-effective heating source, reducing annual energy bills compared to electric dryer operations. Additionally, combusting gas on site for heat avoids the energy losses associated with gas-fired or coal-fired power plants.

## Action Item 13-42

Install front loading, ENERGY STAR washing machine

### Points: 3

#### Responsible party:

Owner, Contractor

#### Intent:

Reduce water, energy and wastewater use associated with laundry activities.



**what:** Horizontal-axis (H-axis) clothes washers place the conventional washer's drum on its side, tumbling clothes clean as opposed to twisting them clean with an agitator, the way standard vertical-axis washers do. ENERGY STAR criteria for clothes washers include an energy factor (the MEF or Modified Energy Factor) and a Water Factor, allowing the purchaser to evaluate both potential water and energy savings.

**why:** According to the US EPA, an ENERGY STAR clothes washer can reduce clothes washer energy use by 1/3 and water use by half compared to industry average. Additionally, H-axis washers spin at a higher RPM than conventional washers, shortening drying time as well as drying energy used.

While H-axis washers tend to cost more than conventional clothes washers, the energy and water savings over the life of the unit more than offset the up-front added cost. The ENERGY STAR website provides a calculator to help determine the savings a homeowner can expect by upgrading to a high-efficiency clothes washer.

**how:** Check the ENERGY STAR website to identify the most efficient front loading washers, as well as a retailer locator and information on special offers and rebates. Most major appliance brands now include a horizontal axis option. Even within the ENERGY STAR program there is substantial variability in the efficiency of models, especially when water use is also taken into account.

The project's water utility may offer rebates for ENERGY STAR and better clothes washers, such as the Saving Water Partnership's Wash-Wise rebate.

**considerations:** In King County, it is legal to use harvested rainwater for clothes washing (Action Item 8-3). Additionally, clothes washer wastewater may be suitable for greywater reuse (Action Item 8-1). Alternatively, plumbing for future rainwater or greywater use (Action Items 8-2) can help facilitate the future retrofit of a property to these uses.

**resources:** The ENERGY STAR program establishes energy and water performance criteria for clothes washers : [www.energystar.gov](http://www.energystar.gov) (click on *Products*, then *Appliances*).



**what:** As with other home appliances, national energy standards have spurred the development of more efficient dishwashers. Energy- and water-efficiency are closely related in dishwashers except for booster heating and drying cycles.

**why:** ENERGY STAR dishwashers are evaluated for energy efficiency; the Department of Energy is currently evaluating whether or not to include a water efficiency metric. ENERGY STAR clothes washers include a water efficiency factor, called the Water Factor.

An ENERGY STAR dishwasher benefits the homeowner from several perspectives—performance, water and energy efficiency, ease of use, total features, quiet operation, and reliability.

The most water-efficient dishwashers use as little as 3.9 gallons per cycle at the economy setting. Energy savings range from 80 kWh per year to 364 kWh per year.

**how:** Find specific brands and makes of ENERGY STAR dishwashers on the [energystar.gov](http://energystar.gov) website. The site also provides a retailer locator and information on special offers and rebates.

Size the dishwasher to the expected volume of use in the home. For smaller households, "European" sized models (narrower, smaller capacity units), or units that allow for half-load cycles may be preferable. However, if a compact model is used more frequently, it can actually use more energy time over time than a larger model. Include information in the Homeowner's Operation and Maintenance Manual about the efficiency benefits of running full loads, and using the air-dry function rather than heat drying dishes.

To receive the benefits of quiet operation and water savings as well as energy use reduction with a new dishwasher purchase, look for the appliance with the lowest sone rating (a measure of noise emitting from the product).

#### considerations:

Achieve additional water savings in the kitchen by installing a low flow kitchen faucet or aerator (see Action Item 8-10).

#### resources:

The ENERGY STAR program: [www.energystar.gov](http://www.energystar.gov) establishes energy performance criteria for dishwashers (click on *Products*, then *Appliances*)

## Action Item 13-43

Install an ENERGY STAR dishwasher

### Points: 1

#### Responsible party:

Contractor, Plumber

#### Intent:

Reduce energy and water use associated with dishwashing.



#### Homeowner Benefit:

Front loading, ENERGY STAR clothes washers save water and energy, which reduces bills related to clothes washing-related electricity, water heating, water and wastewater. They also help clothes dry faster, saving energy. Finally, it reduces costs related to detergent use (front-loader use less detergent and standard top-loaders), and they're gentler on clothing, helping clothes last longer.



#### Homeowner Benefit:

According to US EPA and Department of Energy, ENERGY STAR qualified dishwashers are more than 40 percent more efficient than current federal minimum standards, helping a home save \$30 annually on energy bills, and, if chosen carefully, on water bills as well. Some of the most efficient dishwashers also operate significantly more quietly than conventional dishwashers.



## Action Item 13-44

Install ENERGY STAR refrigerator

**Points: 2**

**Responsible party:**

Owner, Contractor

**Intent:**

Reduce energy use associated with refrigeration.



**what:** The ENERGY STAR program is a partnership of the US EPA and the US Department of Energy that sets energy efficiency and performance standards for a wide variety of energy-consuming goods and appliances.

**why:** Refrigerators are, on average, the most energy-intensive appliance in the kitchen, so replacing a standard model with an energy-efficient version can have a substantial impact on energy use. Energy conservation not only saves homeowners money; it reduces pollution related to electricity production.

In the summertime, high efficiency refrigerators produce less waste heat than older, inefficient models, keeping the home more comfortable.

**how:** Find specific brands and makes of ENERGY STAR refrigerators on the ENERGY STAR website. The site also provides a retailer locator and information on special offers and rebates. Side-by-side and refrigerators with through-door ice and water dispensers use 10-25% more energy than refrigerators with the freezer at the top. ENERGY STAR categorizes refrigerators by configuration, meaning that a search for the most efficient side-by-side refrigerators won't reveal the most efficient refrigerator overall. While auto defrost is a convenient feature in a freezer, be aware that the feature requires additional energy use. (However, manual defrost refrigerators require proper maintenance to maintain optimal energy efficiency.)

Refrigerators are often oversized for their application, due to an urge to provide capacity for the occasional large event. Advise clients as to the efficiency benefits of sizing a refrigerator such that it spends most of its working life relatively full.

**considerations:** Old refrigerators are commonly relocated to the garage or basement, rather than decommissioned. Homeowners should be advised that this unnecessarily adds to a home's energy use; a preferred option is proper recycling of an old fridge. Recycle old refrigerators via local solid waste utilities or services certified by the EPA to handle refrigerants, which contain ozone-depleting CFCs and HCFCs.

**resources:** The ENERGY STAR program establishes energy performance criteria for refrigerators: [www.energystar.gov](http://www.energystar.gov) (click on *Products*, then *Appliances*).



**what:** Natural gas stoves and cook tops combust natural gas at the point of use, using that combustion provides heat for cooking purposes.

**why:** In areas where natural gas or coal constitutes the energy source for electricity at the power plant, it is inherently more efficient to burn natural gas at the point of use.

At current energy prices for natural gas and electricity, natural gas is a less expensive way to cook food.

**how:** Action item 9-19, installing a carbon monoxide detector, is required with this credit.

Gas stoves and cook tops with electronic ignition devices use 40% less gas than those with a pilot light.

**considerations:** This credit conflicts with Action Item 1-41, which provides points for not installing gas-fired appliances in the home. While natural gas is a more efficient form of heating, it also introduces water vapor and combustion byproducts into the living environment.

**resources:** The Consumer Product Safety Commission Document #452: "What You Should Know About Combustion Appliances and Indoor Air Pollution:" [www.cpsc.gov/CPSCPUB/PUBS/452.html](http://www.cpsc.gov/CPSCPUB/PUBS/452.html)

EPA Indoor Air Quality in Homes: Preventing Problems with Combustion Equipment: [www.epa.gov/iaq/homes/hip-combustion.html](http://www.epa.gov/iaq/homes/hip-combustion.html)

## Action Item 13-45

Install gas stove/cooktop (requires a carbon monoxide detector)

**Points: 2**

**Responsible party:**

Contractor

**Intent:**

Reduce source energy use associated with cooking.



### Homeowner Benefit:

According to the ENERGY STAR program, a homeowner replacing their 1990s era refrigerator with a modern ENERGY STAR qualified model can reduce refrigeration-related energy bills. Current ENERGY STAR qualified models are 20% more efficient than current federal standards, and 40% more efficient than the average model produced in 2001.



### Homeowner Benefit:

At current energy prices, natural gas is a cost-effective heating source, reducing annual energy bills compared to electric models. Additionally, combusting gas on site for heat avoids the energy losses associated with gas-fired or coal-fired power plants.

## Action Item 13-46

Install an induction electric cooktop

### Points: 2

#### Responsible party:

Owner, Contractor

#### Intent:

Reduce energy use associated with cooking.



**what:** Induction cooktops use electromagnetism to directly heat a pan or pot by exciting the molecules in the pan, rather than heating resistance coils that then transfer heat to a pan (the process a standard electric cooktop uses) or by combusting natural gas or propane. Essentially, induction cooktops turn the pot or pan into the heating element itself, dramatically reducing waste heat.

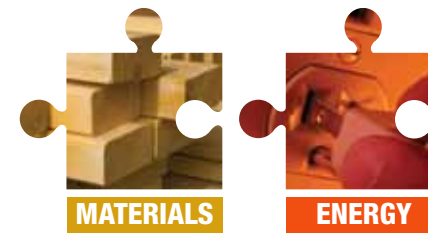
**why:** Due to their increased efficiency with heating for cooking, induction cooktops can reduce a home's energy use and, in turn, reduce its carbon footprint.

According to the American Council for an Energy Efficient Economy, induction cooktops are approximately twice as efficient as standard electric coil element cooktops.

**how:** Induction cooktops are available through most major appliance manufacturers. Still considered a niche market, many of the products are higher-end brands and models. The current price increment for an induction cooktop is likely more than the monetary amount that will be recouped in energy savings.

Additionally, induction cooktops, while energy efficient overall compared to electric resistance cooktops, require substantial amounts of energy during operation. Electrical capacity issues should be considered when a home is being outfitted with an induction cooktop.

**considerations:** Some healthy home experts are concerned with the potential health impacts of electromagnetic radiation, which is produced whenever an electric current is run through wiring or other systems. This is not specific to induction cooktops, but should be considered if a client has concerns about extremely low frequency (ELF) and radio frequency (RF) radiation.



**what:** Many finish items, if properly removed and handled, can be reused either in the current project, other projects, or sent to used building materials retailers or nonprofits. Trim, molding, fireplace mantles and other materials are all candidates for reuse.

**why:** See 1-45 for a discussion of the benefits of salvaging and reusing building materials, and creating a comprehensive salvage and reuse plan for a project.

**how:** Vintage finish materials can be brittle and difficult to remove. Key to success is making sure the materials are not adhered to adjacent surfaces with paint. Use a box cutter or other knife to cut the material free, easing the prying process.

**considerations:** Old painted materials can very likely contain leaded paints. See Resources for EPA guidance related to working with lead during remodeling and renovation. As of April 2010, contractors working on projects that may disturb lead-based paint must be certified (40 CFR 745.80, Subpart E). Find regional used building materials retailers through the Northwest Building Salvage Network or via Habitat for Humanity (see Resources).

#### resources:

The Northwest Building Salvage Network provides links to used building materials retailers and resources on building salvage: [www.nbsnonline.org](http://www.nbsnonline.org)

The Building Materials Reuse Association provides a directory of used building materials retailers and salvage consultants: [www.bmra.org](http://www.bmra.org)

Habitat for Humanity's building materials reuse centers: [www.habitat.org/env/restores.aspx](http://www.habitat.org/env/restores.aspx)

The Green Home Remodel Salvage and Reuse guide provides general information on building materials salvage and reuse: [www.greentools.us](http://www.greentools.us) (click on *Residential Buildings*, then *Residential Remodeling Guides*).

EPA information on avoiding lead based paint hazards: [www.epa.gov/lead](http://www.epa.gov/lead)  
Homeowners should read the EPA document: "Renovate Right: Important Lead Hazard Information for Families, Child Care Providers and Schools."

## Action Item 13-47

Sell or donate reusable finish items

### Points: 1

#### Responsible party:

Contractor

#### Intent:

Reduce waste associated with remodeling and the embodied energy and resource use associated with manufacturing new building materials.



#### Homeowner Benefit:

Induction cooktops save energy, and therefore reduce energy bills, due to their superior efficiency at heating pots and pans. Additionally, they can heat items more rapidly, reducing cooking times. Induction cooktops also reduce the risk of burns from hot cooking surfaces, since nearly all heat is generated in the pan or pot itself.



#### Homeowner Benefit:

By diverting reusable finish items from disposal, a homeowner can reduce disposal costs. Additionally, if the materials are sold or donated, the homeowner can realize additional cash or tax savings.

## Action Item 13-48

Use recycled or “reworked” paint and finishes in addition and for any re-painted surfaces

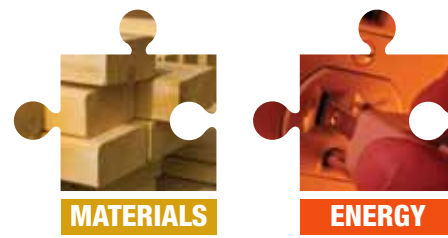
### Points: 1

#### Responsible party:

Interior Designer, Contractor

#### Intent:

Reduce paint waste by promoting paint recycling; reduce demands on virgin resources and the energy use associated with raw material extraction and product manufacturing.



MATERIALS

ENERGY

**what:** Recycled or “reworked” paint is made by redirecting waste paint from disposal, combining it with other waste paint, and then filtering and processing to meet quality control standards. Often run by a local hazardous or solid waste management program, recycled paints are re-sold through those municipal or regional programs or through conventional paint manufacturers.

**why:** Recycled paints are often high quality, offered at a very competitive price. Using these products helps support the diversion of waste paint from disposal, reducing pressures on waste management systems.

According to MetroPaint, a supplier of recycled latex paint from Portland, Oregon, recycling paint saves more energy per pound than recycling most other construction materials, including steel, glass, and lumber: using one gallon of recycled latex paint saves 100 kWh of energy, which equates into an avoided 115 pounds of carbon dioxide emissions. (That’s enough energy to power a refrigerator for two months.)

**how:** To achieve points for this Action Item, the project must use recycled paint for surfaces in any addition spaces and existing surfaces slated for repainting.

Find recycled and reworked paints by inquiring of your local hazardous waste management program or local paint suppliers, and also from some used building materials retailers. Recycled paints are applied and used like standard paint. The California Integrated Waste Management Board’s Recycled Content Product Database includes a category for paints and finishes.

**considerations:** It may be difficult to find recycled paint that can verify its VOC content, although some manufacturers can provide general information on their average VOC levels. It is also possible that recycled paints may contain trace amounts of other toxins (e.g., mercury or cadmium) from the source stock.

**resources:** The California Integrated Waste Management Board maintains a Recycled Product Directory: [www.ciwmb.ca.gov/rcp/](http://www.ciwmb.ca.gov/rcp/) (click on *Construction*, then *Paint and Stains*).



MATERIALS

HEALTH

ENERGY

**what:** Natural finishes fall into several categories. Lime paints contain hydrated lime, and have been used for many centuries to white-wash building materials. They are also combined with pigments and sometimes casein (milk protein) to create interior finishes. These materials usually act like a stain, soaking into the substrate layer and forming a breathable finish. Clay or earthen finishes contain natural clay (and sometimes pigments as well) to create a surface coat similar to plaster or stucco.

**why:** Depending on the source, natural finishes can have very low embodied energy, due to their low-tech, simply sourced ingredients. Clays found onsite can actually be used for clay plasters. The porous nature of natural finishes means they’re less likely to blister or fail when exposed to moisture migrating through a wall assembly. They can also absorb and slowly release moisture, helping regulate a room’s humidity level. Additionally, conventional finishes, like latex paint, have high “embodied energy,” meaning they require a large amount of energy to manufacture. See Action Item 13-48, promoting the use of recycled paint, for facts on energy use related to latex paint.

**how:** This Action Item is worth 1 or 3 points.

- Use natural wall finishes for any amount of wall surface: 1 point
- Use natural wall finishes for 200 square feet or more wall surface: 3 points

Natural finishes are quite different from standard wall finishes, and can require considerable skill and experience in application. Consider hiring a subcontractor with specific experience working with the material being considered for the project.

## Action Item 13-49

Use natural wall finishes, like lime paint and clay

### Points: 1-3

#### Responsible party:

Architect, Interior Designer, Contractor

#### Intent:

Reduce toxins entering a home; reduce embodied energy resource use and pollution associated with paint manufacturing.



#### Homeowner Benefit:

Recycled paints can be of equal quality to paints manufactured from virgin materials, but often cost significantly less. Additionally, it’s possible to specify low-VOC reworked paints, which ensures a project is not trading off indoor air quality goals for cost considerations.



#### Homeowner Benefit:

Natural wall finishes provide breathable, durable finishes without toxic compounds or volatile emissions, creating a healthier indoor environment.

## Action Item 13-50

Install moisture alarms under sinks and dishwasher

**Points: 1**

**Responsible party:**

Contractor

**Intent:**

Protect indoor air quality and building durability by reducing moisture and bulk water damage.



**what:** Moisture alarms (also known as water alarms) sense moisture or bulk water and notify the homeowner, usually with an audible alarm. Units can be battery powered or hardwired.

**why:** Prevention is almost always cheaper than cure, and with moisture damage, this is definitely the case. Leaks can go undetected for months (or years), causing mold and indoor air quality issues, as well as structural damage. Low-cost moisture sensors can help quickly alert a homeowner to a moisture problem.

**how:** Water alarms are available from online retailers and plumbing suppliers. Likely sources of leaks include under sinks, dishwashers, and clothes washers.

For this Action Item, water alarms must be placed under the kitchen sink and dishwasher, and under any bathroom lavatories where a leak may go unnoticed, e.g., lavatory vanities and other sinks with enclosed bases.

**considerations:** Leak detectors are a last line of defense; proper installation, high quality materials and appliances, and designs that prevent leaks from occurring unnoticed help ensure the risk of moisture damage is minimized.



**what:** Homeowner education regarding the storage of household hazardous materials consists of summarizing and developing educational material related to the topic, and then presenting that material to the homeowner.

**why:** Physical separation of household hazardous materials (cleaning products, maintenance materials such as paints and cleaners, etc) helps ensure volatile organic compounds in the materials do not contaminate occupied space, reducing the risk of exposure to these substances.

Create an educational sheet that discusses both the importance of choosing less toxic materials for cleaning and maintenance, as well as the idea of keeping hazardous materials out of occupied spaces and away from children. Provide this material in the Homeowner's Operations and Maintenance Manual. Specifically review the material with the homeowner. See Resources for information that can be readily compiled into information sheets for homeowners.

**how:** A lockable storage closet in the garage (vented to the outside away from fresh air intakes such as windows) prevents fumes from getting into the living area, as well as toxic or otherwise dangerous chemicals from getting into the hands of curious children. Keep the storage closet small, to discourage homeowners from accumulating too many hazardous products, and locate it away from any source of ignition, such as a combustion water heater. Provide a note in the Operations & Maintenance Kit advising that all hazardous materials should be stored in original containers.

Providing a Green Cleaning Kit to homeowners (see Resources), containing healthier cleaning supplies such as baking soda, white vinegar, Castile soap and essential oils such as Lavender and Tea Tree, along with reusable pump spray bottles can serve as a reminder of low-toxic cleaning options.

**considerations:** Safe storage of cleaning and maintenance products is another reason to keep the garage separated from living space (see Action Item 1-34).

**resources:** King County Local Hazardous Waste Management Program includes information for homeowners on household hazardous materials and safer alternatives:  
[www.govlink.org/hazwaste](http://www.govlink.org/hazwaste) (click on *Household*, then *Alternatives*).

## Action Item 13-51

Educate homeowners on keeping hazardous cleaning and maintenance products separate from occupied space

**Points: 1**

**Responsible party:**

Contractor

**Intent:**

Protect occupant health; reduce the incidence of poisonings and exposure to toxics.



### Homeowner Benefit:

Quick identification of leaks helps avoid mold and potential structural damage associated with water. Avoided costs can be substantial, in terms of cleanup, respiratory and health issues related to mold, and even expensive structural repair.



### Homeowner Benefit:

Proper storage of household hazardous materials protects the health of all occupants and the health and safety of small children.

## Action Item 13-52

Provide homeowners with maintenance checklists (furnace filters, under the fridge, etc.)

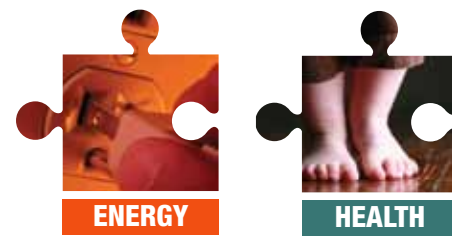
### Points: 4

#### Responsible party:

Contractor

#### Intent:

Ensure proper operation and maintenance of home systems to maintain efficiency and effectiveness of systems.



**what:** Home maintenance checklists organize maintenance activities, often by general category cross-referenced by season or time of year. They provide a homeowner with valuable information on preventive activities that help keep a home functioning properly.

**why:** Beyond the obvious benefits to the homeowner, proper maintenance benefits the environment by keeping building systems running efficiently and lasting longer, reducing the home's environmental footprint. Additionally, proper maintenance helps reduce the likelihood of service callbacks, when improper maintenance is misidentified as possible construction defects.

**how:** Education of homeowners regarding home maintenance requires two steps: creating a checklist and then providing the checklist to the homeowner. Various checklists have been developed and are available for adaptation (see Resources).

The maintenance checklist should feature prominently in the Homeowner Operations and Maintenance Manual, and be specifically referenced when showing the Manual to the homeowner.

Checklists should cover the various Built Green topic areas, including health and indoor environmental quality, water and energy conservation, and moisture management and durability. Sample checklists often cover just one or a few of these areas; it may be necessary to combine elements from existing checklists to create a BUILT GREEN home maintenance resource.

**resources:** Mississippi State University Extension Service's home maintenance checklist: [www.msucare.com](http://www.msucare.com) (search for *Maintenance Checklist*).



#### Homeowner Benefit:

Proper maintenance of appliances, heating and cooling equipment, and home systems helps ensure elements are functioning optimally (reducing utility and maintenance costs) and last longer (reducing replacement costs over the lifetime of the home).

## LANDSCAPING

Landscaping choices can impact water use, water quality, and even home energy use. Additionally, a landscape can serve as a resource to native species, helping provide bird and beneficial insect habitat. Considering the home's site as a system helps capture opportunities that serve multiple beneficial purposes.

## Action Item 14-1

Install landscaping that requires no potable water for irrigation whatsoever after initial establishment period (approximately 1 to 3 years)

### Points: 10

**Responsible party:**

Landscape Architect

**Intent:**

Expand regional water supplies and protect aquatic habitats by reducing peak summer water demand.



**what:** A landscape that requires no additional potable water after establishment is a carefully designed integrated system and includes features such as drought-tolerant plantings, proper plant placement, and properly amended, healthy soil.

**why:** In the mid- to late summer, the Central Puget Sound receives less rainfall than Tucson, Arizona. It's during that time that our regional water supplies are stretched thinnest. Conserving water via water-wise landscaping practices reduces water bills and leaves more water in lakes and streams for people and fish.

**how:** Planning a landscape for irrigation-free maintenance requires in-depth knowledge of plant species and an understanding of the site's specific soil and drainage characteristics. Select plants that are native to the area or suitable for our climate and rainfall patterns, and match the site's micro-climatic profile. Amend soil with compost to help establish good soil conditions (see Action Item 14-5); additionally, proper placement of individual plants in the landscape will reduce supplemental watering needs. Be prepared to remove, or instruct the homeowner to remove the temporary irrigation system after the initial plant establishment period.

**considerations:** This Action Item specifies that no potable water be used for irrigation after establishment. Irrigation with captured rainwater or greywater (Action Item 8-1) is allowed. However, keep in mind that the same precipitation patterns that make for a challenging environment for most plants in late summer also make rainwater catchment challenging during that same period. A subsurface greywater system may be more appropriate, given its supply of year-round water. Note that greywater is allowed and appropriate only for certain species of plants that can withstand the salts present in greywater, and not for edible landscapes.

**resources:** The Saving Water Partnership provides in-depth information on landscape water conservation in the Conserve Outside section. The website includes information on soil preparation, plant selection and placement, and more to help establish an irrigation-free landscape: [www.savingwater.org](http://www.savingwater.org)

King County's Native Plant Guide website provides a wealth of information on designing and installing a native landscape: [www.green.kingcounty.gov/GoNative/Index.aspx](http://www.green.kingcounty.gov/GoNative/Index.aspx)



**what:** This Action Item contains three elements: the water budget, irrigation system testing, and the Landscape Maintenance Plan.

A water budget is a way of calculating the irrigation water needed for a site based on plant selection, soil type, precipitation, and irrigation system. Water budgets are calculated for the peak watering period (in the Pacific Northwest, peak watering occurs in July). See Resources for additional information on water budgets provided by EPA's WaterSense program. Testing for coverage and flow is conducted after the irrigation system has been designed and installed.

**why:** A Landscape Maintenance Plan helps a homeowner identify important operations and maintenance needs for their landscape. This plan includes a maintenance schedule that identifies specific frequencies for the irrigation system, pruning, mulching and top-dressing with compost, and other key tasks. Especially important to include in the plan are maintenance requirements of green building approaches, such as greywater and rainwater harvest irrigation systems, and rain gardens.

**how:** Only with testing can an irrigation system be ensured to function as intended. Additionally, homeowner education is key to maintaining a system in proper working order. This not only saves money for the homeowner, it also reduces the likelihood of callbacks related to system malfunction or failure caused by neglect or damage.

Hire a certified irrigation professional to help design, install and verify performance of a system, as

well as help assemble a landscape maintenance plan. Look for professionals with knowledge in water-wise landscape design and natural landscaping. The US EPA's WaterSense program maintains a list of certified irrigation professionals; see Resources.

**considerations:** Ideally, a landscape should be able to thrive without a permanent irrigation system (see Action Item 14-1). However, if a system is needed (e.g., for on-site food production) or desired by the homeowner, first design a landscape that thrives on as little water as possible (see Action Item 14-1) and then design the most efficient irrigation system for the landscape design (see Action Item 14-3 for information on drip irrigation) and be sure to properly amend soils for optimal plant vitality (see Action Item 14-5). Irrigation systems can be installed that avoid the use of potable water by using rainwater or greywater (Action Item 8-1). Such systems require special system design, permitting and landscape planning; see the action items referenced above for more information.

**resources:** EPA's WaterSense program: [www.epa.gov/watersense](http://www.epa.gov/watersense)

WaterSense includes information on water budget and includes a water budget tool: [www.epa.gov/watersense/specs/homes.htm](http://www.epa.gov/watersense/specs/homes.htm)

The Saving Water Partnership provides information on hiring landscape professionals and maintains a list of certified irrigation professionals: [www.savingwater.org/outside\\_professional.htm](http://www.savingwater.org/outside_professional.htm)

## Action Item 14-2

If installing an irrigation system, provide a Water Budget, test irrigation system to verify coverage and flow rates, and provide a Landscape Maintenance Plan to homeowners

### Points: 2

**Responsible party:**

Landscape Architect, Irrigation Contractor

**Intent:**

Conserve water by ensuring optimal application of water via irrigation system.



### Homeowner Benefit:

An irrigation-free landscape reduces summertime water use, often when water rates and residential water demand is highest. This reduces water-related utility bills, and provides the homeowner with a lower maintenance landscape.



### Homeowner Benefit:

By setting goals for landscape water use and verifying irrigation systems for performance, a project can optimize its use of water for irrigation purposes—saving on water bills and promoting a healthier landscape.

## Action Item 14-3

Sub-surface or drip systems used for irrigation

### Points: 2

#### Responsible party:

Landscape Architect

#### Intent:

Conserve water by ensuring optimal application of water via irrigation system.



**what:** Sub-surface irrigation systems administer water to plants via piping placed under the soil's surface, feeding water directly to the plant's root zone and avoiding evaporation and overspray associated with conventional systems. Drip irrigation uses emitters that restrict water flow so that it is released at a slow drip. Drip systems can be installed on the surface or just below the surface.

**why:** Sub-surface and drip irrigation systems can dramatically reduce water lost to evaporation and improve the efficiency of an irrigation system. According to the US EPA's WaterSense program, drip systems use 20-50% less water than conventional above ground sprinkler systems.

**how:** Sub-surface and drip irrigation systems should be designed and installed by a certified irrigation professional. Find contractors licensed in Washington State and certified through the Irrigation Association, Washington Association of Landscape Professionals, Irrigation Water Management Society, or the US EPA's WaterSense program. See Resources for a list of certified professionals.

**considerations:** Combine this with Action Item 8-1 (plumb for greywater or rainwater for irrigation in place of potable water). Designing a landscape using native or climate-adapted low water use species (Action Item 14-15) will ensure a truly water-wise landscape.

**resources:** The EPA WaterSense program maintains a list of WaterSense certified irrigation professionals: [www.epa.gov/watersense](http://www.epa.gov/watersense) (click on *Find a Product*, then *Landscape Irrigation Services*).

The Saving Water Partnership provides information on selecting and installing drip irrigation systems: [www.savingwater.org/outside\\_watering.htm](http://www.savingwater.org/outside_watering.htm)

The H2Ouse website provides information on irrigating efficiently with portable water and information on greywater and rainwater irrigation systems: [www.h2ouse.org](http://www.h2ouse.org) (click on *Home Tour* and then *Landscaping*).



**what:** Rainwater harvest systems provide site-sourced water for a variety of purposes depending on the system, including landscape water use and non-potable indoor water use (toilet flushing; clothes washing). A rooftop rainwater collection system consists of a suitable roof and guttering system, a storage tank(s) sized to the demand of the application, and a filtration system. The irrigation system can be supplied using a small-scale pressurized pump system or gravity, depending on the system design.

**why:** The Puget Sound area's dry summers put strain on regional water supplies, and with global warming impacts including reduced snow pack, current supplies will be even further strained. Enhancing supply through on-site rainwater catchment and reuse helps reduce this demand. Such systems can also reduce environmental and energy impacts associated with potable water treatment and distribution. Moreover, if properly designed, a rainwater collection system can serve double duty by helping detain and slowly release stormwater during winter storm events.

**how:** With training and experience, a remodeling or contracting firm can add rainwater harvest system design and installation to its suite of services, helping capture this growing market niche.

This action item is worth 5-15 points.

- 5 points for first 500 gallons of cistern capacity
- 1 point for each additional 100 gallons
- Maximum 15 points.

Designing and constructing a rainwater harvest system is a complex project. If the project team does not include a professional with applied experience designing and installing such systems, consider hiring an expert.

**considerations:** The first step in designing a rainwater catchment system is to minimize landscape water demand. This is achieved by proper soil preparation (Action Item 14-5), smart plant selection (Action Item 14-15), and advanced irrigation practices (Action Item 14-3)

While rainwater collection for indoor use is allowed in King and Snohomish Counties, this Action Item covers only systems used for irrigation. (Rainwater collection for potable water use requires individual system approval and compliance with stringent local and state health regulations.)

For collecting rainwater from roof areas:

- Use appropriate roofing materials such as metal, tile, or fiber cement. Lead-containing materials, such as flashing, should not be used in catchment surfaces. Likewise, ensure that no zinc galvanized ridge caps, copper flashing, or copper wires for moss prevention are used. Asphalt composition roofs should not be used for collecting water for watering fruits and vegetables.
- Construct cistern or tank storage sized for the landscape's Water Budget, the rainfall amount and roof size, and appropriate overflow devices. (*continued next page*)

## Action Item 14-4

Install rainwater collection system (cistern) for reuse (minimum of 500 gallons)

### Points: 2

#### Responsible party:

Landscape Architect, Plumber, Expert

#### Intent:

Protect water supply by reducing potable water use for irrigation and non-potable indoor uses, such as toilet flushing and clothes washing; retain stormwater on site for beneficial use.



#### Homeowner Benefit:

By putting water where it's needed and reducing evaporative water loss, drip and sub-surface irrigation systems can provide substantial water savings compared to conventional irrigation systems—reducing water bills. Additionally, drip and subsurface systems can protect plant health by avoiding mold and mildew associated with overhead watering practices, keeping plants healthier and more attractive.



#### Homeowner Benefit:

Rainwater harvest systems reduce a home's impact on the regional water supply system by capturing and using rainfall on-site, reducing water and wastewater bills. Additionally, if used for landscape watering, site-harvested water can help improve plant health and vitality, by providing a chemical-free source of water.

## Action Item 14-4

- Cisterns can be made of pre-cast or poured in place concrete, ferrocement, stone, or prefabricated metal, plastic, or fiberglass. Use only watertight materials for a cistern, and opaque materials for above ground systems.
- Provide an overflow route to direct excess flows away from building and in such a manner as to avoid impact to downstream properties.
- Install gutters and downspouts sized for the roof and rainfall intensity.
- Install screening devices or roof washers to filter leaves, debris, and sediment.

Whether a rooftop cistern will be sufficient to meet all of the irrigation demands during the dry season will be dependent upon the irrigation requirements of the landscape and the system's storage capacity. Cisterns can be placed either above or below grade. For large cisterns, work with a structural engineer to ensure the storage tank does not load onto the home's foundation.

Cisterns sized to provide rainwater for landscape use through the Puget Sound area's very dry late summer months need to be large. Below grade cisterns tend to be more expensive than above grade ones due to the need for excavation.

Cisterns for indoor uses such as toilet flushing (Action Item 8-3) have the dual benefit of being used year-round and providing stormwater management benefit, if the cistern is designed to drain slowly during the rainy season, acting as a de facto detention facility.

**considerations:** While harvested rainwater for potable use is not currently permitted in Washington State, consider building flexibility into a rainwater harvest system by constructing it from materials that will allow for potable water use in the future.

See Action Item 8-2 for discussion of greywater and related requirements. In cases where greywater for irrigation is acceptable, plumbing for greywater would be hooked up to the irrigation system. The irrigation system can be supplied using the tank(s) and a small-scale pressurized pump system. Irrigation for greywater requires special permitting, and must be subsurface application only.

**resources:** Washington Department of Ecology's web page, "Rainwater Collection in Washington State:"  
[www.ecy.wa.gov/programs/wr/hq/rwh.html](http://www.ecy.wa.gov/programs/wr/hq/rwh.html)

The Texas Water Development Board's *Texas Manual on Rainwater Harvesting* is a comprehensive resource on rainwater harvest, including selecting and sizing cisterns:  
[www.twdb.state.tx.us/iwt/Rainwater.asp](http://www.twdb.state.tx.us/iwt/Rainwater.asp)

American Rainwater Catchment Systems Association includes resources and a business directory of firms specializing in rainwater harvest:  
[www.arcsa.org](http://www.arcsa.org)

## Action Item 14-4



Cisterns can take a variety of forms, and can be installed above-grade, below ground, or partially buried. This steel cistern is placed under a porch. Above ground systems can sometimes utilize gravity for water distribution, eliminating the need for pumps.

Image: Nelse Design + Build



## Action Item 14-5

Amend disturbed soil to a depth of 10-12" to restore soil environmental functions

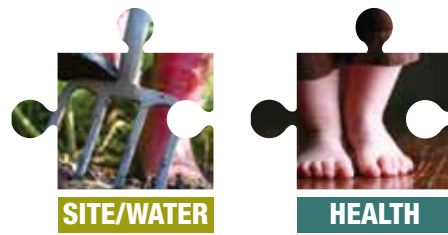
### Points: 4

#### Responsible party:

Landscape Architect

#### Intent:

Reduce landscape-related water use and cleanse, slow and detain stormwater by restoring soil permeability, biological diversity and function.



**what:** Compost is decomposed plant material, often gathered from municipal yard waste collection. The organic material in compost is a valuable soil amendment, helping aerate the soil and introducing beneficial microorganisms to the site. Soil disturbances related to remodeling activity presents an opportunity to enhance the site's soil composition. Amending the soil to a depth of 10-12" inches with compost involves tilling or otherwise mixing the existing disturbed soil with compost.

**why:** Soils on existing sites are often depleted of organic content, and in many cases the original topsoil was removed, leaving subsoil devoid of nutrients and heavily compacted. These soils tend to shed water rather than allowing it to percolate into the ground, increasing runoff and the likelihood of flooding. Additionally, existing plants will find it difficult to thrive and new trees, shrubs and other plantings will have a hard time establishing. The result is a stressed landscape that uses more water and is more prone to disease, prompting the use of fertilizers and pesticides. Compost helps restore soil health and the diversity of soil organisms that will maintain structure, infiltration rates and moisture holding capacity, and healthy plant growth. Construction-disturbed soils are also often mechanically compacted (by vehicle traffic), so tilling or ripping, along with compost amendment, helps immediately restore porosity for better plant growth and infiltration.

**how:** Preferably, have the soil tested by a reputable soil lab to get data about the soil's chemical and physical condition, as well as its biological health. These labs will provide specific recommendations for optimum soil amendment. Amendments may include sand or gravel for improved drainage, lime or other pH modifiers, or organic manures or compost to improve nutrient availability. Compost amendments reduce summer irrigation demand, reduce stormwater runoff and erosion, improve soil quality, and improve aesthetics.

Compost should be mature and stable. Purchase compost from a composting facility permitted by the Washington State Department of Ecology, or have the supplier certify that it meets the definition of "composted materials" in WAC 173-350 Section 220 that specifies composting process, testing, and maximum contaminant levels.

The compost should have an organic matter content (by the standard "loss-on-ignition" test, ASTM D2974 or TMECC 05.07A) of between 40 and 65 percent. Compost for most landscape uses should have a carbon-to-nitrogen (C:N) ratio below 25:1, but the C:N ratio may be as high as 35:1 for landscapes composed entirely of plants native to the Puget Sound Lowlands region.

In King County (and soon in many other Western Washington jurisdictions, as required by the Department of Ecology), code requires disturbed soils be amended to a depth eight to ten inches; projects must exceed code requirements to receive points for this Action Item. As a rule of thumb, a 2:1 ratio of existing soil to compost, by loose volume, will achieve the desired soil organic matter (SOM, by the loss-on-ignition test) in landscape beds of 8 to 13% by soil weight. A 4 to 1 or 5 to 1 ratio of existing soil to compost will achieve the 4-6% SOM desired for lawn or turf installation. The final depth of the amended soil will be between eight and ten inches, depending upon the equipment used.

For typical subsoil in the Puget Sound area, this means approximately 13 cubic yards per 1000 square feet of landscape area, or 7 cu.yd. per 1000 SF of turf area. If instead you start with four inches of healthy native topsoil, you will need only about 7 3/4 cubic yards per 1000 SF of landscape, or 4 cu.yd. per 1000 SF of turf area. On turf areas, achieve best results by using a 1/2 or 5/8-minus screened well-degraded compost. (It is very important to thoroughly mix the compost into the native soil in the turf areas.) On landscape beds, a coarser compost, such as typically used for slope erosion control blankets, can be tilled in, or planted through if the slope is too steep for tilling. This is a two-for-one benefit: using compost for site erosion control, and then tilling it in to improve the soil before planting.

**considerations:** Use the soil amendment process as an opportunity to ensure the ground near the home is properly graded to drain water away from the foundation (see Action Item 3-12), and to consider natural stormwater management strategies such as rain gardens and other strategies that aim for zero stormwater runoff (Action Item 1-8). In areas where soils are not disturbed by remodeling activities, soils can still be enhanced. For example, lawns can be top-dressed with compost, and planted areas can receive a compost mulching.

**resources:** The Building Soils website offers a variety of resources to help projects optimally amend site soils: [www.buildingsoils.org](http://www.buildingsoils.org)

For homeowners and for a general overview the importance and practice of soil amendment, review the *Growing Healthy Soil* guide on the Saving Water Partnership website: [www.savingwater.org/outside.htm](http://www.savingwater.org/outside.htm) (scroll down to *Resources*)



#### Homeowner Benefit:

Amended soils allow landscapes to thrive with less need for irrigation. Additionally, compost-amended soils hold more rainwater, reducing stormwater runoff, which can protect the home from water damage and the site from erosion. Finally, compost helps grow healthier plants, reducing or eliminating the need for fertilizers and pesticides, helping protect water quality and reducing toxics exposure hazards to humans and pets.

## Action Item 14-5

## Action Item 14-6

Grind landclearing wood and stumps for reuse on site

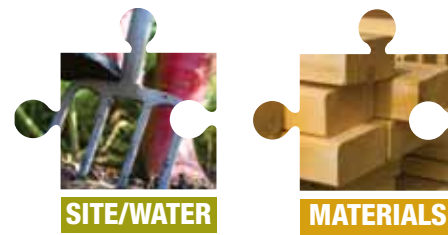
### Points: 3

#### Responsible party:

Landscape Architect

#### Intent:

Reduce waste associated with land clearing activities by reusing materials on site; reduce water and pesticide use.



**what:** Grinding landclearing wood on site entails the use of wood chipping equipment. The resulting material can then be reused on site as mulch or for erosion protection (see Action Item 3-2).

**why:** Grinding land clearing wood waste can be a cost-effective way to reduce jobsite waste and provide opportunities to reuse the material as mulch (on site or at other locations). Mulch can act as an effective natural weed barrier around plants, helps capture and retain moisture, and can also be used to protect stockpiled topsoil.

**how:** Tree service companies are often very amenable to leaving ground materials onsite for reuse. Alternatively, grinding equipment is available from tool rental companies.

A goal of the BUILT GREEN program is to retain tree cover for its stormwater management benefits. Points for retaining healthy trees on site (Action Item 1-4) gives incentive to tree protection. Prioritize retaining healthy evergreen conifers, as these trees are superior at wintertime stormwater management than deciduous trees.

**considerations:** Salvaging plant material for use on- or offsite (Action Item 14-8) is preferable to clearing and grinding.



**what:** Organic mulches include compost products and wood chips. For the purposes of this Action Item, mulching consists of applying a two-inch layer of wood chips or compost to landscape beds after planting is complete.

**why:** Mulching helps reduce erosion and the need for supplemental watering, as well as reducing the need for pesticide application and/or weeding.

**how:** If the new landscape isn't already densely planted, mulching is the next best solution to reduce the number of weeds and make weed removal easier, which in turn, helps to minimize herbicide use. In addition, mulching provides additional soil nutrients, increases the capacity of the soil to retain moisture, moderates soil temperature, and limits soil erosion.

Non-woody mulches, compost, cut grass clippings, or leaves are best for annuals. Woody mulches, wood chips or bark, work best with perennials. However, limit the use of bark mulch as much as possible, since it does not feed the soil life as well as chips, and fine bark mulches can seal the soil surface, limiting air and water movement. Arborist wood chips (mixed tree-service chippings composed of tree wood, bark, and leaves) are recommended as the best mulch for woody plants, because they break down slowly to feed the soil, while maintaining porosity, weed control, and moisture conservation. Contact a tree service for arborist chips, or plan to chip site-generated land-clearing debris or landscape pruning for use as mulch.

Woody mulches should not be incorporated (tilled, mixed) into the soil, because they use up nitrogen as they decompose, robbing nitrogen from plants' roots. Used as surface mulch, this low-nitrogen effect serves to inhibit weed seed germination. It does not affect the tree and shrub (woody plant) roots, which are deeper below the surface, but would inhibit shallow-rooted annuals—thus the recommendation to use other mulches for annuals.

#### considerations:

Amending soils prior to adding a mulch layer is superior to mulching alone. See Action Item 14-5 for additional information on amending soils.

**resources:** Building Soils provides information on applying compost to landscapes: [www.buildingsoils.org](http://www.buildingsoils.org)

## Action Item 14-7

Mulch landscape beds with 2 inches of organic mulch

### Points: 2

#### Responsible party:

Landscape Architect

#### Intent:

Reduce landscape-related water use and cleanse, slow and detain stormwater by restoring soil vitality and function.



#### Homeowner Benefit:

Grinding and reusing landclearing materials on site reduces fees related to off-site recycling or composting, and provides free mulch and erosion control material. Using wood chips as mulch helps retain soil moisture, reducing water bills, and inhibits weed growth, reducing yard maintenance and protecting occupant health by reducing the likelihood of pesticide-associated toxic exposures.



#### Homeowner Benefit:

Mulching landscape beds helps retain soil moisture (reducing water bills) and inhibits weed growth (reducing yard maintenance). Mulching, coupled with other natural yard care practices, can also reduce or eliminate the need for pesticides making the yard and home safer for humans and pets.

## Action Item 14-8

Replant or donate removed vegetation for immediate reuse, or place in established heeling bed for reuse on site or donation

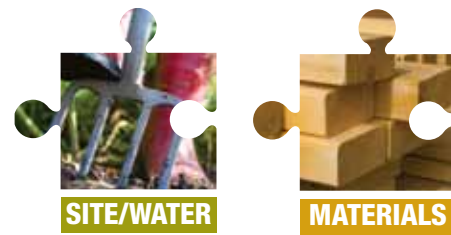
### Points: 3

#### Responsible party:

Contractor, Landscape Architect

#### Intent:

Reduce waste associated with land clearing activities.



SITE/WATER

MATERIALS

**what:** Reusing plant materials on site entails careful removal and proper preparation of the new location. Donation of unwanted materials may involve finding a host site, or using a nonprofit or local government service.

**why:** Reusing plants not only provides free plant material and avoided disposal costs, it can also reduce the environmental impact of a project by avoiding upstream energy and materials use related to growing and transporting commercially supplied plants.

**how:** Plants and trees to be removed due to construction can often be reused for landscaping on site. Replant as soon as possible and take appropriate measure to ensure plants survive in the interim. If plants cannot be replanted immediately, protect the root ball to better the chances of transplant survival.

Fall and spring are the ideal seasons for transplanting in the Pacific Northwest. If plants are unsuitable for reuse on the project site, determine whether they are suitable for other sites with different microclimate or soil characteristics. If so, consider donating them for reuse on another site. Some nurseries participate with local organizations involved in restoration projects to

salvage native plants from development sites. The King or Snohomish County Conservation Districts (see Resources) may be able to use native vegetation that private projects cannot. The King County Department of Natural Resources and Parks and Snohomish County's Native Plant Salvage Program offer plant salvage programs (although these programs usually work with large development projects that are clearing substantial amounts of plant material, rather than a single remodel). Additionally, online classifieds often have "free" sections devoted to helping people unload unwanted goods and materials, and used building materials retailers may offer plant salvage programs in addition to building materials.

**considerations:** While the rainy season is ideal for transplanting, it is not the ideal time for site work. See Action Item 3-13 for information on avoiding site disturbance during the Pacific Northwest's wet months.

**resources:** Plant Amnesty offers an "Adopt-a-Plant" service: [www.plantamnesty.org](http://www.plantamnesty.org)

King County's Native Plant Salvage program accepts native plants as donations: [www.kingcounty.gov](http://www.kingcounty.gov) (search for *Native Plant Salvage*).

Snohomish County's Department of Public Works, Surface Water Management Division also operates a Native Plant Salvage program: [www1.co.snohomish.wa.us](http://www1.co.snohomish.wa.us)



SITE/WATER

MATERIALS

**what:** Often, local projects are faced with plant material they can't use, either from land clearing projects for new development, or landscape modifications on existing properties.

**why:** See Action Item 14-8 for benefits of reusing plant material.

**how:** Projects can work with local developers or other builders to secure plant material being removed from sites, or simply use plants from other projects. Be sure to identify legitimate sources of plant material; some unscrupulous individuals remove plants from public spaces and natural areas to resell. Sticking to donated/free materials eliminates this profit motive.

To help ensure plant survival, focus replanting activities in fall or spring, when rains can keep roots moist and help plants reestablish. Most plants transplant best when dormant. Also follow best practice rules for removal, transport and replanting (see Resources).

**considerations:** Be sure to use plants that will thrive naturally in the conditions afforded by the site in terms of sun and wind exposure, soil type, water and drainage patterns etc. and to avoid introducing invasive or otherwise unwanted species.

**resources:** Plant Amnesty offers an "Adopt-a-Plant" service: [www.plantamnesty.org](http://www.plantamnesty.org)

## Action Item 14-9

Use plants donated from another site

### Points: 2

#### Responsible party:

Landscape Architect

#### Intent:

Reduce waste associated with land clearing activities.



#### Homeowner Benefit:

Reusing plants can reduce project costs by helping avoid the need to purchase new plants, as well as avoiding the cost of disposing of plant material itself.



#### Homeowner Benefit:

Reusing plants from other sites can reduce the overall cost of a landscaping project by avoiding the purchase of plant materials. In addition, plants donated from other sites are more likely to be adapted to regional conditions, meaning they'll perform better in the landscape.

## Action Item 14-10

Remove existing plants listed as noxious or “weeds of concern” as defined by WA State Noxious Weed Board and/or King or Snohomish County.

### Points: 2

#### Responsible party:

Landscape Architect

#### Intent:

Protect local ecosystems by reducing the spread of invasive plant species.



**what:** Noxious weeds are non-native invasive plant species that are listed on the Washington State Noxious Weed Board’s “weed list,” which is updated annually by the Board. Common noxious weed species found in existing landscapes include garden loosestrife and tansy ragwort. “Weeds of Concern” identified by King County include English holly, English laurel, and European mountain ash. See Resources for online resources to help identify invasive plants.

**why:** Invasive species can wreak terrible havoc on an ecosystem, crowding out native plants and reducing species diversity, leaving a region more prone to disease or wildfire. Dramatic examples, such as kudzu in the American South, show the potential for damage caused by invasive species. The ill effects of invasive species are both ecological and economic. Once invasive species are established, they can be very difficult and costly to eradicate.

**how:** Work with the project landscape architect (if applicable) to identify invasive plants and develop a removal plan. The very traits that make invasive species so successful make them a challenge to remove from the landscape (e.g., difficult to remove root systems, the ability to re-grow from small bits of remaining plant, and the ability to spread seeds far and wide). Know the specific traits of the plant(s) the project contains, and develop a strategy based on those traits.

Assembling a plan that does not include pesticides may seem challenging, but it is possible. Many invasive plant removal strategies rely on elbow grease and persistence, and will likely need to be continued by the homeowner after the remodel is finished. Discuss the plan with the homeowner, and include information on invasive species in the Homeowner Operations and Maintenance Guide.

**considerations:** An evaluation of the project’s landscape for invasive species can be carried out during the Site Analysis (see Action Item 1-1), helping ensure that all elements of a site are considered together.

**resources:** Washington State Noxious Weed Control Board: [www.nwcb.wa.gov](http://www.nwcb.wa.gov)

King County’s Noxious Weed Program includes information on weed species, including a photo identification index: [www.kingcounty.gov/environment/animalsandplants/noxious-weeds.aspx](http://www.kingcounty.gov/environment/animalsandplants/noxious-weeds.aspx)

Snohomish County Noxious Weed Program: [www1.co.snohomish.wa.us/Departments/Public\\_Works/Divisions/Road\\_Maint/Noxious\\_Weeds/](http://www1.co.snohomish.wa.us/Departments/Public_Works/Divisions/Road_Maint/Noxious_Weeds/)

*Garden Wise: Non-Invasive Plants for Your Garden* from the Washington Invasive Species Coalition: [www.invasivespeciescoalition.org](http://www.invasivespeciescoalition.org)



**what:** The Washington State Department of Fish and Wildlife’s Backyard Wildlife Sanctuary program identifies both design and maintenance characteristics of a landscape that are beneficial to native animal species.

**why:** Destruction of wildlife habitat by development puts strain on native species’ ability to survive and thrive. Especially for birds and other mobile species, access to food and shelter as they follow migratory routes is key to survival. Providing these resources in a home’s landscape helps facilitate the continuation of species.

**how:** Establishing a landscape as a Wildlife Sanctuary entails several actions, including selecting native plants that provide food and shelter, developing a landscape plan that approximates the layers of a forest including canopy and understory, and using pesticide-free landscape maintenance practices. Specific details of becoming a Backyard Wildlife Sanctuary are available online (see Resources).

**considerations:** Planting Pacific Northwest native plants is a key strategy to creating a landscape welcoming to native animal species (Action Item 14-11). See Resources for a link to King County’s Native Plant Guide, an excellent resource with free native landscape plans tailored to different site conditions. Green roofs (see Action Item 1-12) are another strategy that can assist birds and beneficial insects by providing flyover habitat.

**resources:** Washington Department of Fish and Wildlife Backyard Wildlife Sanctuary program: [www.wdfw.wa.gov/wlm/backyard/](http://www.wdfw.wa.gov/wlm/backyard/)

King County’s Northwest Native Plant Guide: [www.green.kingcounty.gov/GoNative/Index.aspx](http://www.green.kingcounty.gov/GoNative/Index.aspx)

## Action Item 14-11

Establish landscape as a Backyard Wildlife Sanctuary through the Washington State Department of Fish and Wildlife

### Points: 3

#### Responsible party:

Landscape Architect

#### Intent:

Provide habitat to native species.



#### Homeowner Benefit:

Invasive plants can overwhelm more well-behaved plants in a landscape. Removing these plants can reduce maintenance needs and pesticide use, saving time and expense as well as protecting occupants and pets from exposures to pesticides.



#### Homeowner Benefit:

Establishing a landscape as a Backyard Wildlife Sanctuary encourages native bird species to visit a yard, providing interest to adults and children alike. Additionally, the nontoxic yard practices associated with a backyard wildlife sanctuary make the landscape safer for children and pets.

## Action Item 14-12

Use slow-release organic fertilizers to establish vegetation

### Points: 2

#### Responsible party:

Landscape Architect

#### Intent:

Reduce stormwater pollution and resulting damage to aquatic ecosystems.



**what:** Studies have shown that 62% of the phosphorus entering Lake Sammamish is coming from single family residential areas. The primary source for this contaminant is fertilizers and soil wash-off. Slow release organic fertilizers disperse fertilizers more evenly and over a longer duration, reducing the likelihood of wash-off and delivering more of the fertilizer to the plants as intended.

**why:** Excess nutrients promote algae blooms, which in turn threatens fish and aquatic life. Moderate fertilization with natural or natural/synthetic slow-release combination fertilizers will help build soil nutrient reserves and biodiversity without contaminating waterways.

**how:** Specify organic, slow release fertilizers and provide information on application rates to contractors installing plants. Require contractors to use appropriate safety handling and protection procedures to reduce toxics exposures to landscape crews.

If site soils are amended with compost, no additional fertilizer is needed for the first 6 months to a year on turf areas, and trees and shrubs will get all the nutrients they need from annual addition of mulch or mulching fallen leaves on-site. On turf areas, “grasscycling” or mulch mowing (leaving the clippings) has been shown to reduce fertilizer needs by 25-50%, while increasing drought and disease tolerance, promoting deeper rooting and denser turf, and reducing total mowing labor time by up to 40%.

**considerations:** With proper soil amendment prior to planting (see Action Item 14-5), the need for fertilizers—even organic, slow-release varieties—can be dramatically reduced or even eliminated. Additionally, using native and climate and soil adapted species and planting them in the right place (see Action Item 14-15) further reduces the need for fertilizers. Preserving the native topsoil for reuse (Action Item 3-10) helps as well.

**resources:** Natural Lawn and Garden “Growing Healthy Soil” guide includes fertilizer tips, including application rates and carbon, nitrogen and phosphorous ratios: [www.savingwater.org/outside.htm](http://www.savingwater.org/outside.htm) (scroll down to *Resources*).



**what:** Eliminating turf grass entails removing existing sod, either mechanically or manually. Drought-tolerant plants come in many shapes and sizes, from classic Mediterranean herbs (rosemary, thyme, sage) to dramatic and exotic-looking succulent species. A wide variety of native species thrive with little to no supplemental water. Examples include salal, snowberry, sword fern, and Oregon grape.

**why:** Turf grass is low cost in terms of installation compared to other landscape options; however, the lifetime cost of lawn is high due to the equipment and labor associated with maintenance, watering, fertilizer and pesticide use. Beyond the cost to the homeowner, lawns can have a substantial impact on the environment and on human health. Fertilizers and pesticides rarely stay put on a lawn, contaminating local water bodies and damaging fragile aquatic ecosystems. The decline of the health of Puget Sound is due to a variety of factors, including chemical runoff from landscape and agricultural practices. Minimizing, or even eliminating turf grass (Action Item 14-14) can help reduce these landscaping-related environmental impacts. Native plants are adapted to our seasonal rainfall variability, and support native species.

**how:** Turf grass can be removed in a variety of ways. “Sod strippers” mechanically remove the top layer of grass along with some soil and roots; however, these machines often leave substantial amounts of root material to re-grow. King County’s Northwest Natural Yard and Garden website (see Resources) suggests digging a hole twice the

width of the potted plant and removing all grass in a 1’ diameter circle from the plant stem. Follow this by mulching the surrounding grassed area by placing cardboard, overlapped by 6”, on the grass and to within 4” of the new plant’s stem, covering the cardboard with 4” of compost or other mulch.

If retaining turf, place it in areas used for walking or playing, and in sun to light shade, with well-drained soils and on level to slightly sloped areas. Avoid lawns in heavy shade or in areas with saturated soils or heavy slopes. Keep turf away from shorelines to reduce chemical contamination, protect habitat and shading for wildlife, and limit erosion into water bodies. Finally, consider irrigation system design when determining lawn shape (e.g., oval lawn areas to accommodate sprinklers or pop-up irrigation spray heads).

**considerations:** Grass removal dovetails nicely with deep soil amendment (Action Item 14-5), as the tilling process required for 12” deep soil restoration practices provides a chance to sift for errant roots, reducing the likelihood of re-growth. Consider having the landscape certified as a Backyard Wildlife Sanctuary (Action Item 14-11).

**resources:** King County’s Northwest Native Plant Guide: [www.green.kingcounty.gov/GoNative/Index.aspx](http://www.green.kingcounty.gov/GoNative/Index.aspx) (click on *How-to Articles*).

The Saving Water Partnership: [www.savingwater.org/outside.htm](http://www.savingwater.org/outside.htm)

Great Plant Picks: [www.greatplantpicks.org](http://www.greatplantpicks.org)

## Action Item 14-13

Reduce existing turf grass by 50% or more and replace with drought tolerant or native landscaping

### Points: 5

#### Responsible party:

Landscape Architect

#### Intent:

Reduce water, pesticide and fertilizer use and air pollution associated with turf grass cultivation and maintenance.



#### Homeowner Benefit:

Using slow-release organic fertilizers reduces or eliminates the need for petrochemical fertilizers and pesticides, which present exposure and poisoning hazards.



#### Homeowner Benefit:

Turf grass is a high-intensity landscape feature, requiring large amounts of water, frequent maintenance in the form of mowing, edging and aerating, and, often, applications of fertilizers and pesticides. Reducing or eliminating the amount of turf grass in a landscape can save on time and expense related to these activities. Additionally, avoiding fertilizers and pesticides helps protect humans and pets from potential health risks related to these toxic products.

## Action Item 14-14

No turf grass

**Points: 10**

**Responsible party:**

Landscape Architect

**Intent:**

Reduce water, pesticide and fertilizer use and air pollution associated with turf grass cultivation and maintenance.



**what:** Eliminating turf grass entails removing all existing grass, either mechanically or manually, or smothering the grass with a sufficiently thick layer of mulch.

**why:** Although turf grass is a traditional component of residential landscaping, it is not necessary for a beautiful and luxurious landscape. In fact, a landscape, which uses existing vegetation along with well-constructed new plantings, can offer a beautiful, low-maintenance alternative to the “traditional” fare.

Constructed landscapes that mimic ecological habitat models can decrease life cycle maintenance costs, enhance wildlife survival, and blend edges of adjoining existing vegetation. To mimic ecological habitat models, emulate natural succession by planting larger deciduous trees with smaller conifers to gradually develop canopy. Deciduous trees generally perform better in south facing areas, while conifers are better suited near streams or on the north side of the plot.

**how:** Use native plants in the constructed landscape. They are:

- Diverse in color, form, and texture offering a wide variety to fit any design.
- Adapted to the Pacific Northwest climate—rainy wet winters and dry summers. After initial one to two seasons of irrigation, many native plant species become established and require little to no irrigation.
- Adapted to our naturally occurring low levels of soil nutrients.
- Resistant to local insects and diseases, which allow for minimizing fertilizer and pesticide use.
- Habitat for local wildlife.

**considerations:** See Action Item 14-13.

**resources:** See Action Item 14-13.



**what:** The appropriate plant palette for a site (and even microclimates and conditions within a site) is dependent on sun exposure, soil conditions, drainage, temperature and seasonal variations, and other factors. The “right plant, right place” approach customizes the plant selection for the site.

**why:** In the summer, up to 50% of the water supplied by municipal systems is used for outdoor irrigation. The increased demand in summer comes at the same time reservoir and stream levels drop and precipitation dramatically decreases, putting tremendous pressure on local water supplies. Additionally, plants ill suited for site conditions are more vulnerable to disease and are less likely to thrive, increasing the use of pesticides and fertilizers that can pose health risks to occupants and pets as well as harm aquatic ecosystems.

**how:** Landscape architects versed in xeriscaping (low water use landscape design) can help assemble a plant palette that matches the site conditions. Examples of landscaping techniques that will result in low water use include:

- Use established vegetation (see Action Item 3-4).
- Limit turf areas, choose appropriate turf types and plant in suitable areas (see Action Item 14-13).
- Cluster plants with similar water needs (create “water use” zones).
- Select plant native species that will adapt well to the site.

- Use plant species from other geographic areas with similar climates, e.g., Mediterranean; New Zealand.
- Build soil vitality and composition by amending with compost (see Action Item 14-5).
- Mulch plantings with additional compost (see Action Item 14-7).

The Northwest has hundreds of beautiful plants that require little to no supplemental water once they are established. Ask your local nursery or landscaping contractor for information about the water efficient trees, shrubs, perennials, and ground covers they supply. Keep in mind that some low water use plants may have certain needs, such as shade, which when not met can lead to increased water use.

**considerations:** Plants thrive best, and require less water, when they’re planted in healthy, humus rich soils. See Action Item 14-5 to learn about the benefits of amending soils with compost. Additionally, Pacific Northwest native species provide benefit to wildlife that non-native drought tolerant plants may not.

**resources:** Natural Lawn and Garden “Choosing the Right Plants” guide provides detailed information on plant selection for optimal landscape health and vitality: [www.savingwater.org/outside.htm](http://www.savingwater.org/outside.htm) (scroll down to *Resources*).

See also the resources listed under Action Item 14-13.

## Action Item 14-15

Landscape with plants appropriate for site topography and soils, emphasizing use of drought tolerant plants or plants with low watering requirements

**Points: 5**

**Responsible party:**

Landscape Architect

**Intent:**

Reduce need for landscape irrigation, pesticides and fertilizers to help protect site ecology, water quality and human health.



### Homeowner Benefit:

Using slow-release organic fertilizers reduces or eliminates the need for petrochemical fertilizers and pesticides, which present exposure and poisoning hazards.



### Homeowner Benefit:

Plants selected to thrive in the existing site conditions can reduce or even eliminate the need for supplemental irrigation and the application of fertilizers and pesticides. It also can reduce maintenance related to weeding and plant replacement.

## Action Item 14-16

Educate owners/tenants about fish friendly moss control and landscaping practices

### Points: 1

#### Responsible party:

Landscape Architect

#### Intent:

Protect local aquatic ecosystems by reducing/eliminating the use of fertilizers and pesticides.



**what:** Fish-friendly landscaping involves an integrated approach to pest, weed, and plant disease management. Termed “Integrated Pest Management (IPM), this may include accepting a few weeds or some insect damage, setting action thresholds for unacceptable damage, selecting the control method with the least non-target impact (starting with cultural, physical, and biological controls, and using the least-toxic chemical control as a last resort only when and where needed), and modifying landscapes over time to require less regular intervention. Moss is a natural part of life in the Pacific Northwest. It thrives in lawns, on roofs, and in crevices in sidewalks and drives. There are various chemical treatments available on the market for control of moss and other growth. However, several have adverse environmental impacts.

**why:** Herbicides and pesticides rarely target only the offending species. Pest, weed and moss killers may be effective at killing moss, but they are also often quite toxic to aquatic life. Reducing the use of these products helps protect aquatic ecosystems.

**how:** Excellent home and property owner materials on integrated weed, pest, and disease management are available from most local jurisdictions and from the state.

Employ design strategies that reduce the growth of moss in the first place, including materials choices (moss grows readily on asphalt composite roofing, while it has virtually no chance on a metal roof) and design strategies. Mosses love shade and soils with low nutrient content; avoid planting grass in general (see Action Item 14-13) but especially avoid planting grass in shaded, moist areas, and amend soils with compost to boost soil health (Action Item 14-5). Also keep landscaping from excessively shading roofs made from asphalt composite products. Avoid all zinc and copper products for exterior application, including zinc sulfate, monohydrate, copper sulfate (also called blue stone), galvanized ridge caps, copper flashing, copper wires, and composition shingles impregnated with moss killers. In addition, homeowners should avoid the use of table salt to kill moss and algae. It is corrosive to metal and is not very effective.

Instead, homeowners should remove moss from roofs and other areas using a stiff brush, broom, or power washer for hard to reach areas. As a last result, kill moss by spraying it with hot water (use a utility or other sink with hot water supply and connect a hose).

Provide information about environmentally friendly moss control to the homeowner as part of the Homeowner Operations & Maintenance Kit.

**considerations:** Planting shaded areas with native understory plants helps avoid the struggle against moss in the lawn.



**what:** Buffer zones are often required in Critical Areas due to unstable slopes or proximity to sensitive areas. For this Action Item, this buffer area is planted with native species adapted to such conditions.

**why:** An additional measure of protection in buffer zones can decrease the likelihood of damage to adjacent sensitive areas and also reduce the probability of a catastrophic event such as landslide or ground shift. Local water bodies, especially Puget Sound, are under increasing stress due to “non-point pollution,” that is, diffused sources of pollution including automobiles, septic tanks, and home activities such as landscape maintenance, car washing, and home improvements. Adding resiliency to buffer zones helps reduce the impact of these activities.

**how:** Work closely with a landscape architect experienced in restoration ecology and natural landscaping techniques. Find native species adapted to the conditions of your buffer zone; look to undeveloped sites with similar features to see what grows there naturally (e.g., Pacific Madrone and Snowberry on bluffs near Puget Sound).

**considerations:** See Action Item 1-6 for additional information on protecting critical areas, including building away from the area.

**resources:** The *Low Impact Development Technical Manual for Puget Sound*, Chapter 4, includes information on vegetation protection, reforestation and maintenance: [www.psparchives.com/publications.htm](http://www.psparchives.com/publications.htm) (scroll down to *Stormwater Runoff/Low Impact Development*)

The King County Native Plant Guide includes native landscape plans, including specific designs for steep slopes and marine shorelines: [www.green.kingcounty.gov/GoNative/Index.aspx](http://www.green.kingcounty.gov/GoNative/Index.aspx)

## Action Item 14-17

Retain or install continuous forested and native vegetation “buffers” adjacent to lot edges, fence lines, waterways, wetlands, and steep slopes.

### Points: 3

#### Responsible party:

Landscape Architect

#### Intent:

Protect aquatic ecosystems and reduce erosion/landslide potential by maintaining buffer areas between developed land and critical areas.



#### Homeowner Benefit:

Reducing fertilizers and pesticides is not only healthier for the environment; it's healthier for people. Fertilizers and pesticides can be tracked into the home where they present an exposure hazard to occupants. Additionally, storage of fertilizers and pesticides represents a poisoning hazard to children and pets. Choosing practices that are “fish friendly” often means less money spent on lawn and garden chemicals.



#### Homeowner Benefit:

Forested and native vegetation buffers provide an added level of protection to critical areas that may reside on a site, reducing the risk of damage to nearby water bodies, and more immediately, helping protect the property against potentially catastrophic erosion or landslide damage.

## Action Item 14-18

Take part in a city re-tree program, if one exists in area

### Points: 2

#### Responsible party:

Architecte, Owner

#### Intent:

Benefit stormwater management, energy efficiency, air quality and other ecosystem services related to increased tree coverage.



**what:** Re-tree programs are organized by municipalities to help plant trees in areas lacking adequate tree coverage. City departments often offer trees appropriate for urban planting either at a discount or at no charge to residents.

**why:** Many urban and suburban neighborhoods are critically lacking in tree coverage, resulting in flooding, high summer temperatures, and reduced air cleaning capacity. The City of Seattle, for example, currently has 18% tree canopy coverage, less than half that recommended by the American Forestry Association.

**how:** Work with the homeowner to procure trees from the local program, and incorporate the trees into the planting schedule. Most programs allow homeowners to select from a variety of trees. Educate the homeowner (or work with the landscape architect) to select appropriate species and locations, considering factors such as passive solar benefits, location of sewer and power lines, mature tree height, water needs, and allergenic effects.

**resources:** The City of Seattle's Community Tree Program is an example of such a program: [www.seattle.gov/transportation/btg\\_streettrees.htm](http://www.seattle.gov/transportation/btg_streettrees.htm)



#### Homeowner Benefit:

Re-tree programs can provide low-cost or even free trees for planting in parking strips or in some cases anywhere on the property. Strategically placed trees benefit the homeowner by shading the building during the summer months and/or capturing and retaining rainwater, reducing the potential for water damage to the home or downstream.



**what:** Deciduous trees provide shade in the summer, but allow light through when defoliated in the winter.

**why:** Trees provide a variety of benefits, not only to the homeowner, but to municipalities and the larger environment. "Ecosystem services" provided by trees include helping manage stormwater, reducing ambient temperatures, and even filtering pollution and particulates from the air.

**how:** Work with the project landscape architect (if applicable) to determine the optimal placement of trees for shading, and inform the designer of passive solar goals for the home.

Effective tree placement will allow the winter sun to warm the roof and walls of your house. Placing deciduous trees that lose their canopy in the winter on the south side of the house allows solar access to these areas during winter, and shade during the summer.

While deciduous trees are good for allowing summer shade and winter access to the sun, they do not detain stormwater nearly as well as evergreen trees. Consider the different functions of deciduous and evergreen trees when developing an integrated landscape, stormwater and solar access plan. If considering a photovoltaic or solar hot water system at any time in the future, tree placement should be considered as well.

**considerations:** Landscape shading strategies are an integral part of passive solar design (Action Item 1-23), and can take advantage of existing trees on a site (Action Item 1-4).

**resources:** The Department of Energy's Energy Savers website includes information for consumers on shading with landscape elements: [www.energysavers.gov](http://www.energysavers.gov) (click on *Landscape*, then on *Shading*)

## Action Item 14-19

Retain (or add) deciduous trees south and west of house

### Points: 4

#### Responsible party:

Landscape Architect, Architect

#### Intent:

Maintain comfort and reduce cooling-related energy use by strategically placing deciduous trees to provide shade during the summer months.



#### Homeowner Benefit:

Properly placed trees within the landscape can be as effective as other home improvements in reducing heating and cooling costs, while also adding value to the property. Good selection and placement of trees within the landscape can help cool the house in summer and allow the sun to warm the house in winter.



## Action Item 14-20

Reuse concrete or masonry items on site

### Points: 2

#### Responsible party:

Contractor

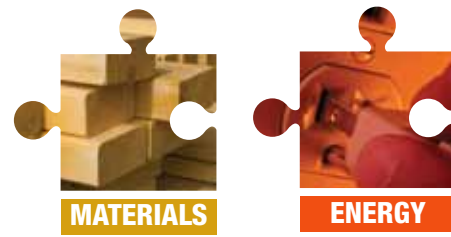
#### Intent:

Reduce environmental impacts related to building material production and disposal by encourage building material reuse.



#### Homeowner Benefit:

Reusing concrete or masonry items on site reduces the need to purchase new materials, as well as the need to dispose of existing materials—saving the project money on both materials purchase and disposal fees.



**what:** For the purposes of this credit, masonry and concrete is considered salvaged if it is purchased from a used building materials retailer, is reused from other jobsites, or salvaged on site.

**why:** See Action Item 12-1 for the rationale behind reusing building materials.

**how:** Concrete and masonry can be reused in a variety of ways. Masonry items with soft mortar can be reused whole. Other materials may be used for landscaping purposes (e.g., retaining walls and pathways) if damaged by the removal process. Salvaged masonry or concrete from projects constructed prior to 1978 may be painted with lead-based paint. See Resources for information regarding safely working with materials containing lead-based paint. Low-cost lead testing kits are available from home improvement centers. When in doubt, do not reuse these materials near areas that will be used for growing food or accessed by small children.

**resources:** The Northwest Building Salvage Network provides links to used building materials retailers and resources on building salvage: [www.nbsnonline.org](http://www.nbsnonline.org)

The Building Materials Reuse Association provides a directory of used building materials retailers and salvage consultants: [www.bmra.org](http://www.bmra.org)

The Green Home Remodel Salvage and Reuse guide provides general information on building materials salvage and reuse: [www.greentools.us](http://www.greentools.us) (click on *Residential Buildings*, then *Residential Remodeling Guides*).

EPA information on avoiding lead based paint hazards: [www.epa.gov/lead](http://www.epa.gov/lead)  
Homeowners should read the EPA document: “Renovate Right: Important Lead Hazard Information for Families, Child Care Providers and Schools.”



**what:** See Action Item 1-10.

**why:** See Action Item 1-10.

**how:** Determine a property’s total surface area for driveways, walkways, patios and other impervious hardscape areas during the Comprehensive Site Assessment (Action Item 1-1) or by creating a scale plan of the property and determining square footage of impervious areas. For this Action Item, existing impervious areas must be reduced, either by elimination or by conversion to pervious hardscape material (See Action Item 1-10). Additionally, 1/3 of new hardscape materials must be composed of pervious materials.

**resources:**  
See Action Item 1-10.

## Action Item 14-21

Use pervious materials for at least one-third of total area for driveways, walkways, patios

### Points: 3

#### Responsible party:

Architect, Landscape Architect

#### Intent:

See Action Item 1-10.



#### Homeowner Benefit:

Reducing impervious hardscape surfaces helps return a property to healthy hydrological function by allowing water to soak into the ground. Depending on the location of the hardscape surface, it can also help protect a home from bulk water and moisture damage related to improperly draining impervious surfaces.

## Action Item 14-22

Provide public amenities adjacent to streets, such as a bench, shade or fruit trees, wildflower garden, art, or make environmental features visible from the street.

### Points: 3

#### Responsible party:

Landscape Architect, Architect

#### Intent:

Enhance community and provide public education by sharing a home's sustainability features with the neighborhood.



#### Homeowner Benefit:

Public amenities help enhance community, and aesthetic and functional elements oriented to the neighborhood help improve a home's street appeal.



**what:** Public amenities include elements that enhance the neighborhood, either aesthetically or socially. Aesthetic examples include landscaping features that highlight organic gardening or xeriscaping practices. Social amenities include benches and other elements that serve as community gathering places and opportunities for socializing.

**why:** Enhancing community through design helps build safer, closer-knit neighborhoods, which in turn can reduce crime rates and make neighborhoods safer. Additionally, helping a neighborhood learn about the green features of a home or landscape helps accelerate adoption of environmentally responsible practices.

**how:** This Action Item is limited only by the homeowner and designer's imagination. Consider involving the neighborhood in the design process, inviting ideas about what elements would be most appreciated. Involving both adults and children can generate creative, out-of-the-box ideas and help bring a neighborhood together.

**considerations:** Using salvaged or recycled content materials, and naturally rot-resistant, low-maintenance materials can add to the green element of a public amenity.

**resources:** Portland, Oregon's City Repair provides an overview of the concept of "placemaking" and how to create community amenities at various scales: [www.cityrepair.org/how-to/placemaking/](http://www.cityrepair.org/how-to/placemaking/)



**what:** Pressure treated lumber is created by forcibly injecting anti-rot and anti-pest compounds into wood. Historically, this was done with highly toxic substances, such as arsenic and chromium. While the worst offending materials have been taken off the market, some pressure treated materials still contain compounds of concern in terms of both human health and environmental impacts.

**why:** Choosing nontoxic and naturally rot-resistant landscape materials not only helps protect occupants, it can also help preserve water quality downstream. Additionally, it reduces worker exposures and toxic emissions associated with manufacturing pressure treated wood. Regional rot-resistant wood species include Western Red Cedar and juniper.

**how:** Look for naturally rot-resistant wood species, including tropical hardwoods and regional species including cedar and juniper. Look for responsibly harvested wood (see Considerations). Additionally, recycled plastic and plastic composite lumber is a good choice for ground-contact applications. Look for plastic lumber with high post-consumer recycled content. The California Integrated Waste Management Board manages a database of recycled content materials, including plastic and composite lumber.

Instead of landscape timbers, which tend to be short-lived in the landscape, consider rockeries and recycled broken concrete for retaining areas. Note that concrete is a high pH substance, and should be installed in areas that do not drain directly to streams or storm system.

**considerations:** See Action Item 4-14 for information on responsibly harvested wood. Also consider reusing landscape elements on site (Action Item 14-20).

**resources:** CIWMB Recycled Content Product Directory: [www.ciwmb.ca.gov/rcp/](http://www.ciwmb.ca.gov/rcp/) (click on the *Construction* category).

Healthy Building Network's *Guide to Plastic Lumber*: [www.healthybuilding.net/plastic\\_lumber.html](http://www.healthybuilding.net/plastic_lumber.html)

## Action Item 14-23

Do not use pressure treated wood in landscaping

### Points: 2

#### Responsible party:

Landscape Architect

#### Intent:

Reduce toxics in building materials and in the greater environment; promote the development and use of least-toxic preservatives.



#### Homeowner Benefit:

Avoiding toxic preservatives in landscape products helps reduce the risk of exposure to humans and pets.

## Action Item 14-24

Use reclaimed or salvaged material for landscaping walls

### Points: 2

#### Responsible party:

Landscape Architect

#### Intent:

Reduce environmental impacts related to building material production and disposal by encourage building material reuse.



**what:** Salvaged landscaping materials take many forms, including used bricks and blocks, recycled concrete, and salvaged timbers.

**why:** Using salvaged stone, brick, masonry, or wood materials to construct landscaping elements not only saves resources and keeps materials out of the landfill, but also can provide a unique appearance to match the style of the home. While the cost of salvaged materials for landscape purposes varies widely, it is possible to realize substantial savings in purchase cost by finding good quality salvaged materials.

**how:** Finding salvaged materials for landscape uses is as diverse as the materials themselves. Conduct an inventory of what already exists on site; for example, if the project is breaking up a conventional concrete driveway to be replaced with a pervious alternative, the concrete may be usable as retaining walls or pavers. Online services such as Craigslist and Freecycle can also be good sources of salvaged stone, concrete or landscape timbers. Many used building materials retailers sell landscape-oriented materials, including salvaged brick and stone, as well as wrought iron fencing and other materials appropriate for creating outdoor art.

**considerations:** Be certain to source materials that are safe for landscape use, paying particular attention to areas that may be used for food production or children's play areas. For example, old railroad ties are treated with highly toxic creosote and other wood treatments and do not meet the intent of this credit. Old treated wood is likely preserved with arsenic and chromium, and other salvaged woods may be painted with lead-based paints. When in doubt, assume a material is unsafe.

**resources:** The Northwest Building Salvage Network provides links to used building materials retailers and resources on building salvage: [www.nbsnonline.org](http://www.nbsnonline.org)

The Building Materials Reuse Association provides a directory of used building materials retailers and salvage consultants: [www.bmra.org](http://www.bmra.org)

The Green Home Remodel Landscape Materials guide provides general information on landscape materials selection, including salvaged materials: [www.greentools.us](http://www.greentools.us) (click on *Residential Buildings*, then *Residential Remodeling Guides*).



**what:** Solar powered outdoor walkway and area lighting utilizes a small photovoltaic panel, a rechargeable battery for storage, and usually a photosensor to turn the lighting on at dusk.

**why:** The low light levels needed for pathway and most outdoor lighting makes solar a good candidate. The low maintenance, easy-to-install systems do not require an electrician to install. These systems reduce or eliminate the need for electric pathway lighting, as well as the materials associated with installing hardwired systems.

**how:** Low-cost outdoor solar lighting systems are available through most home improvement retailers.

Provide information to the homeowner on spent rechargeable battery recycling (see Resources).

**considerations:** Be respectful of neighbors and the night sky when designing an outdoor lighting system. "Light trespass" can be disruptive to the neighborhood, as well as to stargazers and migrating birds. See Action Item 9-14 for points available for limiting outdoor lighting levels to 1.1 watts per square foot; additionally, see Action Item 9-8 for information on providing outdoor lighting controls to save energy.

**resources:** Battery recycling information: [www.earth911.com/hazardous/rechargeable-batteries/](http://www.earth911.com/hazardous/rechargeable-batteries/) (enter project ZIP Code for recycling locations).

The *Green Home Remodel* Lighting guide provides efficient lighting information for homeowners: [www.seattle.gov/dpd/greenbuilding/](http://www.seattle.gov/dpd/greenbuilding/) (click on *Green Remodel Guides*).

The International Dark Sky Association "Practical Guide 3: Residential Lighting" describes how to minimize residential light pollution: [www.darksky.org](http://www.darksky.org) (click on *Quality Lighting*, then *Homeowner's Guide*).

## Action Item 14-25

Solar powered walkway or outdoor area lighting

### Points: 1

#### Responsible party:

Landscape Architect, Electrician

#### Intent:

Reduce energy use associated with exterior lighting.



#### Homeowner Benefit:

A variety of landscape materials can be salvaged and reused, from broken concrete to landscape timbers to wood for garden structures.



#### Homeowner Benefit:

Solar powered outdoor lighting is a low-cost way to enjoy home-generated power. The low cost of purchase and installation makes this an easy green feature for a home.

## END OF PROJECT

The final stage of a green remodel entails verifying the home's performance and providing resources to the homeowner to ensure the systems and products installed are properly cared for, so the newly enhanced environmental and health features remain intact.

## Action Item 15-1

Blower door test results better than 0.30 ACH; 0.25 ACH

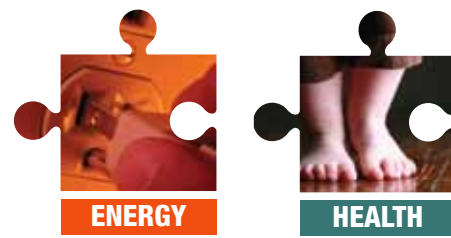
### Points: 5-10

#### Responsible party:

Performance Contractor

#### Intent:

Reduce home energy use and protect indoor air quality issues caused by unwanted air infiltration.



**what:** Blower door tests are used to both identify air leakage paths in a home and to quantify air leakage ranges. Blower doors are also used to locate duct leaks.

A blower door consists of a variable speed fan placed in an exterior doorway and used to blow air into or out of a house. When air is blown out of the house, the house develops a slight negative pressure (or vacuum) relative to outside. The pressure differential drives outside air into the house (infiltration) through any available openings in the exterior shell. These leaks can be located by touch or with smoke, then sealed.

In addition, the pressure induced by the blower door can be used to yield a quantitative estimate of the “leakiness” of the home (in square inches). Additional calculations yield the approximate natural air change rate, measured in air changes per hour (ACH).

Blower door tests of new homes built to code average 0.34 ACH.

**why:** Reducing a home’s infiltration rate to 0.30 ACH through improved air sealing will reduce annual energy use by about 8% and is very achievable. (Homes with forced air systems with ductwork outside the conditioned space will have a slightly higher ACH, due to the inherent leakiness of ductwork.)

**how:** This Action Item is worth 5 or 10 points.

- Blower Door Test results in better than .30 ACH (measured at 50 Pascals pressure): 5 points
- Blower Door Test results in better than .25 ACH (measured at 50 Pascals pressure): 10 points

This Action Item pertains to a final blower door test, performed at the end of the remodel project to determine the home’s performance after air sealing and other improvements. Blower door tests can be performed by home performance contractors (see Resources), including many BUILT GREEN Verifiers. To locate a service that can provide a blower door test, see the Verifier page on the BUILT GREEN website.

**considerations:** Homes achieving this level of airtightness should make sure proper ventilation is provided via whole-house ventilation, and consider installing a Heat Recovery Ventilator (see Action Item 7-14) to minimize the energy penalty associated with providing unheated makeup air.

**resources:** Home Performance Washington is an association of home performance contractors:  
[www.homeperformancewashington.org](http://www.homeperformancewashington.org)

The Department of Energy’s Energy Savers website includes information for consumers on blower door tests:  
[www.energysavers.gov](http://www.energysavers.gov)  
(click on *Designing and Remodeling*, then on *Energy Audits*).



**what:** Doormats come in a variety of styles to complement different decors.

**why:** Toxins and particulates carried into a home on the soles of shoes represent a major contributor to a home’s poor indoor air quality.

**how:** The American Lung Association of Washington suggests purchasing a doormat with stiff bristles made of synthetic material that can be easily cleaned with a hose on a regular basis. Alternatively, a permanent metal walk-off grate installed at major entrances will also satisfy the intent of this credit.

**considerations:** Consider including shoe removal vestibules (Action Item 1-44) at major entrances to encourage a shoe-free household.

**resources:** American Lung Association Health House:  
[www.healthhouse.org/](http://www.healthhouse.org/)

US EPA Indoor Air Quality in Homes:  
[www.epa.gov/iaq/homes/](http://www.epa.gov/iaq/homes/)

## Action Item 15-2

Provide a cleanable doormat at major entrances to house (front, back, garage)

### Points: 1

#### Responsible party:

Architect, Contractor, Owner

#### Intent:

Protect occupant health by reducing the introduction of contaminants via foot traffic.



#### Homeowner Benefit:

Blower door tests help confirm the airtightness of a home, and quickly identify construction errors and design flaws that result in a leaky home. A tight home minimizes unintentional air infiltration, which saves on energy bills and protects indoor air quality.



#### Homeowner Benefit:

A doormat helps protect indoor environmental quality by providing a shoe sole scrubbing function, reducing the amount of contaminants tracked into homes via the soles of shoes.

## Action Item 15-3

Provide a kit and maintenance manual to homeowner along with BUILT GREEN Certificate

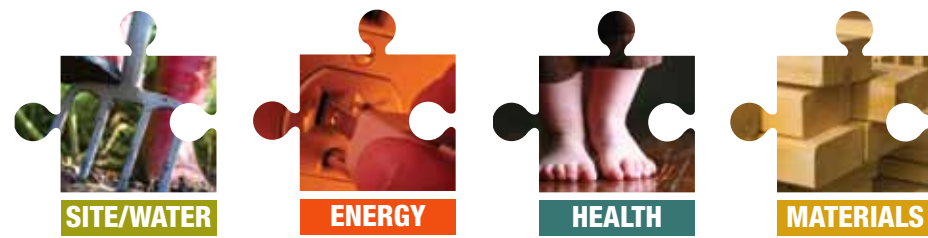
### Points: Req

#### Responsible party:

Contractor

#### Intent:

Maintain a healthy, efficient home after remodel completion.



**what:** A Homeowner Maintenance and Operations Manual and kit is an assembly of information for the homeowner that helps describe the green features of a home and provides information regarding the care and maintenance of those features. Often in the form of a binder with sections corresponding to the elements in the home, the manual provides a centralized location for this information.

**why:** Proper maintenance and operations of a home is critical to its continued environmental and health performance. Additionally, such a manual helps delineate homeowner responsibilities and expectations, helping reduce the likelihood of callbacks. A Maintenance and Operations Manual can also serve as a convenient tool for educating the homeowner about the home's features.

**how:** The BUILT GREEN program provides a basic kit of information and resources to be offered to homeowners, but it is intended as a starting point for a fully fleshed out Operations and Maintenance Manual. Create a Manual that brands the remodeling company as an environmentally aware firm, and includes information specific to the technologies and design strategies used on the home. A three-ring binder can provide flexibility for assembling the pertinent information. Consider having a meeting with the client at the conclusion of the remodel to review the assembled materials and present the Manual.

**resources:** Many resources for specific green building elements already exist and can be modified and customized for specific projects. Review the Resources section of applicable Action Items to access this information.



#### Homeowner Benefit:

A Homeowner's Operations and Maintenance Manual provides essential information on maintaining the green features of a home, to ensure that the goals of the project persist over time. By assembling this information and providing it in a single, convenient place, the homeowner can quickly access information when needed.

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