

Safer Construction Tips for the Environmentally Sensitive

by Julie Genser

non-toxic construction consultants: Melinda Honn, Greg Conrad



El House Snowflake, Arizona ©Snowflake Beach

Note from author

Housing has always been a personal passion of mine, starting when I studied design and environmental analysis at Cornell University in the '80s, ignited while I traveled the world in the late '90s, and continuing as I completed an ecovillage and permaculture design certification course during the summer of 2004 and then went off to study sustainable architecture at ECOSA Institute.

What happened next might have been predictable given all the signs in the preceding years, but being fairly ignorant about environmental illness, it took me quite by horror and surprise. After multiple exposures to various toxins

over the years—mercury, arsenic, fumes from toxic fires (including 9/11), a mold infestation in my small NYC apartment, and Lyme bacteria—exposure to some local pollen or mold in Prescott, Arizona set off a chain reaction in my body, resulting in extensive and severe chemical sensitivities within a few days of my arrival.

I struggled the first month to survive my body's confusing reactions to the extreme heat, constant controlled fire burnings, wood burning stoves, gas fumes, mold, and other environmentally based health challenges. I was experiencing a complete blockage of my sinuses, excruciating migraines, brain fog and confusion, sleep apnea, numbness in my shins, and a host of other debilitating symptoms. Increasingly, I was forced to remain in the house I had rented, as being outdoors caused a great exacerbation of my condition. Indoors was not much better. Soon I was alone 24/7, unable to attend class and struggling just to survive through each day and night. I buried myself in my course books, determined to stay on track with homework and fascinated by passive solar design principles. I learned a lot in that short time.

I ended up dropping out of the program soon after. I had gone there with the dream of designing my own earth house, and left with a desire to build communities for the chemically sensitive, incorporating permaculture and passive solar design principles in the hopes of helping heal the earth as I helped heal people. I started this brochure as a coordinator for MCS-Global, a non-profit organization dedicated to global MCS (Multiple Chemical Sensitivity) education and awareness. I have since left MCS-Global to focus on my own personal project, Planet Thrive, a grassroots community for personal wellness with a focus on the health-environment connection. I hope the following suggestions help guide those starting a construction project to build the safest, most comfortable, most sustainable haven that nurtures spirit and not just body. Please visit my online community at www.PlanetThrive.com for additional resources on non-toxic and sustainable housing. –Julie Genser August 2007

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Disclaimer: Non-toxic construction consultants Melinda Honn and Greg Conrad were instrumental in the creation of this brochure, however, they do not necessarily endorse all tips contained herein.

The author does not profess to be an expert in the field of home construction, nor have personal experience building an environmentally safer home. All information is based on the completed surveys of 18 people who have completed the construction of a home for someone with moderate to severe chemical and/or electrical sensitivities, as well as research in existing publications on related subjects. As these are highly individual conditions, the only 'golden rules' found for building a safe home for the environmentally sensitive person were: 1) Test each material and product well for individual tolerance before installing; and 2) Whenever possible, use inert ('safe') materials rather than merely materials currently tolerated, as one's tolerances may change with time.

Included in this guide is information on how to minimize chemicals, mold, and electric in home design but none of these areas are in any way complete or even comprehensive. However, we felt it important to include this basic information until more research and published information becomes available.

Due to the individual nature of symptoms and triggers for those with severe chemical and electrical sensitivities, there is no guarantee that any of the information provided will work for you or your client; we can merely offer these guidelines based on the experience of others as you pioneer the building of a customized 'safer' home. The process will not be easy but we hope that the results will be well worth the effort, and allow you or your client to recover in peace and safety.

Although created for the marginal population of those with severe chemical and electrical sensitivities, these tips should help provide guidance to any builder who aims to create a healthier environment for their client. This guide may be especially useful for those who are suffering from any other environmentally based illness, including Lyme Disease, Autism Spectrum (AS), Chronic Fatigue Syndrome (CFS), Multiple Sclerosis (MS), Lou Gehrig's Disease (ALS), Parkinson's Disease, etc., as having a home with a reduced toxic load would benefit anyone with compromised health. It might also be valuable for new families who are raising infants and young children, whose developing bodies and minds are also particularly vulnerable to the indoor air pollution commonly found in standard contemporary methods of construction.

Very unfortunately, due to the nature and severity of the housing crisis for those with severe chemical and electrical sensitivities, considerations of energy efficiency and sustainability must take a secondary role; our lives, health, and well-being depend on it. Wherever possible, however, we have included measures to reduce energy use.

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The below is a guide for those in the planning stages of building safer housing for someone with environmental sensitivities, requiring a home free of chemicals, mold, and electro-magnetic frequency (EMF) waves.

great expectations.

BE REALISTIC

- Depending on the materials and consultants used to build your non-toxic home, you can expect to spend anywhere from the same as typical construction up to an additional 35% in building costs.
- Expect to devote lots of time and energy to oversee the project, or hire someone that you can trust to do it.
- Don't assume that if a material is 'green' or 'sustainable' that it is non-toxic and appropriate for you. Test everything first.
- Likewise, don't assume that it is better to use a non-toxic material over a conventional product. Some non-toxic paints and joint compounds don't cure well and will smell for months, or even years. In certain cases, the 'toxic' material will off-gas relatively quickly, cure well, and ultimately do the job better. Keep an open mind and test all materials first.

sources: 1, 2

ENVIRONMENTAL SENSITIVITIES

Chemical Sensitivity (CS)

A syndrome in which one experiences multiple symptoms upon exposure to very low levels of everyday chemicals, such as those found in perfumes, petrol, diesel, smoke and common construction materials. CS can be caused by acute or chronic exposures to chemicals and is often seen with Lyme Disease, Mercury Poisoning, Chronic Fatigue Syndrome, Gulf War Syndrome, Fibromyalgia, Toxic Injury (such as pesticide poisoning), and Mold Illness.

Mold Sensitivity

Includes both an immune-mediated allergy to mold and/or a chemical sensitivity, as the mycotoxins (toxins produced by mold spores) are chemicals themselves.

Electrical Sensitivity (ES)

Causes a range of symptoms, from the uncomfortable to the debilitating, upon exposure to low levels of electromagnetic fields (EMFs) from cell towers, power lines, electric motors, WiFi, computers, cell phones and other sources.

Other sensitivities include those to sound, sun, artificial lighting, vibration, touch, and changes in barometric pressure (weather).

choose your neighborhood.

LOCATION, LOCATION, LOCATION



Valley in Norway ©Rony Zmiri / iStockphoto

- Choose a locale and climate where you have access to clean, fresh air and can keep your windows open most of the year.²
- As a general rule, mountaintops, seashores, and islands tend to have less pollution, provided that they are not down wind from major sources of industrial pollution, as do places closest to the equator where wind patterns and evaporation help disperse pollutants.³
- Locations that may generate high-ion winds such as deserts and areas below mountains and tall buildings may not be well tolerated.³
- Areas where different climatic zones meet may have higher air turbulence and increased electrical activity that result in higher levels of air pollution. Additionally, weather conditions such as fog, snowfall, rainfall, and winds will affect pollution levels.³
- Those with weather sensitivities will need to explore the electrical properties at play in the areas they are investigating.³
- Keep in mind that due to the unpre-

dictability of nature, industry, and other synergistic forces, some places that would seem to have minimal pollution may very well have high particulate levels; likewise, areas that are polluted may have pockets that are well tolerated.³

- At least fifty percent of indoor air is made up of outdoor air. Research local geographical patterns and other environmental factors to determine air quality and other types of pollution in the area: look into dust, pollen, terpene (from pine and other trees), and mold levels, skunk fumes, local pollution, hazardous materials, industry, noise pollution, water quality, radon levels, and soil contamination. Keep in mind that areas in valleys, downstream, and upwind tend to concentrate toxins in air, ground, and water.^{1, 2, 3}
- Avoid low-lying areas that are subject to flooding and high-risk areas for earthquakes, hurricanes, tornadoes, and other natural disasters.



Cell Phone Tower ©Ian Poole | Cooling Towers ©Cliff Parnell | Crop Duster ©Ken Babione / iStockphoto

- Find out proximity to:
 - EMFs** from radio, TV, microwave and cell towers, high voltage power lines, transformers, power plants, airport flight patterns, and overhead street electrical high voltage boxes.
 - PESTICIDES** from neighbors, golf courses, parks, and conventional agricultural areas.

AIR & NOISE POLLUTION from construction sites, industry, nuclear plants, traffic, airports, asphalt or parking lot fumes, future highways, neighbors' laundry exhaust, dry cleaners, gas stations, incinerators, landfills, auto repair and body shops, concentrated wood smoke from wood burning stoves and fireplaces, and other combustion or gas fumes.

- Verify county practices and regulations regarding pesticide spraying on roadsides and mosquito abatement.
- Look to build in low density, outlying areas, but be sure to consider the impact of future growth in surrounding regions.
- Check zoning laws for adjacent properties. Note what is undeveloped nearby and plan for the worst-case scenario.
- Purchase as much acreage as you can, especially in areas with trees or vegetation to act as buffers for air and noise pollution.



Lawn Mower ©Jeffrey Smith / iStockphoto

- Ask about your neighbors' lifestyles. Do they: smoke; use pesticides, herbicides, insecticides; use fabric softeners; remodel cars; use combustion-fueled lawn equipment like leaf blowers, lawn mowers, and chain saws; barbecue or cook outdoors frequently; own a chlorine swimming pool; have pets?

- Consider building on a site with a mountain between you and existing or future cell, radio, or microwave towers. Living in a valley will provide more protection from EMF radiation, whereas a mountaintop will provide almost no protection (however, keep in mind that valleys tend to accumulate environmental toxins in air, ground, and water).

Do whatever it takes to minimize electrical and magnetic fields, microwaves, and radio signals. If you incorporate active solar, keep the inverters far away from your living space.



Vegetables ©narvikk / iStockphoto

- Confirm accessibility of health food stores, doctors, and other vital resources.
- Find out if there are others in the neighborhood or community with environmental sensitivities who may be able to provide support, knowledge, and strength in numbers.

For more on geographic, meteorological, and other location considerations: See *chapter 2 of Optimum Environments for Optimum Health & Creativity: Designing and Building a Healthy Home or Office by William J. Rea, M.D.*

sources: 1, 2, 3

build to local code.

RESEARCH BEFORE YOU PLAN

- Contact the building safety department in your local city or county to find out local building codes. Codes can affect anything from smoke detector placement and the number of electrical outlets to how you handle sewage disposal, and heating and cooling systems. Building Safety should provide informational handouts for items that specifically apply to your project (e.g., Standard Codes for Building a Slab-on-Grade). You can also check online and at the library. Some areas do not have building codes and require no inspection.
- Codes vary greatly by location. If you are inside city limits, the city regulates. If you are outside city limits, the county you reside in will regulate your codes.



Blueprint ©Cruceu Cristian / iStockphoto

- The first step is to draft your plans, showing floor plans, elevations, and building materials, and submit them for review. Once your plans are approved, you will have to pay a permit fee and then you can begin to build. Any changes to these plans must be approved. Once building begins, there will be multiple inspections. They will usually inspect for minimum compliance to safety codes in your area.

- Know what is required by code before you begin designing your home and drawing up the plans, as some items may affect your layout, or the location of the house on your site.



Architect Signs Off ©Helder Almeida / iStockphoto

- You can draw up the plans yourself, but if you are planning to use an alternative building material such as E-Crete, adobe, or straw bale, a registered architect or structural engineer will have to sign off on your plans. Keep in mind that the architect or engineer may have to be present at several steps of the inspection process to sign off on the construction with the building inspector, who most likely is not familiar with alternative building materials. This might influence your building material choice.

sources: 1, 2

check with local utility companies.

ELECTRIC, WATER, SEWAGE

- Requirements for things like the location of your septic tank, or main breaker box may affect where you place your home on the site, how you orient it, and how you layout your space.

source: 2

determine where to build.

OBSERVE YOUR SITE WELL



Airstream Trailer ©Deo Abesamis / iStockphoto

- If at all possible, stay in a camper or build temporary housing and live on the land for a full year before building, to experience it in every season. Don't rush into construction before you know your site—do your due diligence and you will be well rewarded.

1. Note your reactions to trees, vegetation, pollen; watch for the development of seasonal allergies.
2. Get to know natural weather patterns and analyze permaculture 'sectors' of the site: winter and summer sun; fire; cold winter winds; fog; pollution (noise, smells, power lines); flooding and surface water; ugly and preferred views; crime; and wildlife.

For more on permaculture and site sectors:

Read *Gaia's Garden: A Guide to Home-Scale Permaculture* by Toby Hemenway and *Introduction to Permaculture* by Bill Mollison with Reny Mia Slay.

- With regard to flooding and mold, it's ideal to build at the top of a hill. For the same reasons, never build at the bottom of a hill.⁴

...Water follows gravity. Mold follows water. Therefore, avoid having gravity drive water into your foundation. Avoid condensation in the external wall cavity such that the water runs down the foundation or slab. If water contacts your foundation materials it can wick upwards, defying gravity. Don't let water into your understructure! If your home sits at top of a hill, with drainage away from you on four sides, great.

from *Mold Warriors*
by Ritchie J. Shoemaker

sources: 1, 2, 3, 4, 5

plan your home.

DESIGN WELL

- Take note of where the best views are.
- Plan for a one-story home to reduce the amount of toxic products. Finding safe stairway materials is often difficult and expensive. Flooring issues also become difficult with a second floor.



Sunlit Courtyard ©Richard Gunion / iStockphoto

- Consider a courtyard layout, with all rooms exiting directly into the courtyard or exterior perimeter to maintain the integrity of air quality in each space.

- Larger homes with high/cathedral ceilings will help disperse interior pollutants better than a small home with normal height ceilings.
- Build a long house rather than a square one, locating the water heater, electric panel, central vacuum, and other utilities as far away from the bedroom as possible.
- Include an entryway where shoes can be removed to prevent oils, pesticides, and other pollutants from being tracked into the home. The entryway can also create an airlock, providing a buffer from outside air. It's a good place to put an air filter.
- Centralize TVs and other electronic equipment. Consider placing them behind glass and venting to the outdoors.
- Design in large storage rooms with an exhaust fan to the outdoors or an operable window for books, business papers, DVDs, and other household items, where they are within easy reach.



Guest Shower Room ©Marje Cannon / iStockphoto

- If desired, plan for a shower and changing room for spouse, family, and visitors to use before entering main home area to avoid contamination of safe space.
- Garage should always be detached to avoid gas fumes infiltrating your home.

- Isolate and direct air flow in each room to maintain air quality integrity separate from other spaces; use exhaust fans and vents in kitchen, bathroom, closets, kitchen cabinets.
- Keep the bedroom as simple and as uncluttered as possible.
- Plan adequate wiring and dedicated electrical outlets for special appliances like space heaters, air purifiers, and medical equipment.
- Use a high efficiency whole house air purification unit to remove dust, mold, dander, chemicals, and gasses. Be aware that some Hepa filters may use glues that contain formaldehyde. In addition, many with chemical sensitivities cannot tolerate carbon filters, or they tolerate one type of carbon better than another. Make sure to test for tolerance before installing an expensive system.



Covered Exterior Walkway ©Joel Kapp

- Include a portico or other covered outdoor area in your plans for airing out new clothes and other off-gassing products.
- Decide if/where you want a sauna; built into your bathroom, or separated to isolate toxic fumes you may be releasing as you sweat.
- Locate air-intake vent away from neighbor's exhaust.

- Install a central vacuum system that discharges exhaust directly to the outdoors and locate the vacuum hose and wall plate in a utility closet to minimize escaping dust. (With a conventional vacuum, no matter how good the filter, some dust is exhausted back into the air.)
- Install a whole-house purification system with chlorine filters on showerheads. Many with chemical sensitivities cannot tolerate carbon filters, or they tolerate one type of carbon better than another. Make sure to test for tolerance before installing an expensive system.
- It is better to use a stand-alone humidifier rather than one that is built-in, as they are highly susceptible to mold.



Solarium ©Yin Yang / iStockphoto

- Plan for a sunspace or greenhouse, where you can grow edible plants and herbs. This can be an especially nice addition in northern climates where winters can be dreary.
- As those with Environmental Illness are highly sensitive to the energy of a space, consider researching the principles of Feng Shui (pronounced "fung shway"), the ancient Chinese art of balancing the flow of natural energies in our environment. Feng Shui addresses both practical concerns (natural light, air circulation)

and the more metaphysical concepts of the four elements: earth, water, fire, and wind.

- Color can be used therapeutically to affect mood, comfort, and energy levels; evaluate your response to various colors before applying them to your space. At the Environmental Health Center-Dallas (EHC-D), Dr. Rea has found that 'blue colors appear to strengthen the pollutant-weakened individual.'³ This is entirely a personal preference, however, and should be customized to the individual.
- Postpone purely decorative features until after your health has improved to keep total exposure load to a minimum.

heating

- Use passive solar design principles—thermal mass, insulation, orientation of house—to minimize mechanical heating system requirements. (See page 10 for more on passive solar design.)



Laying Radiant Heating Pipes ©Melinda Honn

- If mechanical heating is required, the ideal method is hydronic radiant floor heating. In this system, the pipes are laid before concrete is poured, preventing leaks and off-gassing of VOCs. The propane tank, solar inverter—or whatever

system you choose—can be located outside the home in a utility shed far from your living space.



Heat Exchanger in Shed ©Melinda Honn

It is best to use a 'closed system' that recirculates the same water in a continuous circuit, completely separate from the domestic water supply. This reduces the water pressure and the resulting water damage should a leak occur.

The benefits of this type of heat include:

- Economical and energy efficient—for the same comfort level, the space can be maintained at a lower temperature than with a forced air system.
- Comfortable—warm floor radiates heat into living spaces.
- Separates heating from ventilation system.

Because the floor is heated, is it critical to use an inert flooring material such as concrete or ceramic tile that will not outgas when warmed. In addition, care must be taken to avoid tracking in pesticides, oil, and other contaminants on shoes. When heated, any such pollutants will become volatile. For this reason, it would be best to avoid wearing shoes at all (year-round) on a floor with radiant heating.

You must also keep garbage disposal

away from the heated floor or the garbage will start to spoil and smell very quickly. The biggest disadvantage to this system is that if a pipe breaks, the floor must be jack-hammered to repair it.

- For supplemental heating, the EBHA Cadet Soft Heat liquid filled electric hot water baseboard heater, direct-wired into the wall (220 volts, with an inline thermostat) has worked well for many with chemical and electrical sensitivities.



Cadet Baseboard Heater ©Joel Kapp

Make sure to remove all exterior and interior stickers from the unit and replace the plastic-covered steel bands that are holding up the pipe with copper bands to minimize off-gassing and avoid galvanization of metals before operating unit for the first time.

Wipe down with a tolerable cleaner and/or warm water and dry well. Run for several hours or days, as needed, outside or with sufficient ventilation to allow all materials to off-gas.

Also available as a portable 110-volt unit.

Note: both models contain ethylene glycol (antifreeze).

- Remember that seemingly benign materials like plastic, aluminum, and copper may off-gas fumes when heated; test all

materials in operation before installing. Safer materials for heating include ceramic tiles and stainless steel.³

- If using propane gas, locate the heater outside the home and pump heated air inside.

AVOID Forced-air heating due to dust and mold in vents and EMF problems.

cooling

- Use passive solar design principles—insulation, orientation of house, window placement—to minimize mechanical cooling system needs. (See page 10 for more on passive solar design.)
- If you must install air conditioning, consider a split system air conditioner system with a heat pump, but instead of having the heat exchanger in a furnace which then ducts the heated or cooled air to the separate rooms, the heat exchanger is on the wall in the room being cooled or heated, thereby eliminating the need for duct work. Those with severe ES may not tolerate this option.

AVOID Central air conditioning due to dust/mold in vents and EMF problems.

ventilation

- Use passive solar design principles—night-flushing, orientation of house, landscaping and landforms—to minimize mechanical ventilation system needs. (See page 10 for more on passive solar design.)

- Supply slightly positive air pressure and cross-ventilation. (For example, plan windows on two walls for bedrooms and other rooms where cross ventilation is desired.)
- Install ceiling fans to move air.
- Install large exhaust fans that vent to the outdoors in the laundry, bathroom and kitchen areas. Provide for an alternate air supply source (i.e., an open window or door) during operation in order to keep air pressure balanced in home.³
- Those with Electrical Sensitivity may not tolerate overhead or exhaust fans, however, may want to include them to operate when they are not in the home.



Kitchen Door ©Melinda Honn

- If you choose not to install exhaust fans, you might want to provide a door to separate the kitchen from the rest of the living space so that any cooking fumes can be diverted outside through open windows or exterior doors without infiltrating the main house. Some have installed a glass wall to maintain a feeling of openness in the home while still protecting the living area from cooking smells.

sources: 1, 2, 3

**DESIGN FOR BEST VENTILATION,
COOLING, AND HEATING OF AIR—
SPECIFIC TO THE CLIMATE
YOU ARE BUILDING IN—USING
PASSIVE SOLAR TECHNIQUES**

climatic design priorities	U. S. region
a, b, c	New England; Northern Plains, Midwest
a, c, b	Great Plains, intermountain basin, and plateaus; northern California, Oregon, and Washington coastal regions
a, c, b, f	high, mountainous, semi-arid regions above 7,000 feet in southern latitudes and above 6,000 feet in northern latitudes
a, g, c, d, f, k, h, b	California's Central Valley and parts of the central coast
a, e, c, d	Mid-Atlantic Coast
c, e, b, d, i	Mississippi Valley
a, e, c, d, b, i	Appalachia
g, d, h, f	Southwest desert regions
i, c, d, a, h, b, e, g	west Texas and southeast New Mexico
k, c, d, b	Oklahoma and north Texas
f, d, j	eastern Gulf Coast
h, f, d, j	western Gulf Coast
l, d, f, j	southern Florida
l, d, c, e, g	semi-arid region of southern California

WINTER HEATING STRATEGIES

a. Keep the heat in—and the cold air out.

1. Locate spaces that need less heat (closets, stairs, garages, etc.) along the north wall, and spaces that need more heat (sun room, greenhouse) on the south wall.
2. Minimize windows on all walls except the south.
3. Insulate well.

b. Shelter from winter winds.

1. Don't build on windy hill tops.
2. Create wind breaks with evergreens.
3. Put garages and utility spaces on winter windward side (usually north).
4. Minimize openings on the sides facing winter winds.
5. Use tight construction, caulking, and weatherstripping to minimize wind infiltration.

c. Maximize solar gain.

1. Build on south, southeast, or south west slopes to maximize solar gain and daylighting.
2. The long axis of house should run east to west.
3. Most windows should face south.
4. Use direct gain, Trombe walls, and sun spaces for passive solar heating.
5. Use thermal mass to absorb and store solar radiation.

SUMMER COOLING/VENTILATION STRATEGIES



Trees Provide Shade ©Joan Kimball / iStockphoto

d. Protect from sun.

1. Do not build on east or especially west slopes. South slopes are best if solar heating is required in winter (north slopes are best, if not).
2. Place trees strategically for summer shade.
3. Avoid east and west windows.
4. South windows should have a generous soffit overhang.
5. Add shutters or shades to help cool the house.

e. Ventilate naturally to cool.

1. Use “night flush cooling” to cool your home at night in preparation for heat of the next day.
2. Situate your home to take advantage of prevailing winds.
3. Use landscaping and land forms to direct and channel winds toward your home.

f. Ventilate naturally to cool and remove excess moisture.

1. Same techniques noted under “ventilate naturally” above.
2. Elevate the main living area away from

high humidity near the ground.

g. Use thermal mass to flatten temperature swings—reducing heat during the day and increasing heat at night.

1. Make use of “night flushing” to cool the home overnight.
2. Use materials with thermal mass—brick, concrete, stone, adobe—to absorb the high heat of the day and release it slowly at night.
3. Insulate all thermal mass.

h. Keep hot temperatures out.

1. Maintain cool air around the perimeter of the home using plants and exterior shade structures
2. Windows should be few, and small.



Cooling Pond ©Elena Elisseeva / iStockphoto

i. Use evaporative cooling.

1. Make use of pools, ponds, fountains—inside your home or in a courtyard.
2. Plants will cool both indoor and outdoor air.

j. Don't add humidity.

1. Do not use evaporative cooling techniques.
2. Maintain proper drainage of the land around your home.
3. Minimize indoor plants.

SPRING AND FALL

k. Ventilate naturally to cool during Spring and Fall.

1. Use “night flush cooling” to cool your home at night in preparation for the heat of the next day.
2. Situate your home to take advantage of prevailing winds.
3. Use landscaping and land forms to direct and channel winds toward your home.

YEAR-ROUND

l. Open your home to the outdoors if temperatures are comfortable year-round.

1. Have a variety of outdoor spaces with different orientations—use spaces on the south side during winter, and on the north side in summer.
2. Build outdoor living spaces protected from summer sun and winter winds.
3. Use non-compact home design—one story with many wings.

m. Ventilate naturally to cool and remove excess moisture.

1. Same techniques noted under “ventilate naturally” above.
2. Elevate the main living area away from high humidity near the ground.

The preceding passive solar information is an abbreviated summary of comprehensive climatic design strategies found in Heating, Cooling, Lighting: Design Methods for Architects by Norbert Lechner.

source: 6

landscape your home.

LET FORM FOLLOW FUNCTION

- Design landscaping and building foundations to require no chemical maintenance.
- Use plantings that mitigate airborne mold or pollens upwind or along the paths of travel to your home.
- Design so that you don’t need combustion-fueled landscape maintenance equipment—like leaf-blowers, lawnmowers, or chain saws.
- Certain types of plants will help detoxify indoor air pollutants like benzene or formaldehyde. These include Boston fern, chrysanthemum, dracaena, ivy, and ficus. Note: Indoor plants will increase humidity and may encourage mold growth.

For more on detoxifying plants, read: How to Grow Fresh Air: 50 House Plants that Purify Your Home or Office by B. C. Wolverton

money saving tips

- Harvest edible weeds like dandelion leaves (great for the liver) and nettle (big source of magnesium) for food rather than trying to eradicate them.
- Consider using natural farming methods to grow local, organic crops so that you can control the purity of your food while enriching the soil and ecosystem around your home.

note: Make sure no chemical pesticides were used by prior occupants if you do!

sources: 1, 2, 7, 8

build the safest house possible.

WHEELCHAIR ACCESSIBLE, EMF-, MOLD-, AND CHEMICAL-FREE

- Mold and electrical sensitivities are environmentally triggered illnesses that occur in a subset of those with Chemical Sensitivity. We recommend that those building a safer house include considerations to minimize both mold and electromagnetic frequencies (EMFs), as they are a potential risk factor for those with CS even though symptoms may not yet be present.
- Consider that your condition might decline with age, change or be compounded by other situations.
- Create a house that visitors who may be more sensitive than you can enjoy.

wheelchair accessibility



Wheelchair Access ©Dmitriy Rashap / iStockphoto

- Provide at least one ramp entrance into home.
- Make sure all doorways provide wheelchair clearance.
- Include interior ramps if home is multi-level.

- Build at least one bathroom and shower with wheelchair access.

emf-free

SITE SELECTION

- Ideally, locate your home at least 5 miles from the nearest microwave or cell phone tower, high tension power line, or other radio, TV, transmitter, etc. Test the background magnetic field levels with the power off. Due to net neutral current problems between homes, shared transformers should be avoided. Make sure to check for future cell tower sites as well as existing.
- Consider building on a site with a mountain between you and existing or future cell, radio, or microwave towers. Living in a valley will provide more protection from EMF radiation, whereas a mountaintop will provide almost no protection (however, keep in mind that valleys tend to accumulate environmental toxins in air, ground, and water). Do whatever it takes to minimize electrical and magnetic fields, microwaves, and radio signals.

HOME DESIGN / LAYOUT

- Design with as much natural lighting as possible so that you are less dependent on artificial lighting.
- Ideally, locate the electrical power panel, solar inverters (if you are using active solar), clothes dryer, hot water heater, and any other large electric appliance at least 20 feet from living/sleeping areas. For the hot water heater, make sure the wires between the upper and lower elements are not spaced apart; install a new pair if they are.
- The routing of any dedicated circuits for

computer and other equipment should be kept away from critical areas like the bedroom.

MATERIALS SELECTION

- Steel studs should only be used inside walls when they can be adequately grounded to earth. Some of the benefits of using metal studs are that they do not contain terpenes found in wood framing studs nor do they attract termites—they also conduct heating and cooling more quickly through the wall.

The steel should first be checked with a gauss meter for EMFs and degaussed if necessary. The steel framing system should be cleaned of any oil and grease using a tolerable cleaner or placed in the sun for a long time before using.³

The steel framing system must be grounded but if the area is plagued with objectionable ground currents then the ground might actually feed back into the walls and an alternative should be sought.

- Ceramic, stone, and marble floors have a grounding effect and may be better tolerated by those with ES than other materials.³
- Although hardwood will not shield EMFs, William J. Rea, M.D. of the EHC-D reports that some with ES do better with hardwood environments rather than porcelain. Keep in mind that many with CS do have trouble tolerating both wood and sealant odors.

APPLIANCES / PRODUCTS

- It is usually safer to use a ceramic top electric range (lower EMF and less burnt oils) and to locate the kitchen at least 14 feet from other living/sleeping areas. Many ES people are not able to use an

electric oven and prefer to use an outdoor gas oven. A hot plate, toaster oven and/or crock pot might also work for you. A non-electric solar oven is also an option for those who have access to sunlight year-round, no matter how cold it is out.

active solar tip

If you choose to use an off-the-grid photovoltaic electrical system, normal operation is for sunlight to generate power in the photovoltaic panels that is stored in batteries at 24 volts direct current. An inverter takes the 24 volts DC and transforms it into 120 volt AC power for the house.

A mode is available so that when the amount of 120-volt AC house power being used drops below a certain point, the inverter is turned off (to conserve power). A test pulse is sent to the house every couple seconds or so to see if someone has turned on an appliance, in which case the inverter comes back on line for normal 120-volt AC power.

By carefully managing the house electrical loads, it is possible for 120-volt AC power into the house to be automatically off much of the time except when needed. If you do use active solar, make sure you locate the inverter far from your living space.

- For greatest safety, locate your refrigerator in the storage room, garage or an exterior building.
- Consider purchasing a counter-height refrigerator/freezer to avoid running the freezer motor fan at the same level as your head.
- Some ES people are bothered by dimmers, motion detectors, fluorescent light-

ing, High Intensity Lighting (HID), Metal Halide, and arc lamps. Test for your sensitivities before installing electrical and lighting equipment.

- Low-e coatings on windows can help block radio and cell phone waves.
- Add 'kill switches' for TVs, computers, phones, electric water heater, etc. and provide wall switches for all lights so that you can turn off power easily and prevent EMFs from emitting at night while you're sleeping or when not in use.
- Check that all A/C cube adapters are unplugged when not in use and at night when sleeping. It is best to use these devices away from areas where you spend most of your time.
- If you do not have an adverse reaction to motion detectors, you can install one on the electric stove and refrigerator so that they turn off when you enter the room and then automatically turn back on after a safe period of time.
- To safeguard against the brain fog and short-term memory loss that can occur during reactions, you might install a timer on your electric stove to help avoid burning your food so that it automatically turns off every 20 minutes or so unless you reset the timer.

WIRING

- Bring wiring down vertically from the attic to each outlet and light switch instead of running horizontally around the room.
- Some prefer to shield their wiring in EMT conduit, but many just use standard Romex® or other NM type cable without any shielding.
- Have a dedicated circuit to any electronics, such as computers. Also provide a dedicated circuit for the refrigerator so that you can turn off other breakers at night, except for the fridge.
- Most new Ground Fault Circuit Interrupters (GFIs) are now constant ElectroMagnetic Interference (EMI) generators. Cooper brand GFI units are EMI free and should be used for anyone with chemical or electrical sensitivities.
- Minimize on the use of cable lines inside the home. When used, they should be in EMT (electrical metallic tubing, commonly known as thin wall conduit) or preferably rigid conduit. Digital cable causes problems for some with ES.
- Phone lines should be either double shielded cable (heavy braid over foil) or run in EMT conduit. DSL and WiFi introduce much the same problem as digital cable as far as site selection.
- Wiring must be tested for net current: Each neutral conductor in the panel must be disconnected, and then continuity tested against the remaining bussed neutrals. Any shorts (common neutral connections) must be located and corrected. Common neutral connections between circuits will not trip the breakers. Each 120v hot breaker must be continuity tested (all breakers switched open) against all others for a common hot connection. Same phase common hot errors will not trip the breakers. Do not use shared neutral wiring methods.
- Avoid hard-wired smoke alarms (but you may need to install them initially to meet the local building code).
- Check and correct wiring errors to dual 220/110v devices: stove and dryer. Stove and dryer must be configured to have a separate ground, and isolation between



Check Dryer Wiring ©Luke Daniek / iStockphoto

ground (chassis) and neutral.

PLUMBING

- Copper pipes, although preferred by many who are chemically sensitive, are not ideal for ES as they conduct EMFs. It is recommended that polyethylene (PE) or chlorinated polyvinyl chloride (CPVC) be used for all water pipes extended through the house wall to prevent stray ground current paths on water pipes. PE is the preferred choice for both interior and exterior piping. In comparison with polyvinyl chloride (PVC) and CPVC, PE uses fewer problematic additives, is less likely to leach into the ground and landfills, and is easier and cheaper to recycle.

PVC, although a cost-saver for the average home builder, is not allowed in or under a building per the Uniform Plumbing Code.² It is not as durable as the other plastics and does not handle hot water temperatures well. In addition, from its manufacture to its disposal, PVC emits highly toxic compounds.

Keep in mind that although plastic pipes will smell at first, they do seem to off-gas after several weeks. Consider running your laundry for a couple weeks before moving in to start the off-gassing process.

emf-free lifestyle tips

Note: Many with ES have food sensitivities, sun and light sensitivities, and other issues—these are all general guidelines and of course, one must take into consideration your particular tolerances and financial resources. Most importantly, listen to your body!

- Rise with the sun and go to bed early to make maximum use of daylight and avoid using artificial lighting whenever possible.
- Do things manually if there's a way—don't use electricity as a matter of convenience or to save time. For example, use a manual juicer, a 'bike blender,' or a broom/mop instead of a vacuum cleaner—all great ways to incorporate exercise into your lifestyle and stay fit, without needing a gym membership or having to leave your home!



Beach Stroll ©Anne Clark / iStockphoto

- Work on strengthening your immune and nervous systems with a nutrient-rich organic diet, nerve-balancing foods and herbs, 8 hours of sleep, moderate exercise, and plenty of fresh air and sun.

emf-free lifestyle tips (continued)

- Practice a chemical-free lifestyle to reduce your total body burden of toxins: replace all personal care and home-cleaning products with chemical free versions, wear organic clothing, etc.

For more tips on a chem free lifestyle: see *PlanetThrive.com's Chemical Sensitivity Tips in the INFORMATION section.*



Tree Hugging ©Pete Smith / iStockphoto

- Wear shoes with a sole made from natural materials (like undyed leather), walk barefoot on the beach or earth, or hug a tree—these all may help you release excess EMFs into the earth and ground your body.
- Keep all electrical appliances unplugged when not in use.
- Shut your breakers off at night (if you have a separate circuit for the fridge).
- Avoid the use of microwave ovens, hair dryers, electric toothbrushes, electric blankets, and other electric products; limit the use of cordless and cell phones.
- Use a standard Trifield meter to monitor EMFs in your bedroom monthly and to help you keep away from hot spots.

emf-free lifestyle tips (continued)

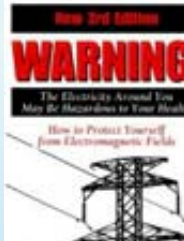


AM radio ©Dóri O'Connell / iStockphoto

- Use an AM radio as a near field RF (radio frequency) device, as well as a broadband RF meter.
To use: keep AM radio tuned between stations near the low, mid and upper AM bands. If you hear static only near the appliance then there is a bad connection. On the same circuit, but with the appliance unplugged, if you hear static on a lamp cord then it may be a severe power quality problem, not the appliance's fault.
- Keep computer use to a minimum. Laptops are sometimes better tolerated than desktop PCs—use a long cord on an external keyboard and mouse to keep the laptop pushed back, minimizing your EMF exposure. Keep unplugged when not in use.
- Avoid areas with wireless networking (WiFi)—internet cafes, airports, etc.
- Some people with ES are bothered by fan motors on car heaters and air conditioners, windshield wiper motors, and other electronic devices like navigational systems. Some don't do well with hybrid cars, while others prefer them.
- Avoid metal eyeglass frames (use plastic instead) and underwire bras.

emf-free lifestyle tips (continued)

- Experiment with EMF shielding devices that have helped others. These may include pendants, chips, home harmonizers, boji stones, and gemstones like black tourmaline that are thought to have electro-magnetic shielding qualities. Results are highly individual and require experimentation. Some of these products can be quite expensive so if possible, experiment with products that are returnable—and make sure the return policy is in writing.



- Read *Tracing EMFs in Building Wiring and Grounding* by Karl Riley and *WARNING: The Electricity Around You May Be Hazardous to Your Health* by Ellen Sugarman.
- Good sources for EMF related products: LessEMF.com and CutCat.com.

For more EMF-free lifestyle tips: See PlanetThrive.com's *Electrical Sensitivity Tips* in the INFORMATION section.

sources: 1, 2, 3

mold-free

- Ideally, build your foundation on a slab to avoid basements and crawlspaces, as both can have moisture and mold problems in just about any climate.

- According to Ritchie Shoemaker, M.D. in *Mold Warriors*, if you choose to build your home into the side of a hill with a walk-out basement, there will be great ground water pressure on three sides of the foundation. With porous materials like brick, concrete, and block, there is the constant threat of water intrusion that can lead to toxic mold growth. The solution? Dig out an extra six feet on the uphill and slope sides of your foundation before you lay the concrete. Then make use of French drains, swales and berms, and gutters to move water at least 6 to 20 feet away from the perimeter of the house and your basement walls:⁴



French Drain ©JES Construction, Inc.

French drain: layers of pebbles, rock and sand surrounding perforated pipes that will help collect the downstream flow of water into conduits, and drain the water away from the foundation safely.

Swales: a shallow trench that collects water into an area, and can be used to divert it from your basement walls.

Shoemaker suggests building a pond uphill, long and not too wide, for protection from surface water intrusion and to fill it with goldfish and water lilies for year-round beauty.⁴

Berms: down-slopes of land that can direct water away from your foundation. Shoemaker advises: fill the berm with pebbles, then cover with mesh near the top of the uphill grade, and put a thick bed of flowers and shallow rooted shrubs over the void.

Gutters: metal channels that catch water and direct it off of the roof of a house. If your site is level, look at water flow patterns during heavy rainstorms to see where water flows downstream naturally. You want to avoid having your gutter downspout feed water into your basement every time it rains. Attach a diversion pipe to the downspout to lead the water at least 20 feet away from your foundation, if necessary.



Clearing the Gutter ©Mitch Augner / iStockphoto

Make sure you do regular gutter maintenance to prevent clogging and other simple maintenance failures that can be the cause of water infiltration into your basement, leading to mold growth.

- Place plants, trees, and other potential sources of water infiltration at least 10 to 12 feet from house.
- Avoid porous building materials that could give a foothold to mold. Glass and metal are the most mold resistant, whereas wood is very susceptible to mold. Mold

can grow on the edges, bottom, and in the grout of ceramic tiles. Concrete is naturally mold resistant due to its high pH but under the right conditions, it can breed mold. Where humidity levels are over 50% and ground water soaks into basements, mold can grow in the 'water and dirt soup' that saturates the concrete.

- Shoemaker says that when you eliminate a basement, you eliminate a major mold source and when you eliminate a powerful attic fan or air conditioning, forced heating, duct work and other hidden sources for dust, water, and mold to collect (use passive solar design instead), you eliminate a potential mold delivery system.⁴
- The attic and any crawlspace created by a foundation must be ventilated:
 1. If there is a mechanism in place to force air through the length of the crawlspace, leave a few small vents open year round.
 2. Install joist-mounted fans.
- Never put any HVAC equipment in a crawlspace, where water condensation and puddling in flexible ductwork can go unnoticed.⁴
- Keep humidity levels at 30 to 50 percent.
- Install large exhaust fans vented to the outdoors in the kitchen, and bathroom areas, where humidity levels are higher.
- Vent clothes dryers to the outdoors.
- Seal electrical outlets and top plates where wires and/or pipes enter the walls.
- Use dehumidifiers to remove water from your home, especially in areas where water tends to collect like basements and bathrooms.

- Install a whole house HEPA air purification system to remove mold spores. Be aware that some Hepa filters may use glues that contain formaldehyde. In addition, many with chemical sensitivities tolerate one type of carbon filter better than another. Make sure to test for tolerance before installing an expensive system.
- Check caulking and flashings around windows and doors.

mold-free lifestyle tips

- Make your meals fresh each day, avoiding left-overs if possible.
- If you ferment foods in your home, keep a close eye on kombucha, sprouts, etc. to watch for mold growth.
- Keep kitchen counters and bathrooms/showers clean and dry to avoid mold; wipe down sinks after use and shower/bathtub tile surfaces after bathing to reduce standing moisture.
- Clean shower curtains and the underside of bathmats (where mold usually grows) regularly.
- Conduct regular maintenance and cleaning according to the manufacturer's instructions on all humidifiers.
- Eliminate standing water and repair all leaks and water damage from floods within 24 hours, before mold can grow. Remove or replace wet carpets.
- Take the Visual Contrast Sensitivity (VCS) test at www.chronicneurotoxins.com if you suspect mold-related illness.
- Read Ritchie J. Shoemaker, M.D.'s book *Mold Warriors* to find out more about bio-toxin related illness.

sources: 1, 2, 4, 5, 9

protect yourself.

CHOOSE YOUR BUILDER WITH GREAT CARE

- Oversee each step of the construction process yourself, or hire an architect or other professional consultant you trust to do it. Someone who understands chemical-free building, and who will stand up to the builder and sub-contractors if necessary.
- Quiz your builder until you are satisfied he/ she can (and will!) control his/her subcontractors.
- Do not believe everything he/she tells you, even if he/she says he/she fully understands Chemical Sensitivity, agrees to put everything in writing, etc.
- Put all agreements in writing, although this will not necessarily save you unless you have the time and money to pursue legal action.
- Require an MSDS (Material Safety Data Sheet) on all materials used and require your written approval of each.
- Specify that there are to be no substitutions of toxic brands and keep an eye out to enforce it. It only takes one bad product to ruin an entire home.
- Examine all installed products to make sure they are what you specified.
- Require a fragrance-free crew and do not allow smoking on the site.
- Place a sign on front of property explaining that this is a chemical free construction site.

sources: 1, 2

select your building materials wisely.

LIVE WITH ALL MATERIALS BEFORE BUILDING

- Personally test all materials overnight, or longer, to see if they are well tolerated while you sleep, as reactions are often more prominent at night. Tolerance to products should be tested long before work commences.



Completed Detached Garage in Background,
Main House in Foreground ©Melinda Honn

- Consider constructing outlying buildings (detached garage, shed, guest house, pumphouse, and workshop) prior to starting the main house so you can experiment with and test all materials.
- Do your research and read books, check the Internet, speak with architects, consultants and others with environmental sensitivities, but ultimately, do not rely on anyone but yourself for what materials to use. We are all unique in our sensitivities and we must individually test all materials to truly know what will work for us and what doesn't. Skimp here and you will pay later.
- Consider using salvaged materials that have already off-gassed only if you have a source that is guaranteed fragrance- and pesticide-free.

materials testing tips

sniff test: Place a sample of material in a glass jar and let it sit out in direct sunlight for 2 or 3 days. Be sure to let the sample dry thoroughly (up to 2 weeks or so) before putting it in the jar. Then take the jar inside and open it to get a sense of how an entire room would smell. This works well for paint and caulk samples. If you are very sensitive, make sure the jar is held far away enough before you open it to avoid severe reactions.

muscle test: Some have used muscle testing/kinesiology to assist in the materials selection process.

sleep test: It is recommended that you test all materials overnight or for several days. After off-gassing each material for a couple weeks, sleep with them near your head, one at a time. For paints and other items that require application, have your contractor paint on a tolerable/inert material (tile, stone, glass, or metal) to isolate the fumes.

shed test: The best way to test materials is to build a small building (shed, pumphouse, etc.), let the materials off-gas for several weeks, and then sleep in it to see what it is like to be surrounded by that material on all sides as you would be in a room in your home.

MATERIALS / FIXTURES / PRODUCTS

exterior

- Use cement block or non-wood construction. William J. Rea, M.D., founder of the Environmental Health Center-Dallas (EHC-D), recommends brick, stone, glass, adobe, and aluminum for home exteriors.

adobe

- Adobe is a great building resource in dry climates, however, in wet climates those with chemical sensitivities may be sensitive to the wet earth smell of adobe, and mold will most likely become an issue.
- If sold commercially, adobe may have chemicals added to kill mold and bacteria or to make it stick together more; may also contain asphalt emulsion to help stabilize the blocks.



Adobe Inn ©Martin McCarthy / iStockphoto

- Adobe requires maintenance, which is not ideal when your health is compromised. If you make the blocks yourself, you'll have to reseed the outside with fresh mud every few years.
- A roof on an adobe home requires large overhangs to protect the walls from rain.
- Excellent for storage of solar thermal gain.
- Has a low insulation value; exterior adobe walls need to be supplemented with some type of insulation.
- Load bearing, no additional framing needed but a concrete or wooden bond beam is required to bear the roof's ceiling joists or rafters.

strawbale

- Straw bale is okay for some but may be conducive to mold in certain climates. Use lime plastering to retard mold growth.

concrete hybrids

Various forms of a hybrid concrete material sound promising for the future, but currently the materials are new enough that most building safety departments in America are unfamiliar with them and require engineering on your plan. That means that at each step along construction when you have an inspection, a registered architect or structural engineer must show up and sign off and get paid again, adding to the total cost of the project.

It may also be difficult to find a mason who is familiar enough to work with the material. If you live in a state where this type of material is harvested locally, this might not be an issue. For example, Pumice-Crete is a common building material in New Mexico and local cities/counties may not require an architect or engineer to sign off.

• Pumice-Crete

Pumice-Crete is a low density, load-bearing concrete made from pumice aggregate (an inert, naturally occurring volcanic rock), Portland cement, and water that provides structural strength and insulation in one material. Walls made of Pumice-Crete are very durable and are resistant to moisture, fire, noise, and insects. Although there is no need for vertical wood framing with Pumice-Crete, a concrete bond beam is required to carry roof loads.

• Autoclaved Aerated Concrete (AAC)

Also known as E-Crete, AAC is fire-

resistant, energy efficient, and durable. Its manufacturing process emits no pollutants, creates no by-products or toxic waste products, and uses 80 percent less energy than concrete or lumber manufacturing. However, it would not be strong enough for a foundation, and its use as an exterior material would require plasticizers to make it non-porous and waterproof.

- **Rastra®**

Rastra® is an inert building material that uses ground-up recycled polystyrene packing peanuts and Styrofoam drink cups mixed with cement to form giant building blocks. It offers superior insulation, and protection from mold, insects, noise, and fire.

AVOID Stucco, wood, vinyl siding and masonite-type or wood/paper composite siding that continually off-gasses chemical smells.

weathering

- Use Tyvek wrap.

roof

- Install a pitched roof, as flat roofs are prone to leaks, and therefore, to mold.



Pitched Metal Roof ©Joel Kapp

- Use metal for the roof to avoid the smell of petroleum based shingles.
- White metal will deflect heat; black metal will absorb heat.

foundation

slab-on-grade



Smoothing the Slab ©Susan Molloy

- Slab-on-grade additive-free concrete on the ground is recommended to provide thermal mass (see passive solar tips on page 10) and prevent mold accumulation that can occur in a crawlspace, but preparation is highly recommended:

Make sure there are no voids, logs, big rocks, or other items down to about 5 feet that may allow settling overtime.

Then the ground (preferably as dry as possible) should be compacted with a thumper machine. Then add layers of:

- compacted native soil
- dry sand, four inches
- radon barrier
- foam insulation, one to two inches
- concrete slab, four inches minimum

If you want a hydronic heating system, lay in pipes and seal with gypcrete, a

gypsum concrete floor underlayment used in concrete construction, then install ceramic tiles on top.

pier and beam

- If your house needs to be elevated, make sure it's 5-10 feet off the ground to provide adequate ventilation underneath and to prevent mold, which can travel from the foundation into your home. Screened vents and fans can be used as well, to keep air circulating and dry.³
- Installing a sub-floor would most likely require the use of wood as a flooring material, which is poorly tolerated by many with severe environmental sensitivities.

For foundation blueprint diagrams showing proper drainage and ventilation: See chapter 3 in *Optimum Environments for Optimum Health & Creativity: Designing and Building a Healthy Home or Office* by William J. Rea, M.D. .

framing

- Steel studs should only be used inside walls when they can be adequately grounded to earth. Some of the benefits of using metal studs are that they do not contain terpenes found in wood framing studs nor do they attract termites—they also conduct heating and cooling more quickly through the wall.

The steel should first be checked with a gauss meter for EMFs and degaussed if necessary. The steel framing system should be cleaned of any oil and grease using a tolerable cleaner or placed in the sun for a long time before using.³ The steel framing system must be grounded but if the area is plagued with objectionable ground currents then the ground

might actually feed back into the walls and an alternative should be sought.

AVOID Wood framing—studs are usually made of high-terpene woods that will off-gas for years.

insulation

- Use formaldehyde-free insulation.

Consider:

- Recycled cotton batt insulation; tolerated by some with CS.
- Rock wool batt insulation; the fibers are larger in diameter than other fibrous insulation materials and are less likely to disperse particulate contaminants into the air.
- AirKrete insulation; a lightweight foamed concrete insulation with high thermal efficiency over time.
- For noise protection, use an insulated double stud wall to separate the utility room from bordering rooms, muffling the sound of any mechanical systems used.

AVOID Styrofoam, fiberglass, mineral rock, wood, and recycled paper in insulation products.

air-vapor barrier

- We recommend avoiding the use of air/moisture-vapor barriers, as they tend to encourage mold growth.

wiring

- Install twisted wiring (use at least three wires to cancel out EMFs) in a thin steel conduit to reduce exposure to electrical and magnetic radiation, as well as to plastic and oil-based wiring materials.

plumbing

- Although preferred by some with CS, copper pipes are not ideal because they conduct electricity. Copper also does not insulate, and has been linked to brain disorders like Alzheimer's Disease.
- For water pipes, polyethylene (PE) piping is the better choice for interior and exterior piping. PVC, although a cost-saver, emits highly toxic compounds from its manufacture to its disposal.

AVOID Polyvinyl pipes.

water filtration systems

- Install a whole-house water filtration system or use water filters at all sinks and in the showerheads.
- In addition to chemicals, some with environmental sensitivities cannot tolerate high mineral content in water (for both drinking and bathing); others cannot tolerate high mold/algae levels. One should determine what he or she needs decontaminated prior to selecting a water filtration system.³
- The type of water filter needed will be dependent on the source of the water: spring, well, reservoir, or rainwater. Complete a water analysis to determine the specific contaminants that will need to be removed.³
- William J. Rea, M.D. of the Environmental Health Center-Dallas (EHC-D) says that ceramic/carbon water filters encased in stainless steel appear to be the best filters available today. The filters are replaceable and will need to be changed every 6 to 12 months.³

- Safer materials for water filtration systems include stainless steel, glass, and ceramic.
- If you are using spring and/or distilled water for your drinking water, make sure to store in glass or stainless steel bottles as plastic will leach into the water. Assess mineral content of spring water to evaluate whether you can tolerate the ratio of minerals.³

AVOID Galvanized, copper, cement, and vinyl water pipes; plastic parts; glues and synthetics.

doors

interior

- Use exterior steel doors for interior doors.

exterior

- Standard steel-clad insulated doors.

AVOID Sliding doors—they will let in ants, and allow heat / cool air to escape.

windows



Aluminum Window Frame ©Snowflake Beach

- Use Energy Star-qualified wood, aluminum-clad wood, or all-aluminum windows; wood-containing types usually use pine treated with a water-based solution

to protect against water absorption, termites, and decay; contain no solvents or heavy metals. First test to see whether you tolerate air leaking through solid wood casement windows vs. aluminum; do not use the cheap window casements made of particle board.

AVOID Cheap windows that may leak smoke and other fumes into the house.

light fixtures

- Use ceramic sockets instead of plastic, which off-gas when heated.
- Wire unit and path of travel for magnetic ballast-free light fixtures as an alternative to fluorescent or halogen. Or, you might want to provide a choice of lighting in each room to accommodate different sensitivities, including fluorescent, incandescent, and battery lights.

interior walls

- Finish walls and ceiling with no or low-VOC surfaces or coatings.

drywall

- Consider using foil-backed drywall turned inside out.
- Dense Armour paperless, fiberglass embedded drywall is mold resistant and works well for some when taped and textured using Murco 100 dry mix joint compound.

ceramic tiles

- Ceramic tiles are completely inert (no off-gassing fumes), extremely durable, and clean easily. Some with severe chemical sensitivities have tiled the floor, walls, and ceiling of their bedroom.
- To lay tiles, use thinset mortar with no



Ceramic Tiles ©Vladislav Gurfinkel / iStockphoto

additives and use Salfillo tile grout as it contains no polyvinyls. Or use a simple Portland cement mix without toxic additives.

porcelain (silica fused to steel)

- Well tolerated by many with environmental sensitivities since it is dust-free, chemically inert, and provides shielding from EMFs. There is also minimal mold growth with porcelain.³

glass

- Some have placed glass panes over wallpaper and other materials to seal any off-gassing fumes.

adobe

- Adobe is a great building resource in dry climates, however, in wet climates those with chemical sensitivities may be sensitive to the wet earth smell of adobe, and mold will most likely become an issue.
- Excellent for storage of solar thermal gain but has a low insulation value.
- If sold commercially, adobe may have chemicals added to kill mold and bacteria or to make it stick together more. May also contain asphalt emulsion to help stabilize the blocks.
- You must use soil with a high clay content.

earth plaster

- Tolerated by some with chemical sensitivities but mold may become an issue. Read *The Natural Plaster Book* by Cedar Rose Guelberth and Dan Chiras.

AVOID

wood: Not recommended for those with chemical sensitivities, as many cannot tolerate the smell of wood and wood finishes, and for maintenance the wood must be repainted / resealed several times over the lifetime of a house, re-exposing the occupants to the off-gassing fumes again and again.

- If you are set on using wood, poplar and maple contain few tanins or terpenes and may be more tolerable by those with chemical sensitivities.¹⁰
- Fillers and finishes can be toxic; choose unfinished wood with a non-toxic finish and nail down to avoid the use of toxic glues.
- Coat hardwood flooring with a water-based finish to minimize chemical off-gassing.

wallpaper: Although newer, greener options for wallpaper tout water-based inks without formaldehyde, heavy metals, PVC, or vinyl backing, wallpaper is a definite no-no in terms of mold and mildew, which collects underneath it.

- If you do choose to use wallpaper, the Environmental Health Center-Dallas sells various patterns of aluminum wallpaper for those who want to use it for its partial EMF-shielding qualities. Aluminum wallpaper is also free of particulates but if not well sealed with non-toxic glue, mold can grow behind it. Some with

chemical sensitivities do not tolerate aluminum.

portland cement: Avoid spraying on walls as a base coat. (However, it is well tolerated when used as grouting.)

caulking

- Choose one that does not contain fungicide.
- Test several brands on a piece of tile, rock, glass, or metal so that you can sniff them to choose the best one for your home.

joint compound

- Choose a vinyl- or asbestos-free brand; read labels carefully.
- Use a dry mix joint compound, which has no preservatives, solvents, polyvinyls, or antifreeze.

window and door trim

ceramic tile

- Use ceramic tiles for window and door trim—some have designed beautiful trim using decorator tiles.



Tiled Window Sill and Trim ©Melinda Honn

baseboards

- For tile floors, don't forget to install a 3- to 4-inch baseboard using the same tiles as you use on the floors. This will protect the walls from damp mopping, a necessary maintenance to control dust and other allergens if you have a tile floor.

AVOID

wood: Generally wood is not recommended for those with chemical sensitivities, as many cannot tolerate the smell of wood and wood finishes.

- If you do choose to use wood despite the warnings, make sure you test first to see if you tolerate the wood smell, the primer, the paint, and whether you can still smell the wood thru the paint, as some paints will not seal in the wood smells.
- If you do use wood, some recommended using 'factory primed hardwood' or kiln dried (i.e. furniture grade) wood.
- Poplar and maple contain few tanins or terpenes and may be more tolerable by those with chemical sensitivities.¹⁰
- Avoid woods from endangered rainforests (see Rainforest Relief's *Guidelines for Avoiding Woods from Endangered Forests*¹¹) and look for wood that is Forest Stewardship Council (FSC) certified.
- Avoid using salvaged wood unless you know the history of the wood and can confirm that it has not been treated with pesticide or for termites.
- Pine has been a problem for many with chemical sensitivities due to aromatic terpenes.

paint

low voc paint

- Readily available in retail stores, easy to tint, easy to apply, and only slightly more expensive than other water-based paints. Made from non-renewable petrochemicals they give off minimal odor during application, dry quickly, but not as fast as traditional paint and should be tested for individual tolerance.

zero or no voc paint

- Note that there is no EPA or standard definition for VOC content—it usually means extremely low. The odor is less than most traditional or low-VOC paints but zero VOC paint is not good for metal, plastic, or other shiny surfaces. Dries slower than traditional paint and should be tested for individual tolerance.

milk paint

- Casein-based paint made from milk and natural pigments contain no VOCs when dry. They are best for walls that are unfinished, porous, or made from plaster, wood, or earth. Milk paint comes in powdered form, so you can mix only as much as you need. Gives a Historic look (used in the Colonial period). Smells milky when wet; no paint odor dry or wet and has a naturally streaked appearance.
- Generally nontoxic but you should check the label to confirm ingredients.
- Milk paint doesn't fade and is very long lasting. It can crackle and scuff but doesn't chip or peel like traditional paint.
- Readily available through Internet, but probably not locally.
- Watch for latex or oil imitations.

silicate/mineral or silicate dispersion

- Silicate / mineral paints have a very low VOC level with very little odor, contain no solvents, are colorfast and have a rock-like durability which bonds well with masonry surface.
- They are anti-microbial, water resistant and vapor permeable. paint pigments (for mixing your own homemade paints).
- Can be relatively harmless or highly toxic—check labels.

AVOID Synthetic, oil-based paints that contain fungicides.

flooring

ceramic tiles

- Completely inert (no off-gassing fumes), extremely durable, clean easily and can contain recycled content, but are energy intensive. A good choice for those with chemical sensitivities, and can be used throughout the house including areas with radiant floor heating.
- To lay tiles, use thinset mortar with no additives and use Saltillo tile grout as it contains no polyvinyls. Or use a simple Portland cement mix without toxic additives.

concrete

- Can be easier on knees/hip joints than ceramic tiles. Tolerated by some with chemical sensitivities.

stone, porcelain, glazed brick, marble, terrazzo, and glass

- Tolerated by some with chemical sensitivities.

AVOID

wood: Not recommended for those with chemical sensitivities, as many cannot tolerate the smell of wood and wood finishes, and for maintenance the wood must be repainted / resealed several times over the lifetime of a house, re-exposing the occupants to the off-gassing fumes again and again.

- If you are set on using wood, poplar and maple contain few tanins or terpenes and may be more tolerable by those with chemical sensitivities.¹⁰
- Avoid woods from endangered rainforests (see Rainforest Relief's *Guidelines for Avoiding Woods from Endangered Forests*¹¹) and look for wood that is Forest Stewardship Council (FSC) certified.
- Avoid using salvaged wood unless you know the history of the wood and can confirm that it has not been treated with pesticide or for termites.
- Fillers and finishes can be toxic; choose unfinished wood with a non-toxic finish and nail down to avoid the use of toxic glues.
- Coat hardwood flooring with a water-based finish to minimize chemical off-gassing.

carpeting: Not recommended for those with chemical sensitivities; difficult to clean, harbors dirt, dust, mold, and pests and off-gasses hazardous fumes. Synthetic fibers are from non-renewable petrochemicals.

porous surface tiles: They need to be sealed after installation and resealed one or two times a year thereafter with toxic sealants.

natural linoleum: Not recommended for those with chemical sensitivities; if you do choose to use linoleum be aware that it must be treated with linseed oil approximately once a year for maintenance.

earthen floors: Not recommended for those with chemical sensitivities; offers no barrier for radon gas and may be full of mold spores, fungus and other contaminants that are often not tolerated by those with extreme sensitivities.

cork: Not recommended for those with chemical sensitivities; has a natural odor that may be intolerable and requires monthly waxing to maintain.

bamboo: Not recommended for those with chemical sensitivities; all bamboo requires lamination and contains adhesives; some use toxic, out-gassing formaldehyde.

vinyl: It off-gasses chemicals, and is highly susceptible to mold growth underneath.

most laminate flooring: Not recommended for those with chemical sensitivities.

grouting

- Portland Cement is well-tolerated by those with chemical sensitivities for grouting in place of standard grout that contains plasticizers. (Note: Caused respiratory problems for some when sprayed on as a base coat for walls; the same people tolerated it well when used for grouting.)

grout sealer

- No grout sealer is necessary if you are using Portland Cement as your grout. If

not, look for a non-toxic grout sealer.

kitchen counter

- Use metal, slate, ceramic tiles, or glass for counters.

AVOID Laminated products and granite. Granite is very porous and requires a sealant. Until a non-toxic sealant is available, we cannot recommend it.

kitchen backsplash

- Use ceramic tiles or tiles made from recycled post-consumer glass.

kitchen cabinetry



Powder-Coated Steel Cabinets ©Melinda Honn

- Stainless steel and powder-coated steel cabinets are both well-tolerated by those with chemical sensitivities as they are inert and will not off-gas. They will also last a lifetime without needing to be refinished or replaced.
- It is not recommended to use cabinetry containing any wood even if it is well tolerated now, as it may need to be refinished at a time when you are more reactive to it, and is more likely to harbor cooking odors.

AVOID Composite or other formaldehyde or phenol off-gassing wood product shelving, kitchen or bathroom cabinets, or doors (e.g. plywood).

kitchen appliances

refrigerator / freezer

- Use transparent drawers to minimize risk of food spoilage.
- If you have ES, consider purchasing a counter-height refrigerator/freezer to avoid running the freezer motor fan at the same level as your head.

AVOID Using a recycled refrigerator due to risk of mold contamination.

stove

- Consider purchasing from an appliance recycling store to avoid off-gassing that occurs with new appliances, but make sure you check the history of the appliance to see whether pesticides were used around it.
- Buy self-cleaning rather than continuous cleaning to avoid uncontrolled emissions.
- Consider using a renewable-energy sun stove, also known as a solar oven, which requires only sunlight to cook food, providing you are in a climate where adequate sunlight is always available. It can be used even in cold months as long as there is sunlight. Added benefit: no costly energy bills.

stove hood

- Install an updraft stove hood.

dishwasher

- Use stainless steel, or powder-coated steel.

- Consider omitting a dishwasher from your kitchen. Hand-washing dishes saves natural resources.

AVOID Gas appliances.

bathroom wall / floors

- Use ceramic tiles or tiles made from recycled post-consumer glass.

bathroom fixtures

sink

- Use stainless steel, powder-coated steel, or porcelain.
- Corian® integrated sink and counter will eliminate mold growth around sink.

bathtub

- Consider enameled steel.

toilet

- Consider a low-flush toilet.

sauna



Sauna ©Bojan Tezak / iStockphoto

- Use poplar, hardwood, glass, or ceramic tile with non-toxic grout. Filter air.

AVOID Cedar and other high-terpene woods for saunas, as well as toxic glues and sealants.

storage shelves

- Use stainless steel, or powder-coated steel.

furnishings

TV/book cabinets

- House TV and other electronic equipment behind closed doors (glass works well) when not in use to minimize off-gassing into living space.
- Consider adapting for a reading unit (a piece of glass over the desk top to contain fumes from reading materials).
- Ideally book cabinets should have glass or metal doors and be vented.

seating



Metal furniture ©Marje Cannon / iStockphoto

- Consider using metal or glass furniture; some have even used outdoor iron patio furniture. Those with severe ES have tolerated metal furniture, however it is recommended to test your tolerance especially if you have WiFi, cell phone towers, or other EMF-emitting devices in your area.
- An alternative that has worked for some is off-gassed hard plastic furniture, which may be better tolerated than wood.

- Use chemically untreated cotton (no fire retardant or soil/stain repellent) or other tolerable material for upholstered items. Pre-wash fabric several times with tolerated detergent to remove chemical finishes and odors.

AVOID Foam-filled cushions, as foam is most likely chemically-treated.

window treatment

- Aluminum blinds are the most inert window treatment available and are the best choice for those with chemical sensitivities, but may need to be off-gassed.
- Others have used cotton fabric blinds and cotton lining. Pre-wash fabric several times with tolerated detergent to remove chemical finishes and odors. It is ideal to purchase untreated cotton fabric that is well tolerated and have custom blinds made.
- Likewise, some have tolerated cotton drapes. Pre-wash fabric several times with tolerated detergent to remove chemical finishes and odors. It is ideal to purchase untreated cotton fabric that is well tolerated and have custom drapes made.
- In hot climates glass blinds have been used to redirect sunlight.



Glass Louvres ©Carsten Böttcher / iStockphoto

AVOID Woven wood shades, wood blinds, and wood shutters; although sometimes tolerable for those with CS, they are not recommended. Remember, your tolerances may change over time so it is best to start with a 'safe' material (i.e. inert) rather than a merely 'tolerable' one. With that said however, if you do want to have some wood touches in your home, removable items—such as blinds—are the safest way to go (financially speaking) rather than installing expensive wood doors/trim/flooring and having to replace them all later with more tolerable materials.

general products to avoid

- Wood products; they harbor odors, use toxic sealants, will need re-finishing over a lifetime.
- Porous materials requiring toxic sealants.
- Solvents.
- Some of the new 'green' products that use recycled plastics may be using plastic from former containers of fabric softener, bleach, and other toxic substances.

sources: 1, 2, 3, 7, 9, 10, 11, 12, 13

For a source list of specific brand name materials with website links: See *PlanetThrive.com's WELLNESS | Green Lifestyle | Home section under housing | build—materials.*

To purchase a printable version of this brochure: See <http://tinyurl.com/3259rj> or go to *PlanetThrive.com | WELLNESS | Green Lifestyle | Home | Safer Construction.*

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Greg Conrad (GregoryAZ@msn.com) recently retired as Head of Residential Building Safety for the City of Phoenix where he worked for 25 years. Melinda and Greg just completed the construction of their own environmentally safe home in Snowflake, Arizona, a labor of love that took over 3 years of research, testing and experimentation.

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SOURCES

- 1 individual surveys of 18 people that built housing for someone with moderate to severe chemical and/or electrical sensitivities including: Ariel Barfield, Nancy Entreken, Erik Johnson (aka *Erikmoldwarrior*), Susan Molloy, P. Ruggles, Andres Schulz, Ernie Stiltner, and Jackie Wayman. All others prefer to remain anonymous.
- 2 Melinda Honn and Greg Conrad, non-toxic construction consultants
- 3 *Optimum Environments for Optimum Health & Creativity: Designing and Building a Healthy Home or Office*, William J. Rea, M.D.
- 4 *Mold Warriors*, Ritchie C. Shoemaker, MD, with James Schaller, MD and Patti Schmidt
- 5 *Gaia's Garden: A Guide to Home-Scale Permaculture*, Toby Hemenway
- 6 *Heating, Cooling, Lighting: Design Methods for Architects*, Norbert Lechner © 2001 by John Wiley & Sons, Inc. All rights reserved. Reprinted with permission of John Wiley & Sons, Inc.
- 7 *Recommended Architectural Features for Multi-Family Housing to Better Accommodate Chemical and Electrical Sensitivities*, Susan Molloy, M.A., New Horizons Independent Living Center, Inc.
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- 12 *Research House for the Environmentally Hypersensitive*, Canada Mortgage and Housing Corporation
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