



TURNER BUILDING SCIENCE & DESIGN, LLC

Providing a future/moving toward resilient building construction-

William A. Turner, MS, PE, LEED® AP.

CEO

TURNER BUILDING SCIENCE & DESIGN, LLC

26 Pinewood Lane Harrison, ME 04040

(207) 583-457 Ext. 311

bturner@turnerbuildingscience.com,

Moving Toward Resilient Building Construction

**Meeting the Challenge of Weather Hazards and
Climate Change in The Northeast**

***For:
UCONN Health Workshop:
Hurricanes and Mold***

**William A. Turner, M.S., P.E.
Turner Building Science & Design, LLC
www.turnerbuildingscience.com**

Agenda

- 1. Defining
Enhanced Resilience, Climate Trend, &
High Performance**
- 2. Critical Components**
 - **Moisture Management**
 - **Climate & Location Specific Building Enclosures**
 - **Key Critical Component Management**
- 3. FEMA and Other Recommendations**
 - **New Construction**
 - **Retrofits**

Resilience is...

“...the capacity to adapt to changing conditions and to maintain or regain functionality and vitality in the face of stress or disturbance. It is the capacity to bounce back after a disturbance or interruption of some sort.”

[Resilience Design Institute](#)

Overall Building Concerns: Storm Surge, Wave, and Wind Action



Courtesy of David Johnston & Company

Climate Data Regarding Ocean Level

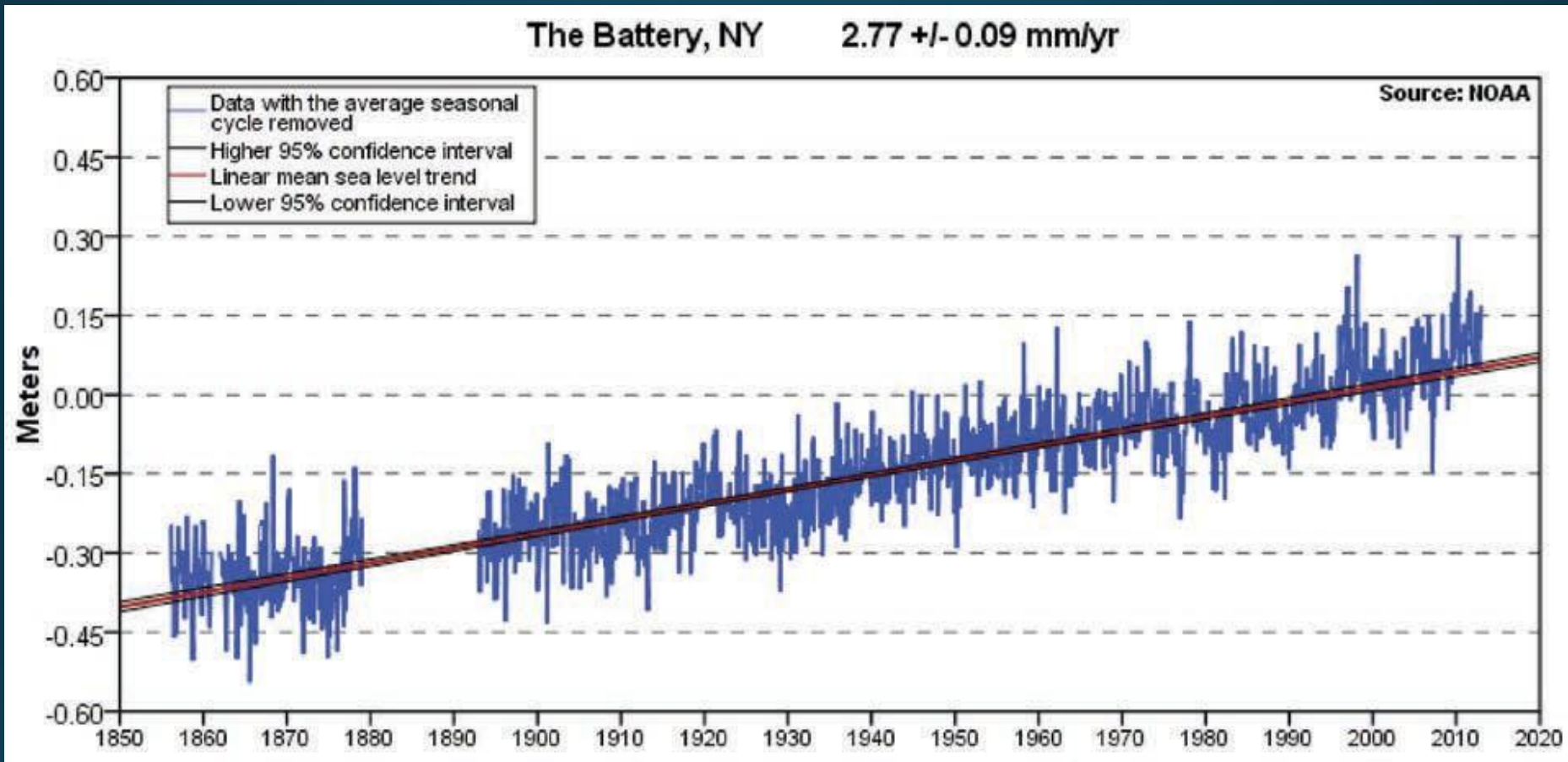
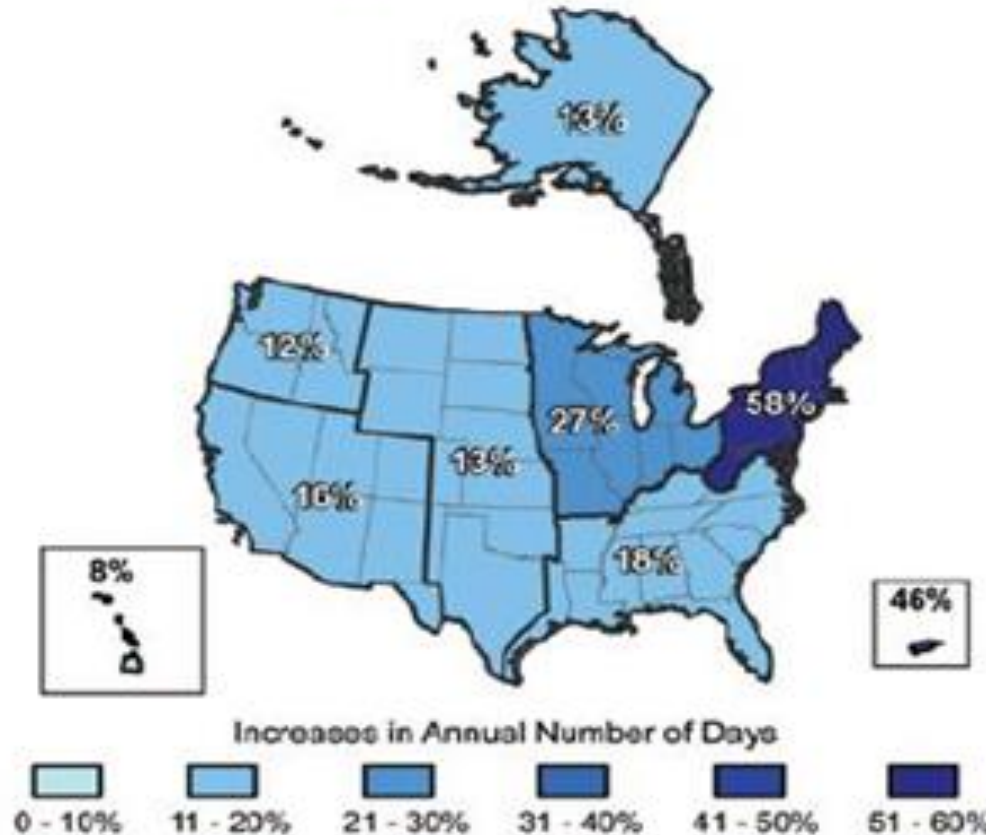


Figure 8: Sea level rise at The Battery, NY, 1856–2006 (Source: NOAA Web site)

From FEMA RA5 Design Above BFE (average 1 foot per century?)

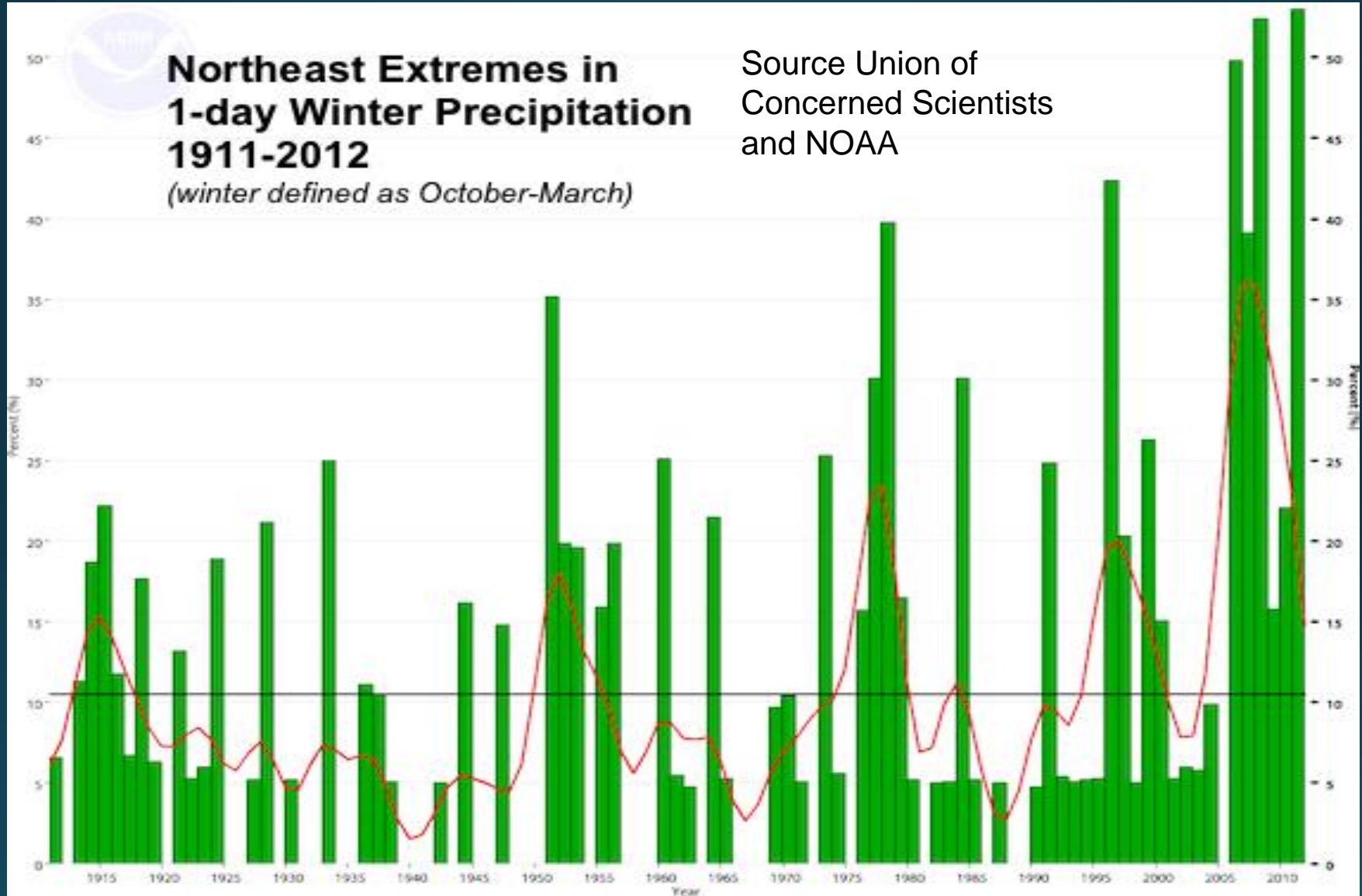
Increased Wetness in the Northeast

Increases in Heavy Precipitation (Number of Top 1% Days, 1958 to 2007)



Source: Scheraga JD, 2012. Development of EPA's New Climate Change Adaptation. Tribal Consultation Webinar Series. Courtesy Thomas J. Phillips
www.epa.gov/tribal/consultation/pdf/ccap-document-04-2012.pdf

Increased Winter Intensity



Resilience STAR: Dept. Homeland Security Pilot Project

- ◆ New and renovated homes
- ◆ Built to resilience standards of insurance industry
- ◆ Natural hazards addressed
 - ✓ Wildfire
 - ✓ Tornado, high winds
 - ✓ Flooding
 - ✓ Hurricane
 - ✓ Hail
 - ✓ Freezing weather
 - ✓ Lightning
 - ✓ Earthquake



✓ Extreme Heat and Climate Change projections not addressed

Source: Insurance Institute for Business and Home Safety, 2013.
Resilience STAR. www.disastersafety.org/resilience-star/

How Will Climate Change Affect IEQ?

◆ Extreme heat

- ✓ More frequent, hotter, and longer
- ✓ More humid
- ✓ Warmer nights

◆ More extreme storms

- ✓ Wind and rain
- ✓ Flooding

Courtesy of Thomas J. Phillips

Climate Change and IEQ (cont.)

- ◆ **More, bigger wildfires**
- ◆ More outdoor air pollution: ozone, particles
- ◆ More pollen, spores
- ◆ More insect-borne and soil-borne diseases
- ◆ **More frequent power outages**

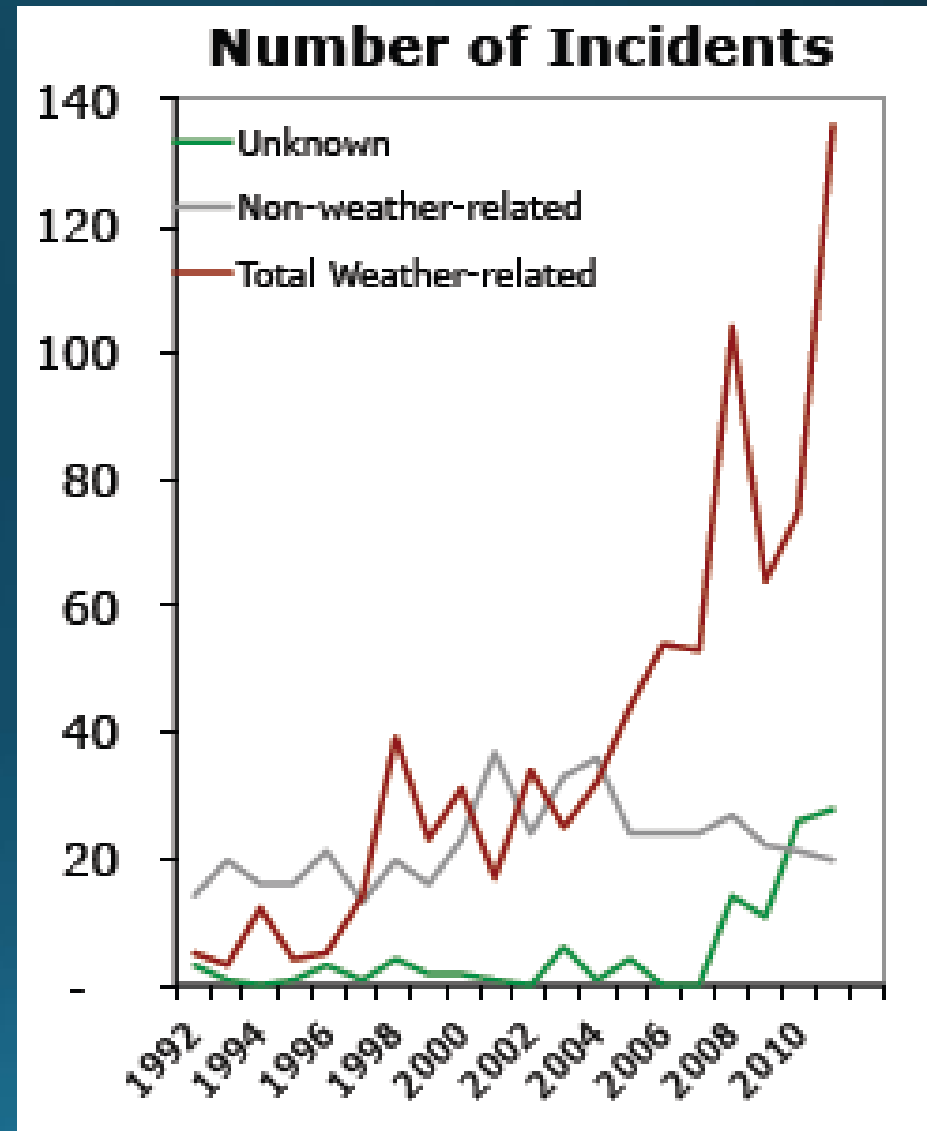


Courtesy of Thomas J. Phillips

Weather-Related Outages Surge

Weather-related causes have climbed sharply, from 25% to 75% of outages.

Mills E., August 30, 2012. Electric Grid Disruptions and Extreme Weather. US Disaster Reanalysis Workshop.
<http://evanmills.lbl.gov/presentations/Mills-Grid-Disruptions-NCDC-3May2012.pdf>. Courtesy of Thomas J. Phillips



Power Outages - Vulnerability

- Loss of livability
 - Loss of heat
 - Overheating of buildings
 - Loss of water
- Enhanced Vulnerability
 - Loss of communication
 - Loss of function (medical equipment)
 - Loss of refrigerated medicine (insulin)

Flooding - Vulnerability

- Insurance Claims – *50% outside of flood plain?*
- Loss of electricity
- Entrance of storm water through sewers
- Loss of HVAC equipment/appliances
- Loss of personal property
- Damage to structure & building materials
- Damage to foundation
- Loss of home, life, or health

Wind - Vulnerability

- Pressure effects due to pressure breach
 - Loss of roof
 - Ventilated attic
 - Garage door
 - Broken windows
 - Structural failure
- Power failure
- Water damage

Trends: Vulnerable Populations

Growing number and % of vulnerable persons: Elderly*, Obesity, diabetes, hypertension, and other medical conditions

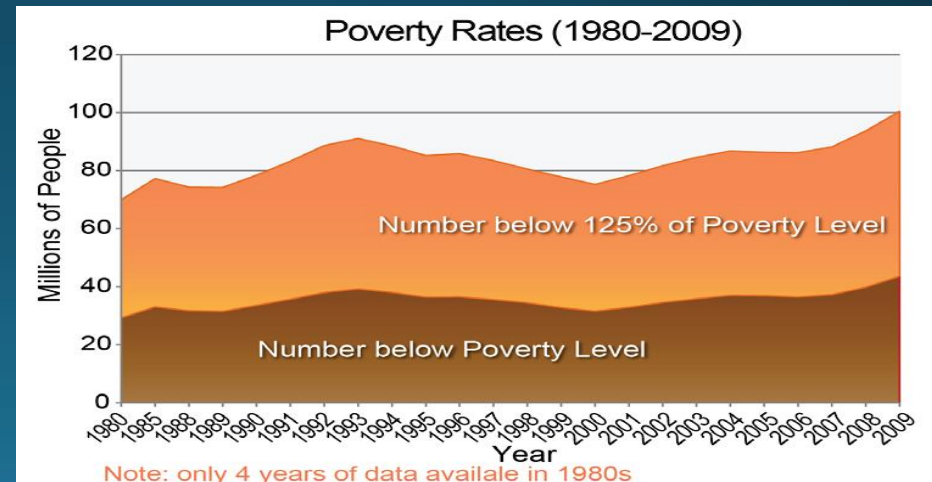
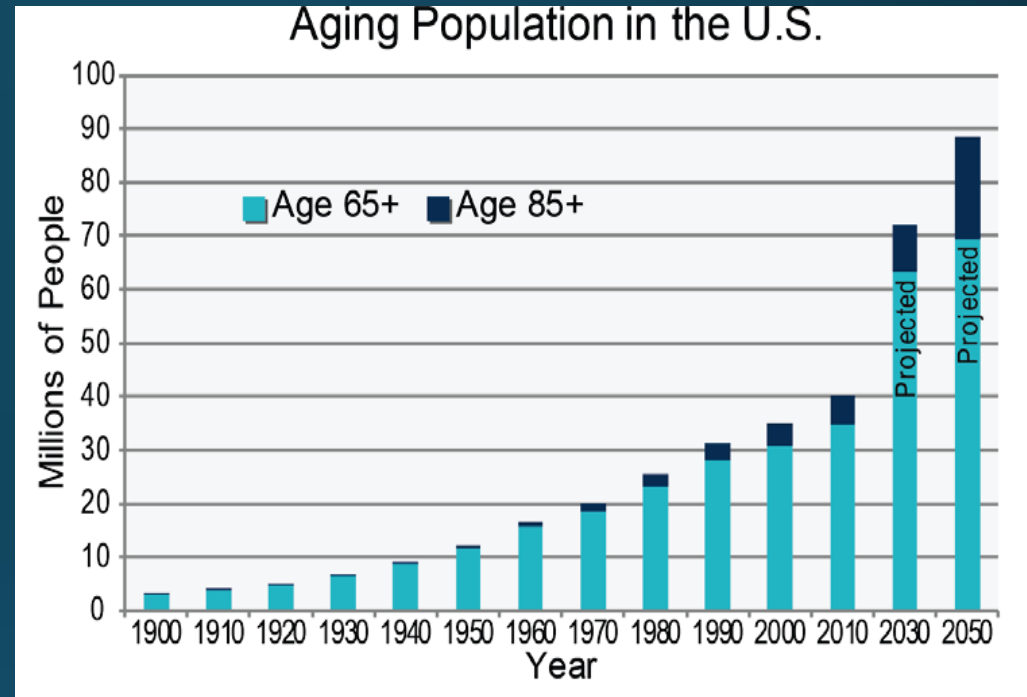
Poor*

Asthmatics

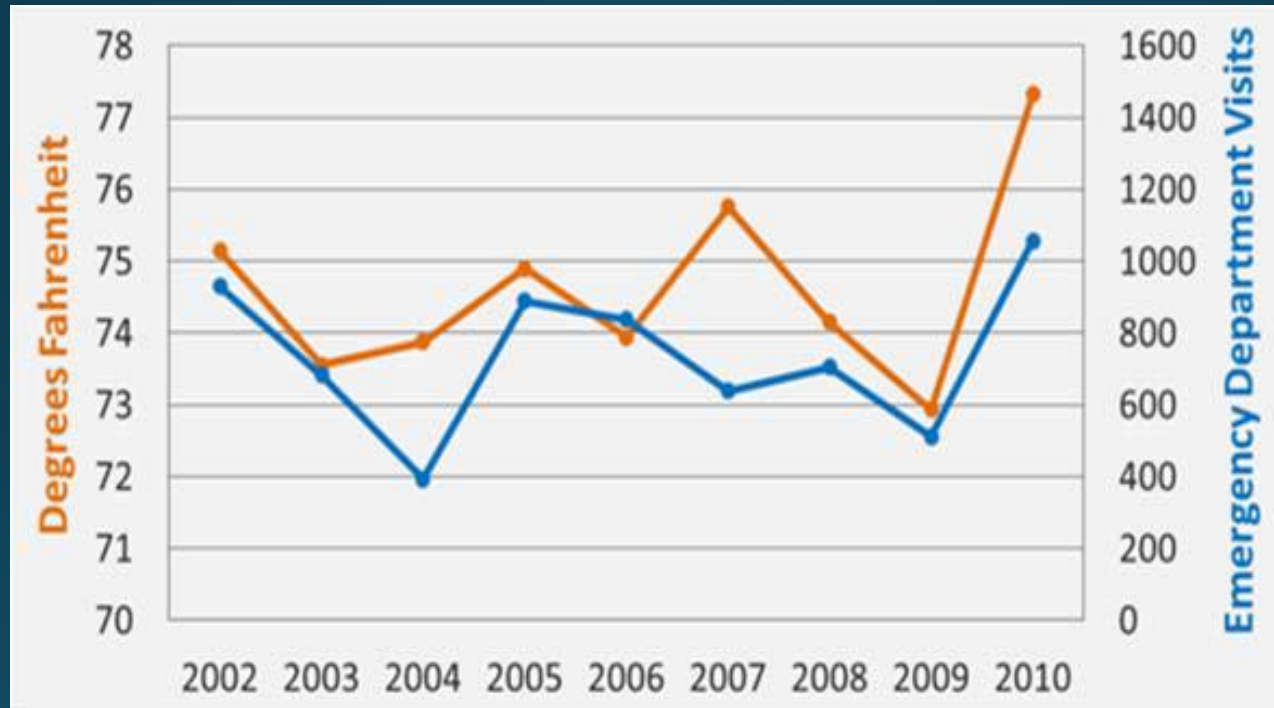
Climate change refugees, possibly by 2030

* U.S. EPA, 2014. National Climate Assessment.
Figure: Elements of Vulnerability to Climate Change.
<http://nca2014.globalchange.gov/report/sectors/human-health#statement-16518>.

Courtesy of Thomas J. Phillips



Heat stress ED visits and average of daily maximum summer temperatures in Massachusetts, 2002–2010

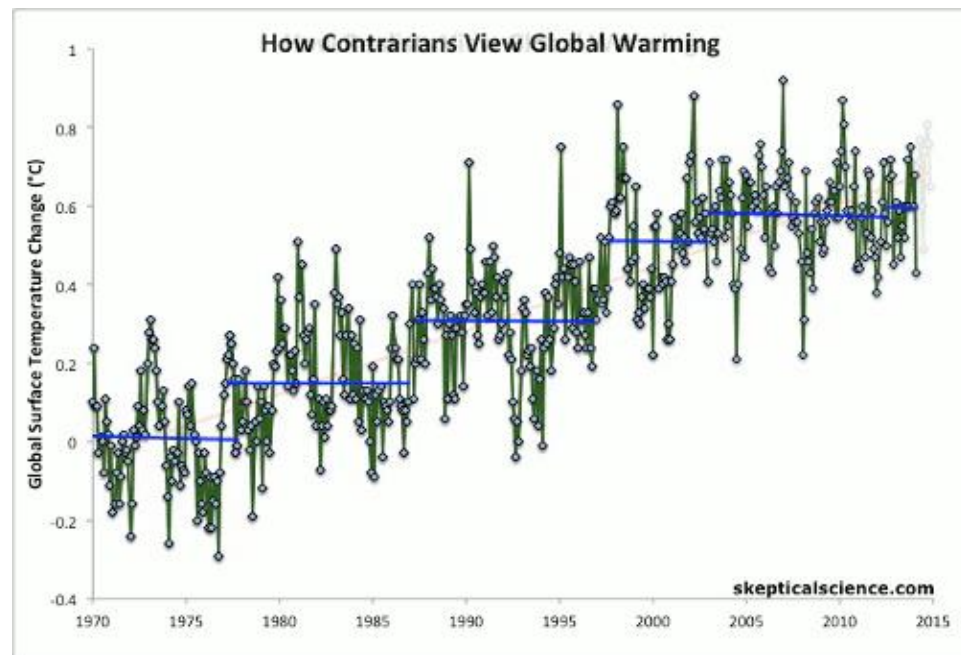
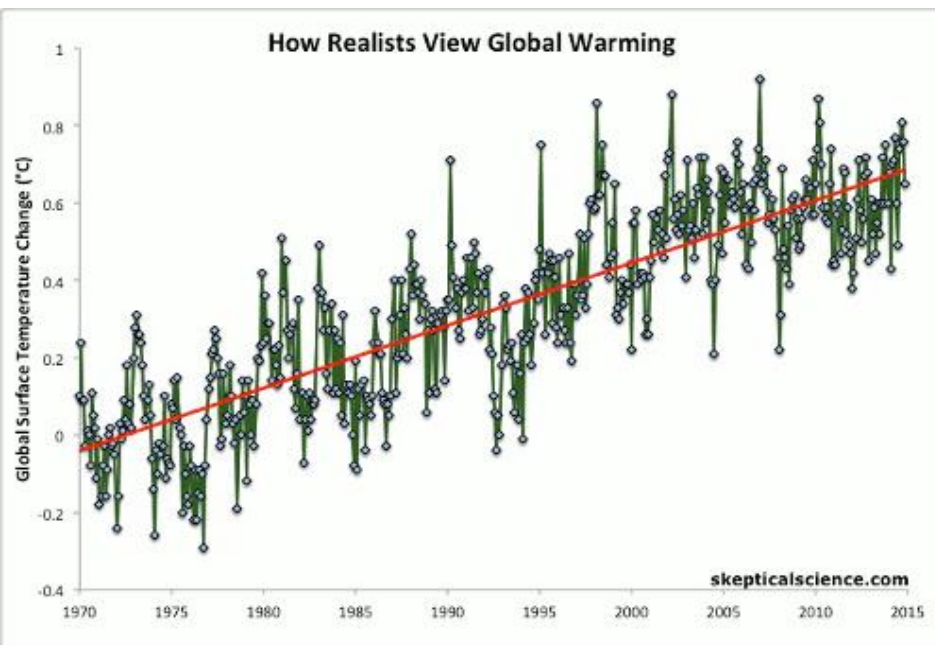


NEHTP: <http://ephtracking.cdc.gov/showHome.action>

CDC Climate and Health Program: <http://www.cdc.gov/climatechange/>

Global Temperature Data Interpretation

The 10 or 11 Year Cycle Info



Who will be most affected by extreme heat?

- Vulnerable populations:
 - Over 30% of adults, and growing
 - Young children
 - Pregnant women
 - Users of certain medications

2014 Connecticut Natural Hazards Plan Update

Department of Energy and Environmental Protection and
Department of Emergency Services and Public Protection
(Division of Emergency Management and Homeland Security)
January 2014

This plan meets requirements for a Standard State Plan under Interim Final rule 44 CFR 201.4, published by the Federal Emergency Management Agency.

Connecticut Department of Public Health Preparedness and Response

Natural Disasters – Floods

http://www.ct.gov/dph/cwp/view.asp?a=3126&q=389000&dphNav_GID=1601&dphPNavCtr=|47076|#47091

Hurricanes

http://www.ct.gov/dph/cwp/view.asp?a=3126&q=389016&dphNav_GID=1601&dphPNavCtr=|47076|#47092

How do we adapt building design and operation for climate change?

- ◆ **Weatherize plus Passive Cooling**
- ◆ **Future Proofing**
- ◆ **Resilient Design**
- ◆ **Integrated Design**
- ◆ **Quality Assurance**
- ◆ **Flexibility**

Courtesy of Thomas J. Phillips

U.S. Home Characteristics*

Home Characteristic	National Average (%)	Regional Range (%)
Poor or no insulation	21.0	19.5 - 24.8
No large tree shading house	55.8	54.8 - 60.3
Single pane windows	41.5	29.9 – 64.9

*2008 survey, 6 climate zones.

Source: Energy Information Agency, 2011. Residential Energy Consumption Survey (RECS) - Analysis & Projections - U.S. Energy Information Administration (EIA). Air conditioning in nearly 100 million U.S. homes. Available at: <http://www.eia.gov/consumption/residential/reports/2008/air-conditioning.cfm>.

Courtesy of Thomas J. Phillips

When renovating consider both Resilience and High Performance

New or renovation..... code+?

Energy Efficient & Resilient

Durable / Sustainable

Environmentally Friendly

Easier to warm & cool when needed

Very Useful Reference

Building America Best Practices Series Volume #12

Builders Challenge Guide to 40% Whole-House Energy Savings in the Cold and Very Cold Climates:

ref

http://apps1.eere.energy.gov/buildings/publications/pdfs/building_america/cold_climate_guide_40percent.pdf

Chapters: 6,7,8, (13 has checklists)

High Performance Operational Metric

Thousand Home Challenge Net Annual Household Site Energy



Customized Metric, Score 1-10
10 is Best



1 – 100 ENERGY STAR
score benchmark,
25 types of facilities

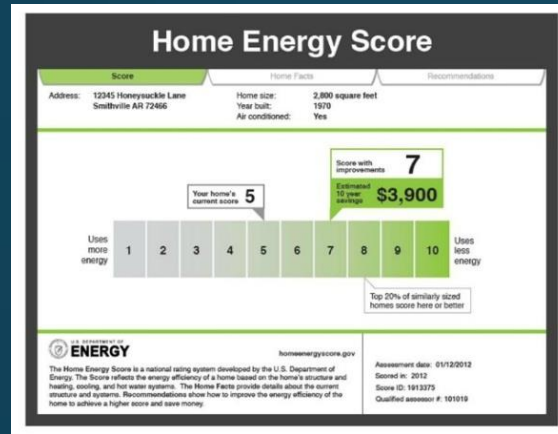
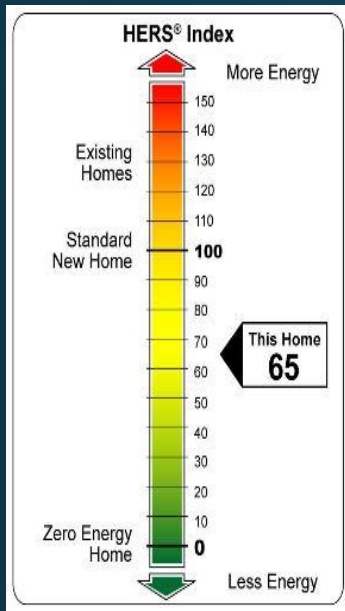
Building Energy Use per Year

(Homes) US avg. 36,065 kWh/yr. (EIA 2009)

Other?

Energy Use Per Square Foot/Year?

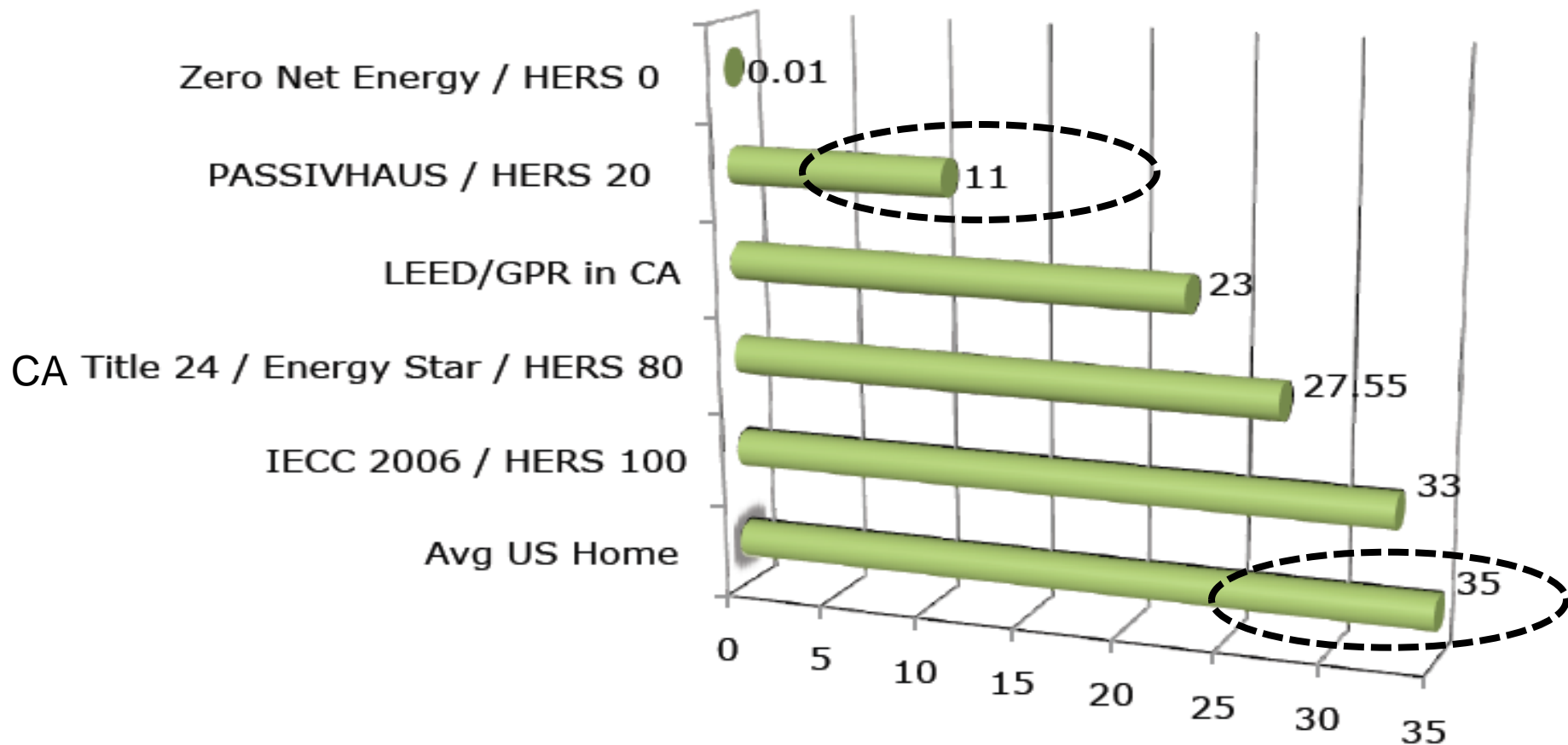
Asset Metric



www.usgbc.org

Other?

Annual Source Energy Consumption of a Single Family Residence - kWh/sf



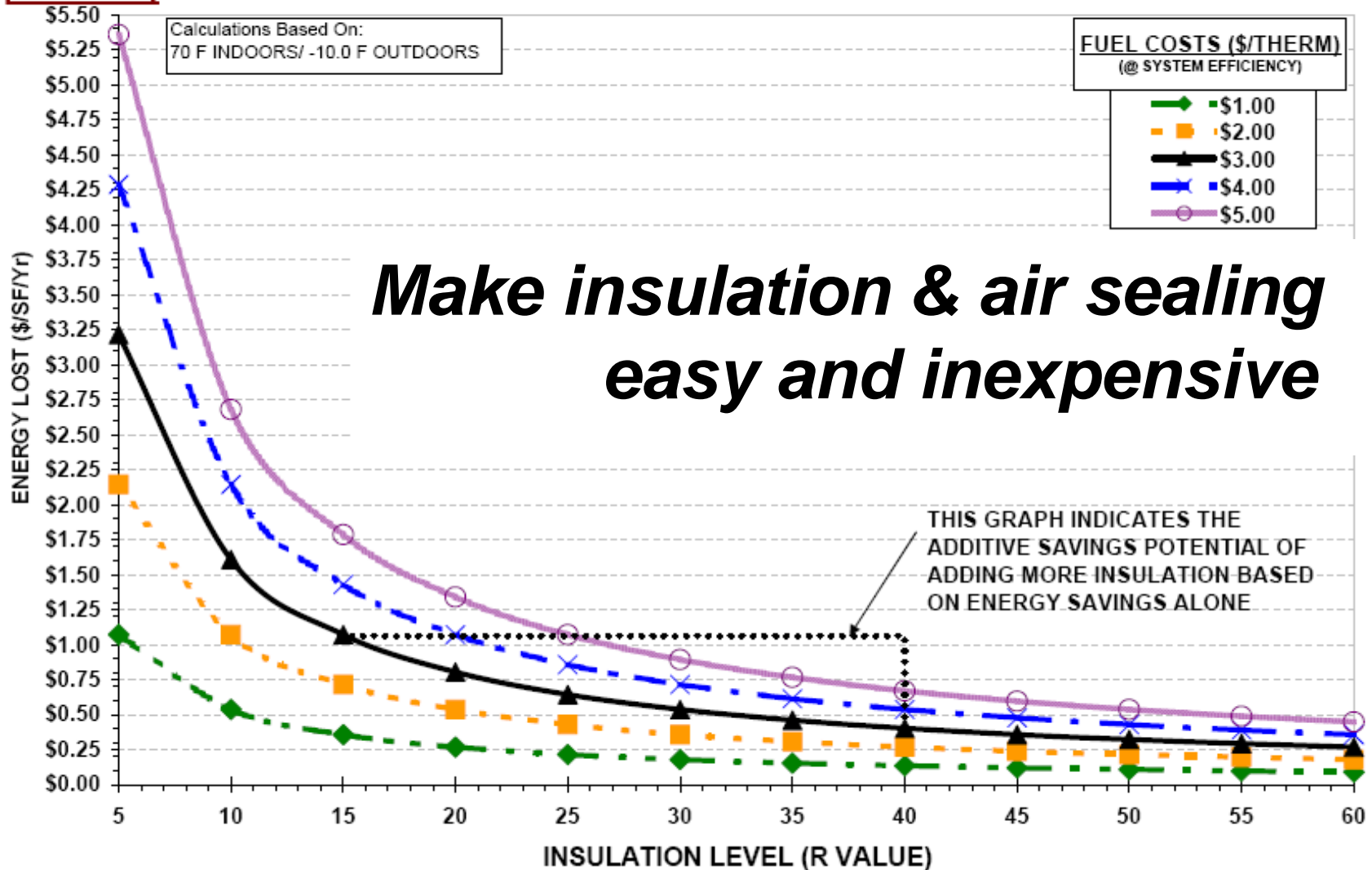
Source: Integral Impact, Inc., 2013. Introduction to PassivHaus.

<http://www.integralimpactinc.com/Passivhaus.pdf>.

Courtesy of Thomas J. Phillips

INSULATION COST EFFECTIVENESS

COST OF HEATING ENERGY LOST DUE TO INSULATION LEVELS



Address: Comfort, Health, & Cost Efficiency

The really good, just enough, not
too overboard building?



Reduce energy requirements,
downsize systems, serviceable

Zero Net Energy? Or Positive, if you
can add renewables?

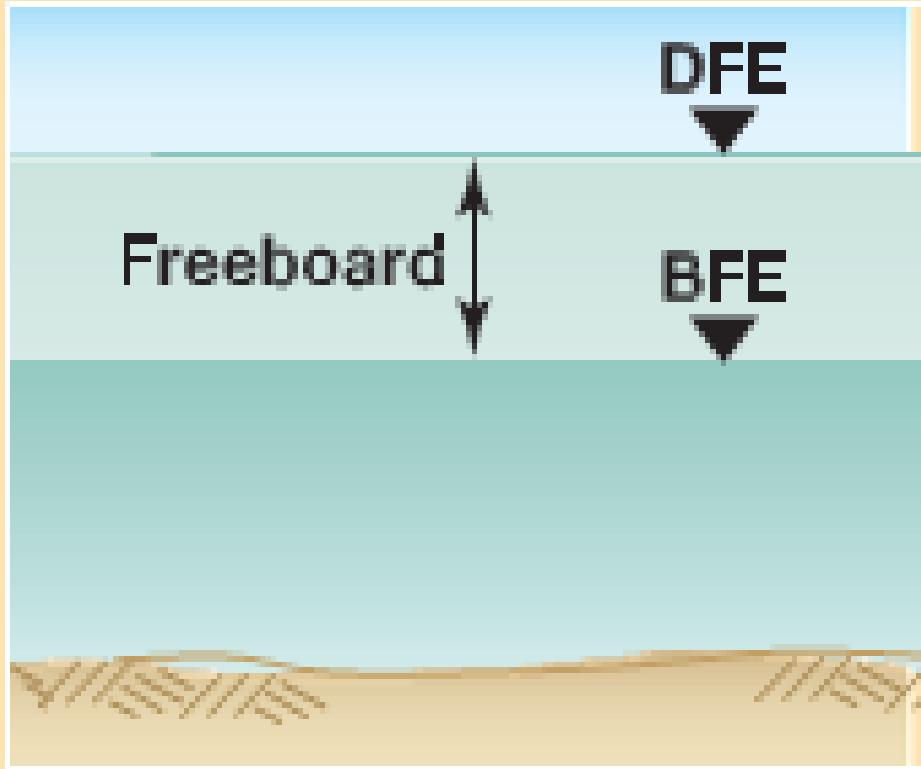
Balancing act?

As you renovate...

- Control moisture
- Use robust materials
- Elevate critical components
- Manage combustion appliances
- Provide ventilation
- Avoid exposures to mold, dust and VOC's
- Locate pest entry points and block
- Educate occupants

Critical Component Moisture Control

FEMA Terminology



Regulatory Flood Level,
May be ABFE

Freeboard in Feet,
vs. lowest level of
the building

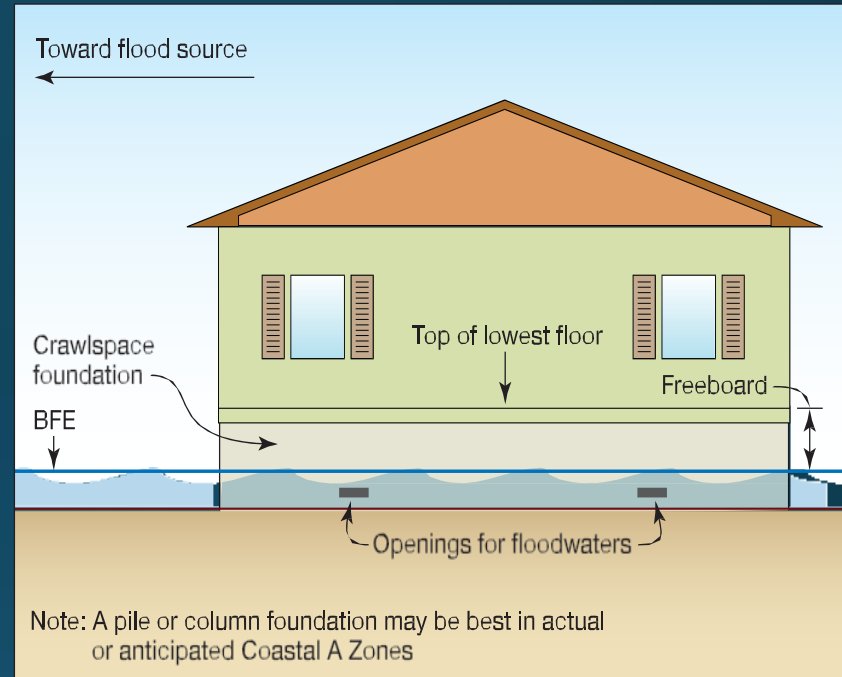
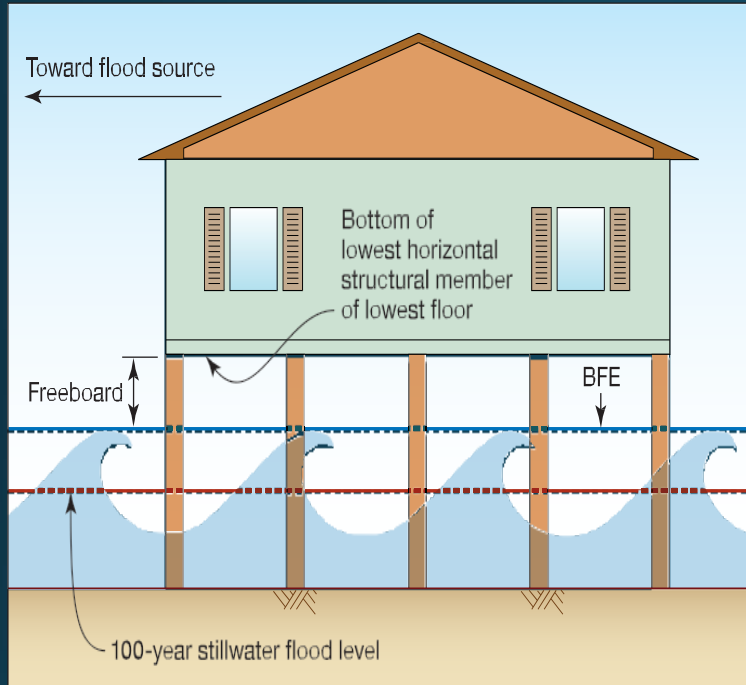
BFE is Base Flood
Elevation

<http://www.region2coastal.com/sandy/table>

“Today’s base flood will be more likely to occur in the future, and future BFEs will increase above today’s level”.

Adding 1 foot of freeboard above the BFE can save an owner approximately 25 to 40%. Adding 4 feet of freeboard can save approximately 50 to 65 percent in annual flood insurance premiums in some flood zones.

FEMA Recommendations



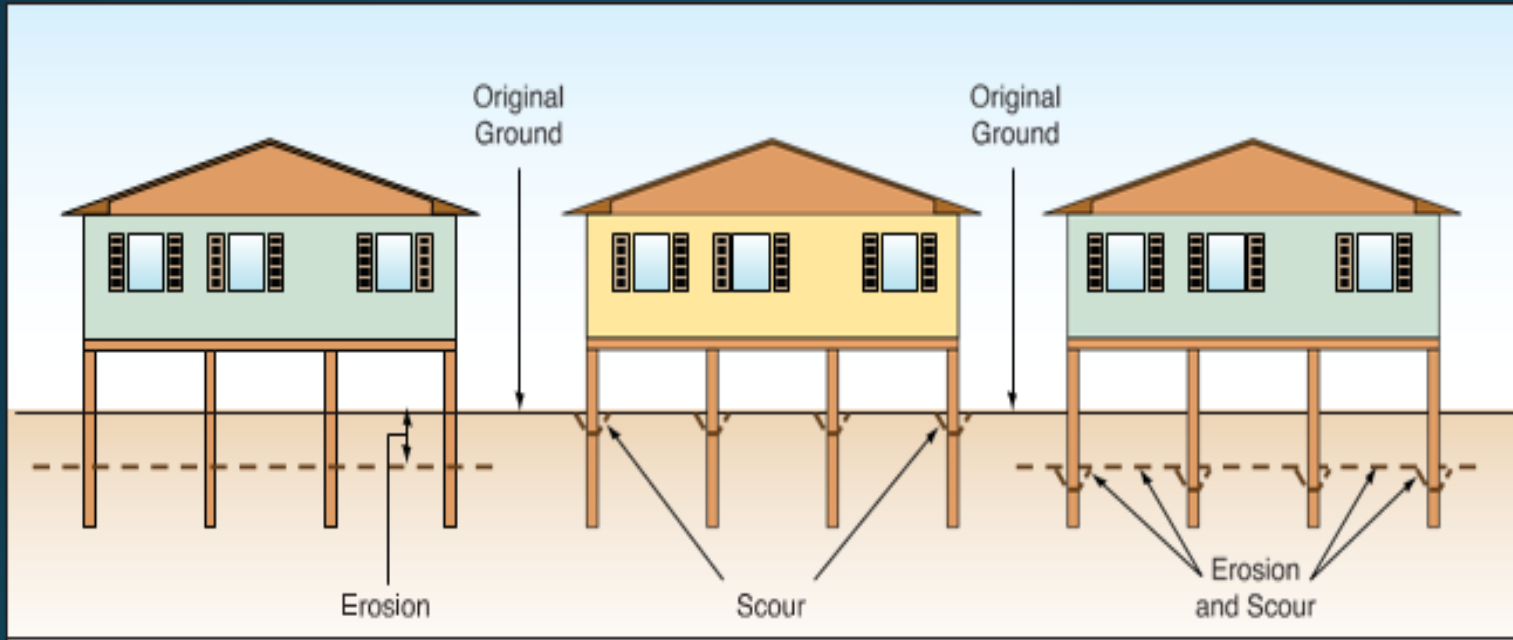
From FEMA HSFE60-13-02 April 2013, Figure # 1 and Figure #11

Select Building Materials That Can Endure Periodic Flooding and Corrosion- Resistant



From FEMA Home Builders Guide to Coastal Construction, Fact Sheet #1.7

Proper Pile Design & Lateral Bracing Needed



*From FEMA Home Builders Guide to Coastal Construction,
Section 3.2*

Below BFE: Storage or Parking May Have Breakaway Walls



*From FEMA Home Builders Guide to Coastal Construction
Section 8.1*

Resilience.... 9th Ward



Courtesy of Turner Building Science & Design

Basement Completely Decoupled From the Cold Earth



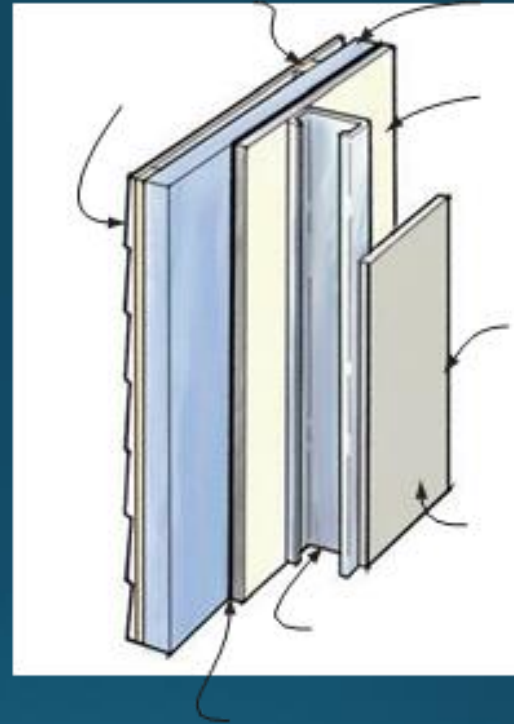
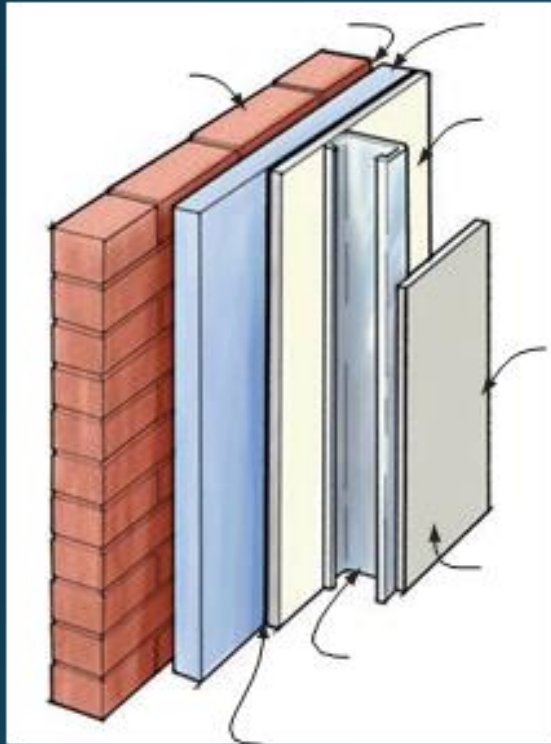
Courtesy of David Johnston & Company

Raise HVAC and Electrical



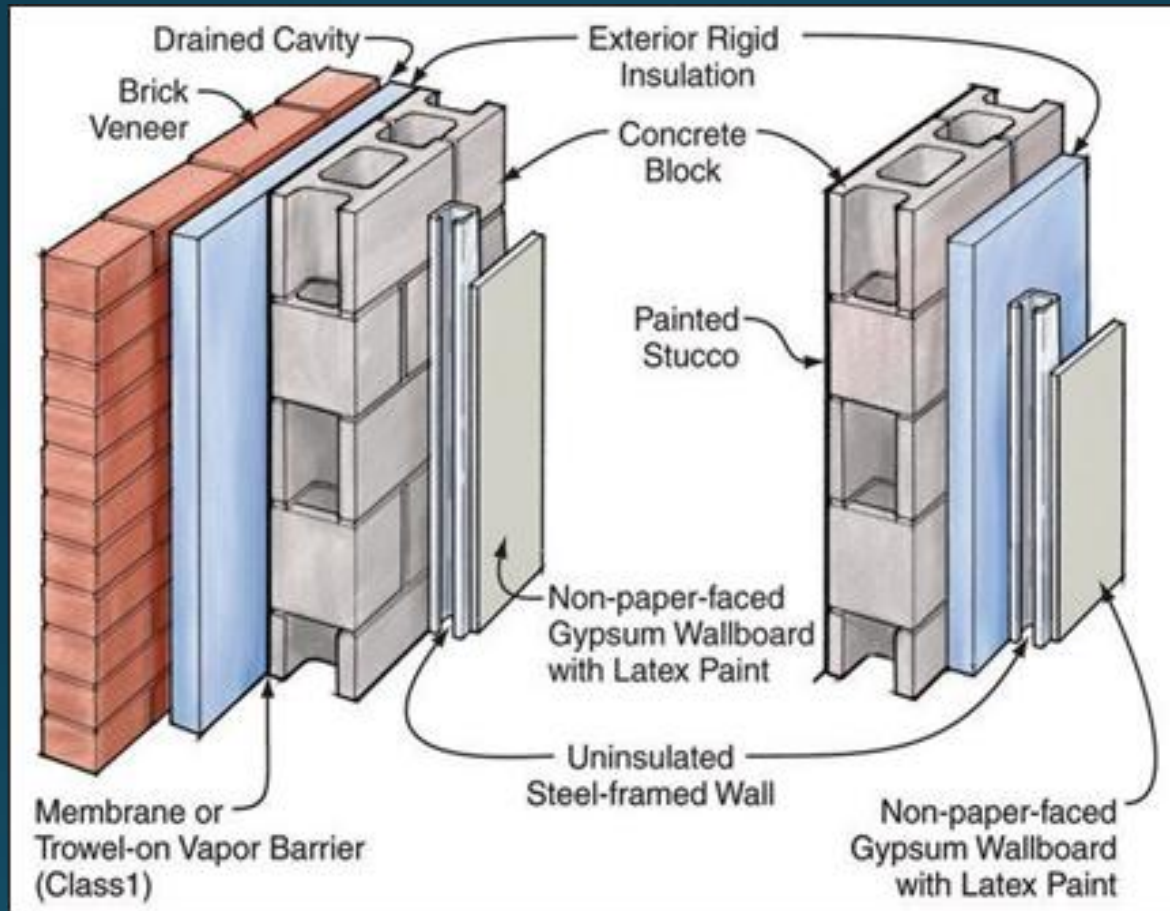
*From FEMA Home Builders Guide to Coastal Construction
Section 8.3*

Flood Resistant Exterior Walls



*From FEMA Home Builders Guide to Coastal Construction
Figure #10*

Flood Resistant Exterior Walls



*From FEMA Home Builders Guide to Coastal Construction
Figure #11*

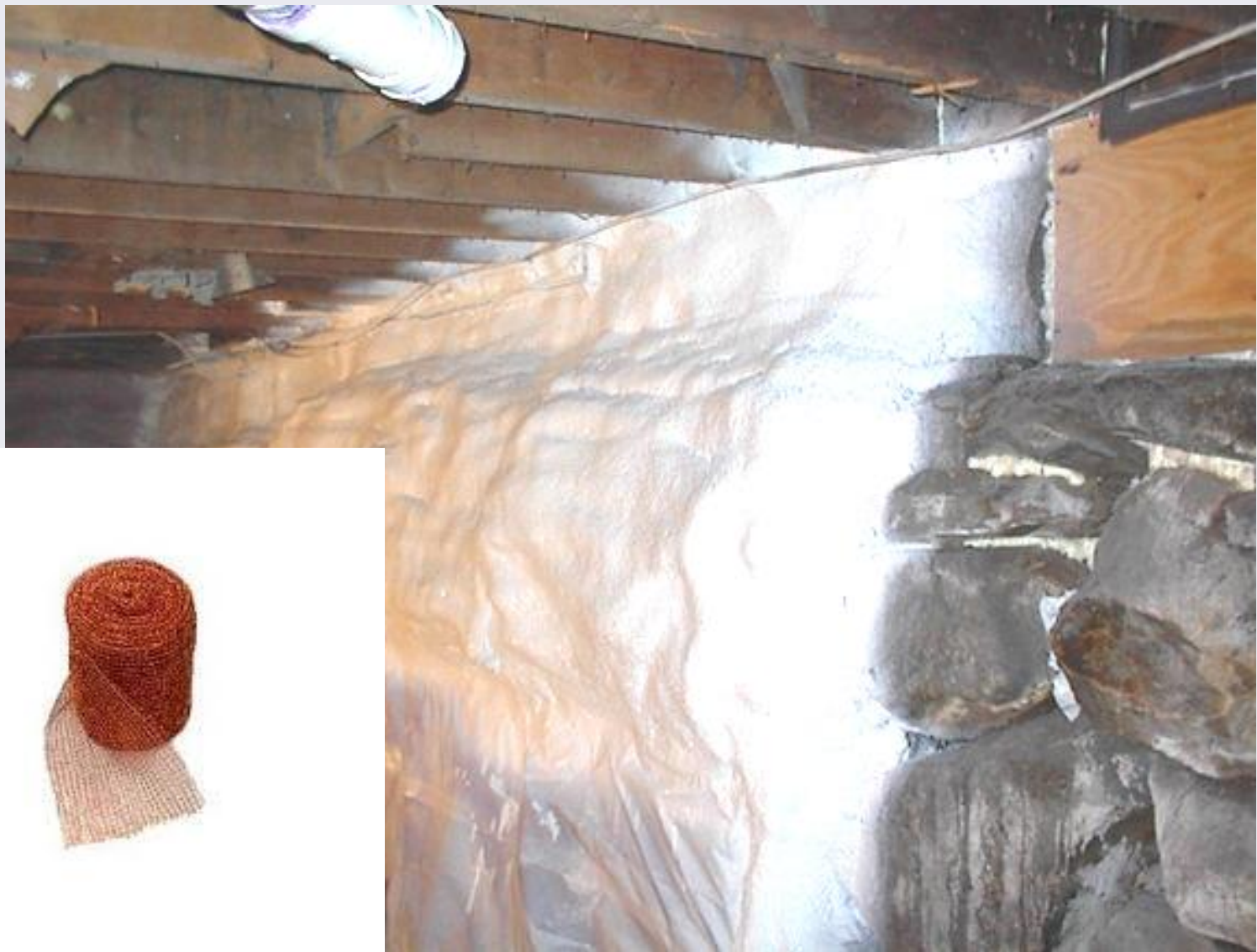
Basement Moisture Strategies

1. If feasible, prevent site water from entering
2. Create warm surfaces (insulate) to prevent condensation
3. Allow construction moisture sufficient time to dissipate
4. Provide dehumidification when needed
5. Or,

Completely & totally isolate it from the house air??



Courtesy Camroden Associates.



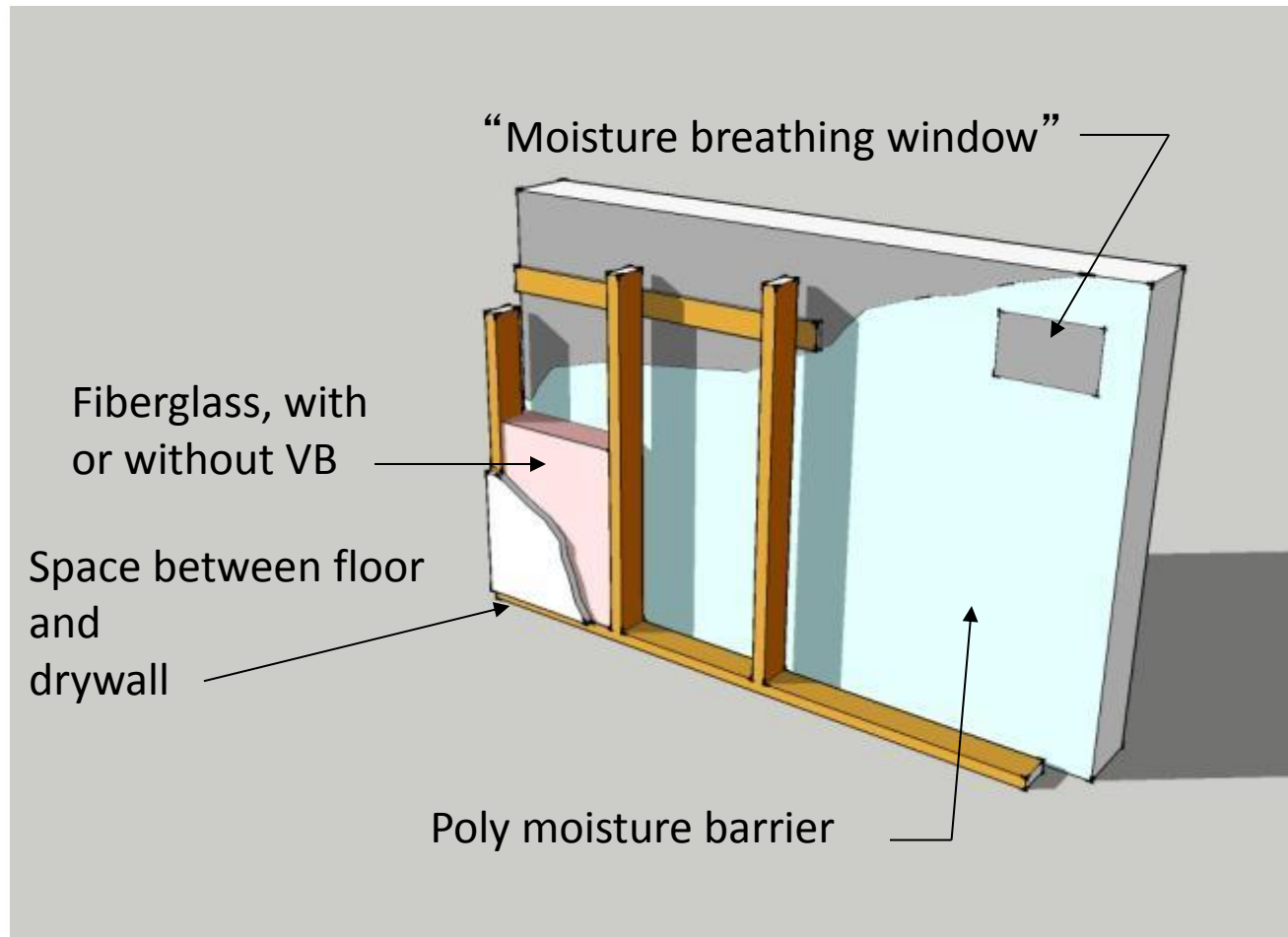
Spray foam and field stone

Clothes Dryer Exhaust



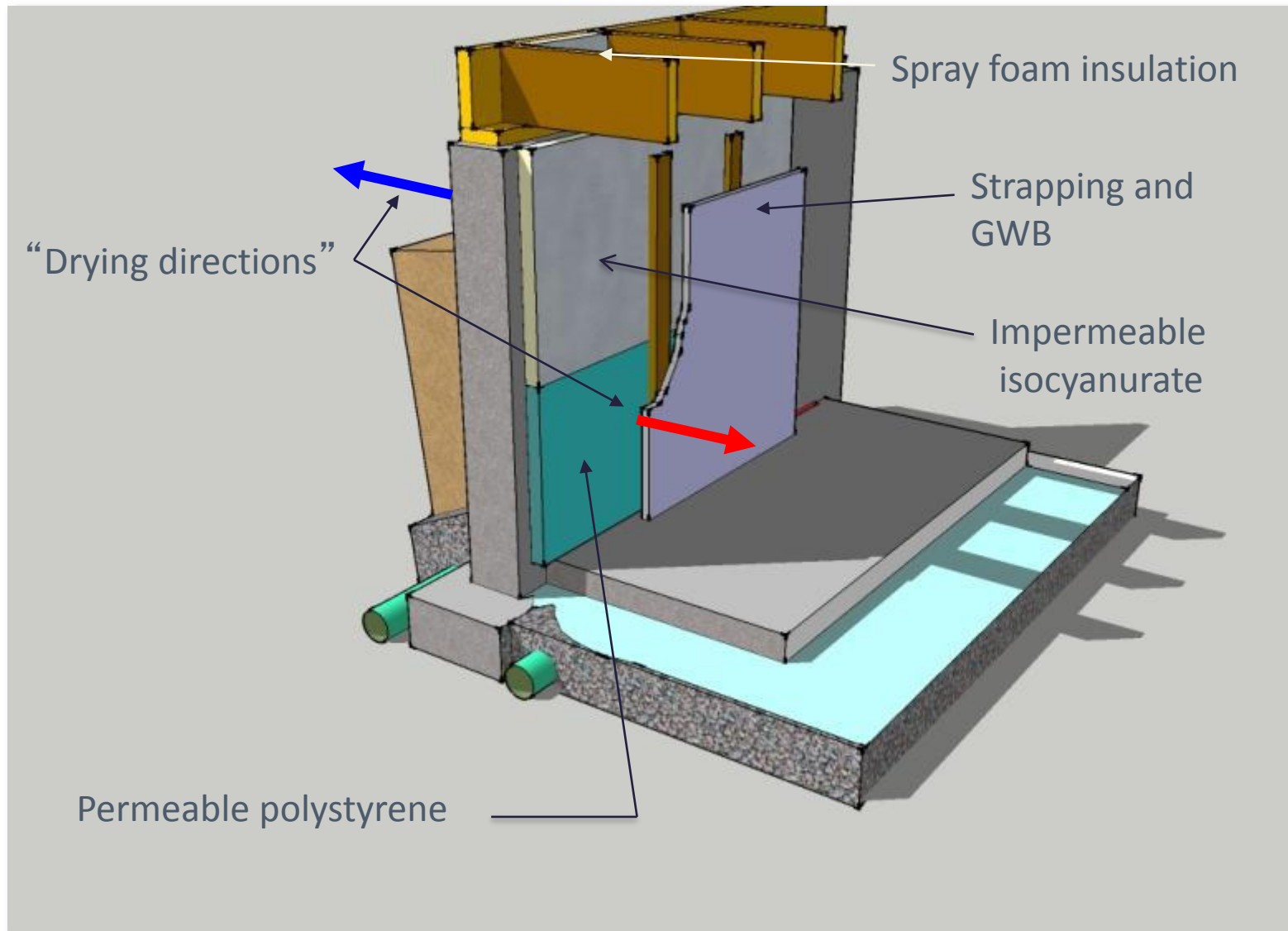
Courtesy Camroden Associates

Don't put old style stud walls back up in basements



- Concrete wall will stay wet... cannot dry to the inside
- Insulation will stay wet once wetted

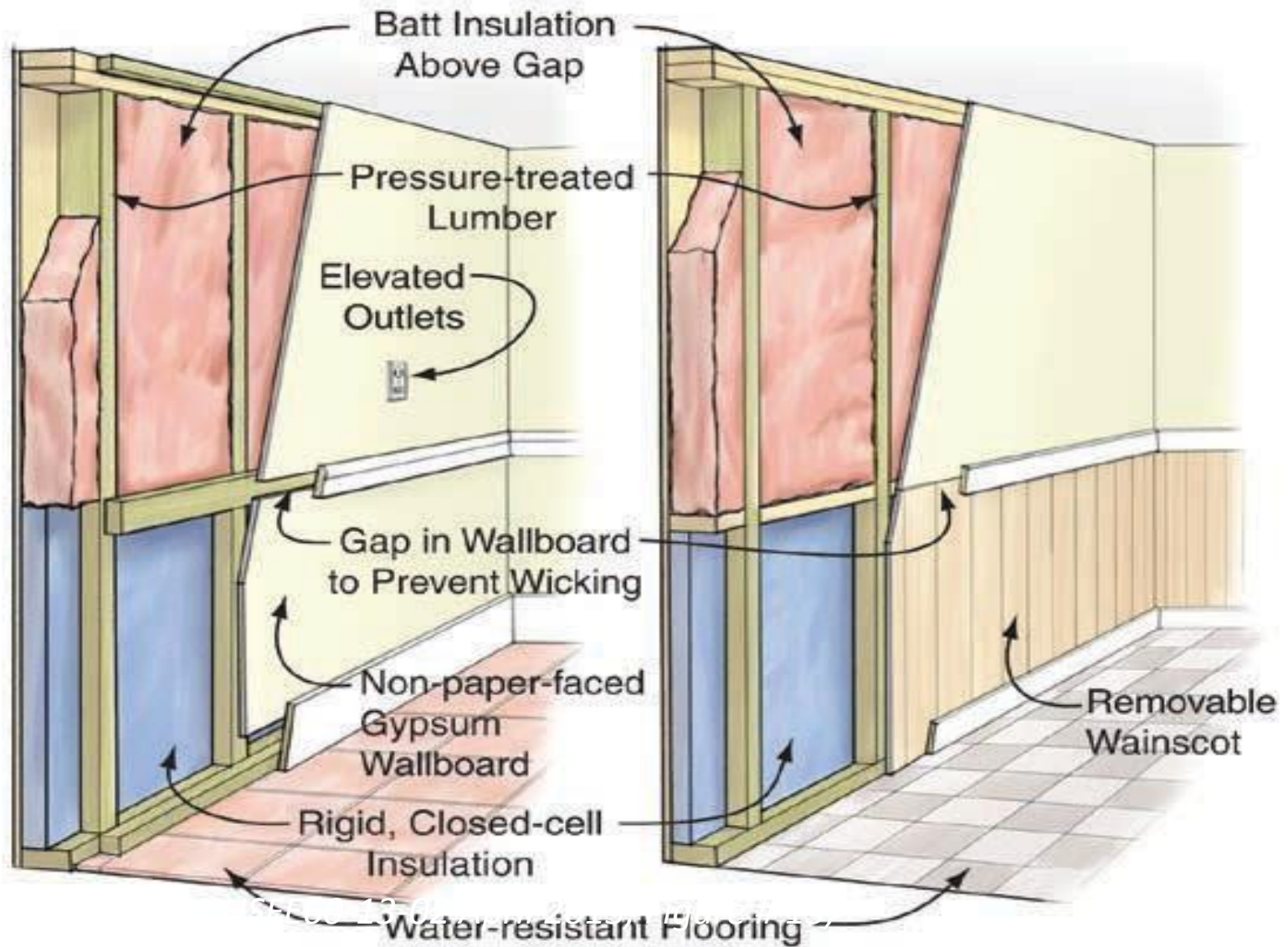
Rigid foam and strapping



Stud wall rigid foam hybrid

- PT plate
- XPS behind studs
- Space left for removable baseboard
- Easy wiring





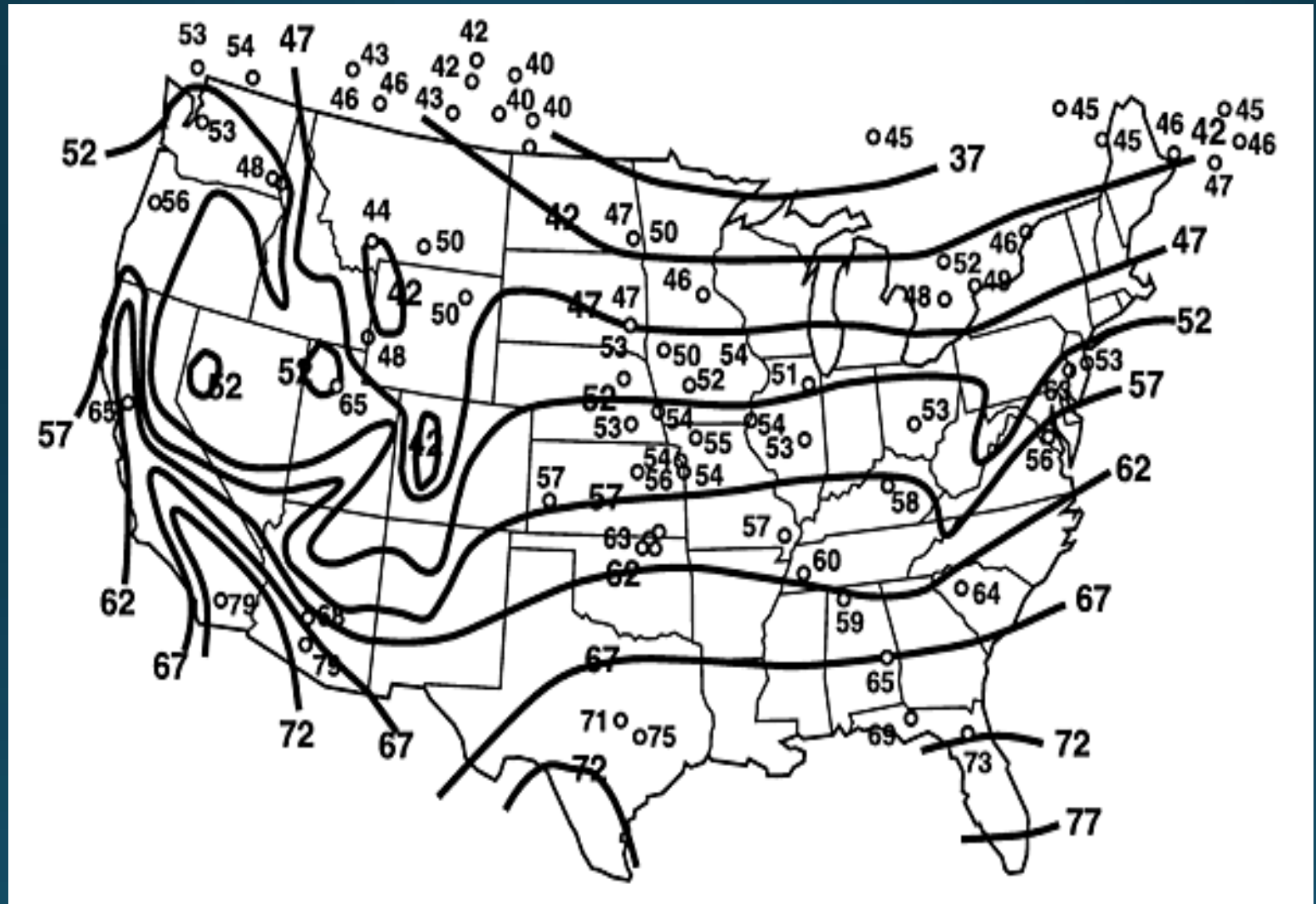
Avoid using low permeability vinyl wall paper on an outside wall in an air conditioned space or a basement



Courtesy of Aerotech Laboratories, Inc.

Mean Annual Earth Temperature

Source: Virginia Tech



Dew Point: What Happens Outdoors...



Courtesy of UNC

Dew Can Happen in Hidden Locations



Courtesy of Camroden Associates

Leaving basements and crawlspaces cold is **risky**



Courtesy of Turner Building Science & Design

Concrete Moisture Testing

Wet?
Damp?
Dry?



Courtesy Camroden Associates

Is basement wood wet or dry?



Inexpensive moisture meter

Don't open the vents during High Dew Point Days



Winter cold defeats the purpose of insulating the crawlspace

Summer humidity will condense

IRC allows this



Courtesy Foam-Tech



Santa Fe™ Crawlspace Dehumidifier

Is basement going to need a serious dehumidifier

Sante Fe Classic by Thermastor™



Removes 110 pints/day
Draws 6.4 amps, works at
cold temperatures

*Others remove 30 pints/day
& draw 4.0 amps, at what
temperature?*



**Less serious moisture problem?
Lots of hot water use? Use a heat
pump water heater?**



Courtesy Vaughn



Courtesy GE

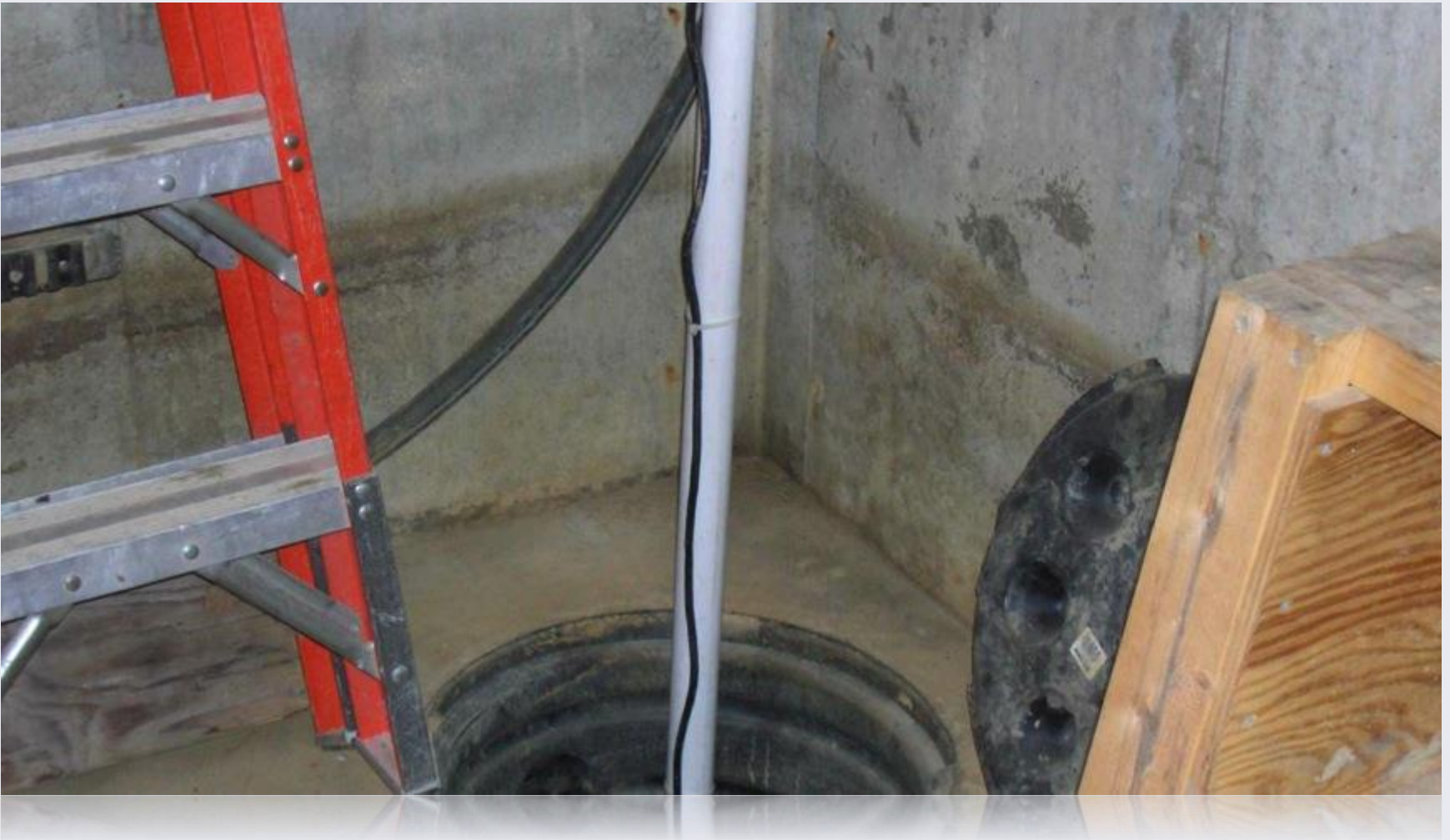
Avoid Paper Covered Gypsum & OSB in Damp Areas Like Basements?

“Was Wood”



Courtesy Building Science Corp.

When should finishing a basement be avoided?



Exterior water management



- If you can't manage the water, don't finish the basement
- Sumps and stand-by generators are not good alternatives
- The law of gravity has never been repealed...

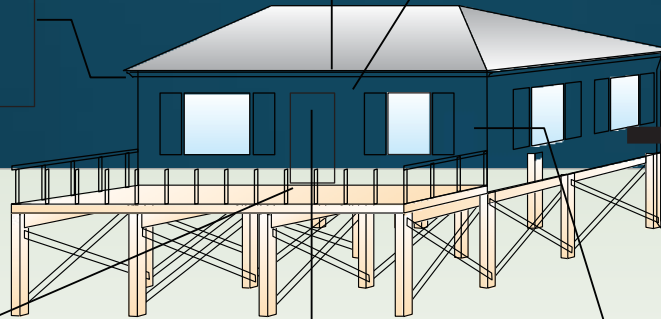
Reduce Water Intrusion Sites

Use Roof Overhangs

Use Good Flashing Techniques for Doors, Windows, and Kick-outs

Use Hurricane Clips Throughout to Prevent Up- Lifting of Roof

Use Water Resistant Robust Siding



Use door pan flashing

Do not depend on sealants to keep water out, always flash.

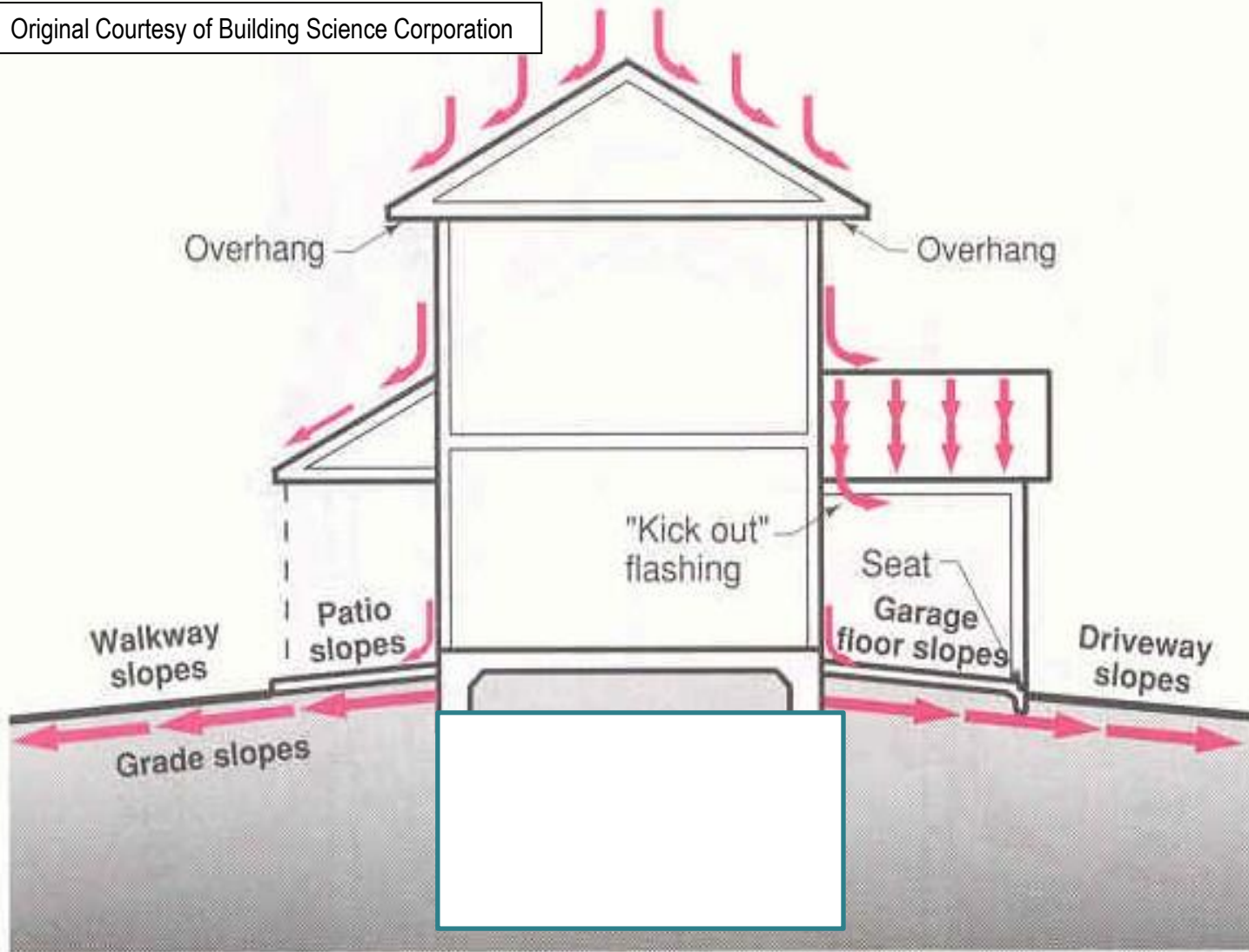
Always use a drainage layer under siding.



*From FEMA Home Builders Guide to Coastal Construction
Section 1.9 Moisture Barriers*

Enclosure #1... Drain the Rain

Original Courtesy of Building Science Corporation



Drain and Vent



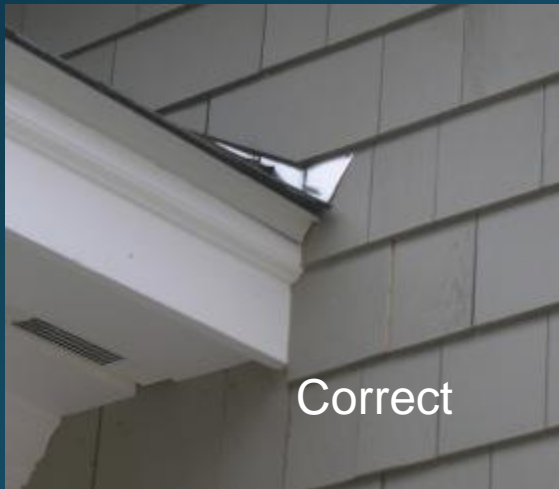
Continuous
airflow/drainage
behind the
cladding
and the trim...

Window pan
woven into
shingles

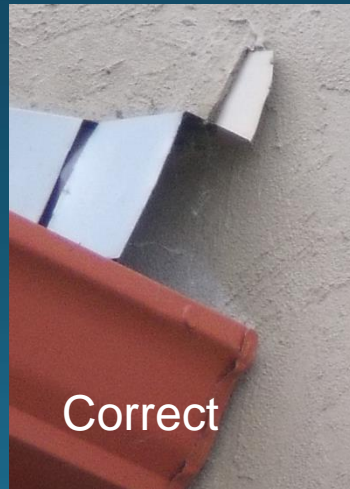


Drain behind the trim

Use Correct Flashing



Correct



Correct

Classic failure to properly weave step flashing into horizontal cladding

Courtesy of Turner Building Science & Design



Pay attention to
Doors, Windows,
and other holes in
the enclosure

Tyvek™ Flex
Wrap,
Metal apron

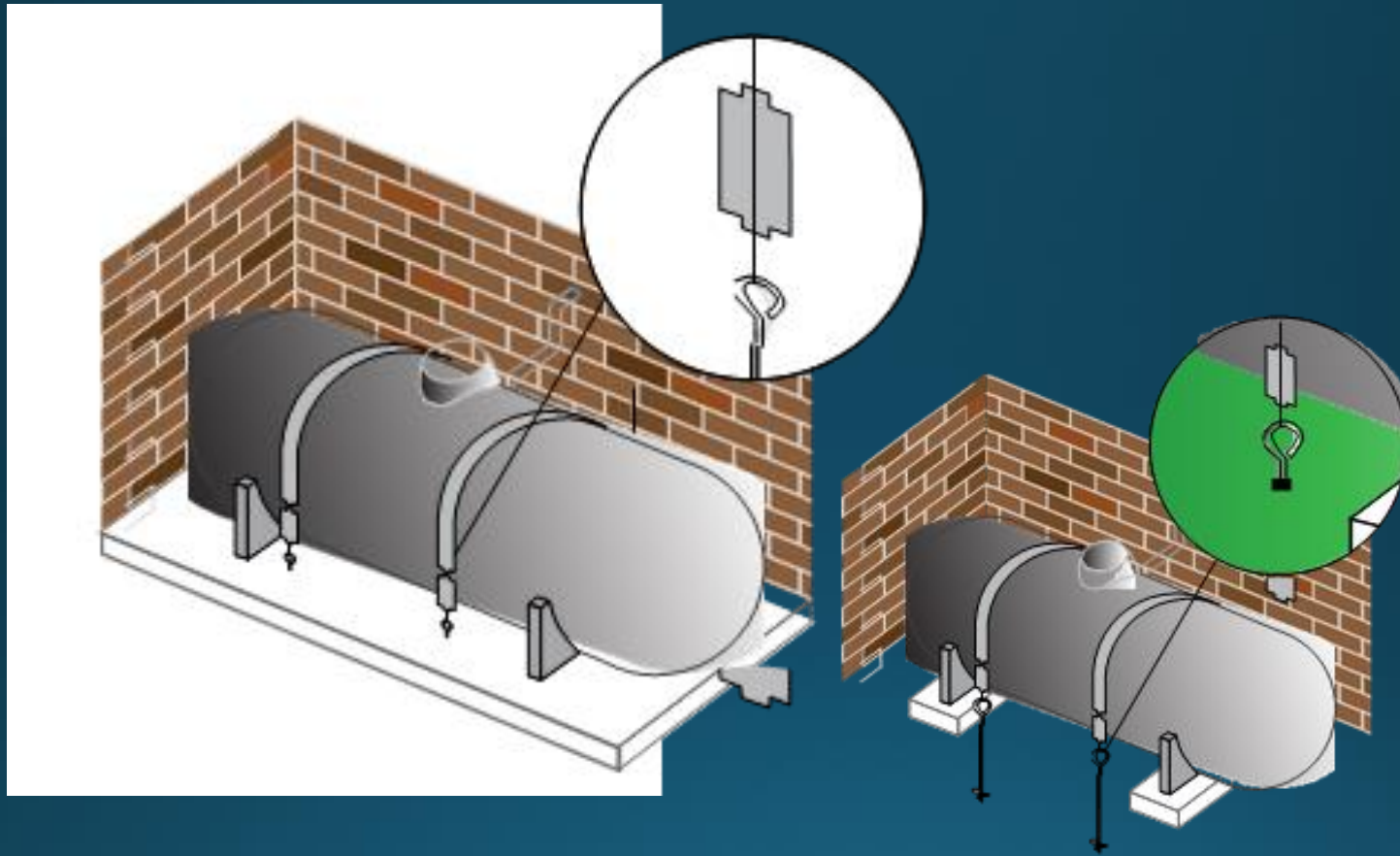
Strong Wind Areas

Special: Roofing Attachment ,
Windows, and Doors May be Needed



*From FEMA Home Builders Guide to Coastal Construction
Section 6.2*

Anchor Fuel Tanks / Gas Shutoff?



Courtesy www.toolbase.org 2012

Renovations/Remodel Summary

Opportunity for Improvements?:

- Elevate Entire Structure?
- Elevated HVAC above DFE
- Elevated Utility Connections
- Hot Water Heater above DFE

- Moisture Resistant Materials
- Retrofit of Framing Connections
- Corrosion Protection Metals
- Sewerage Backflow Valve
- Site Drainage
- Anchor Fuel Tanks

*From FEMA Home Builders Guide to Coastal Construction
Section 9.1*

Always provide climate & location specific building enclosure

**BASEMENTS (Warm and Dry, or
complete decoupled from the cold earth)**

**WALLS (Air Sealed, Optimum Insulation, Manage Vapor
Drive for the Climate)**

ROOFS (Cold in Snow Areas, Limit Heat Gain in AC Areas)

**MECHANICALS (All components Inside The Thermal
Enclosure)**

Make it easy to accomplish

Summary: *Repairing damage, remodeling or building a new home subject to wetting:*

- Don't use paper in likely to be wet or damp areas.
- Use area rugs, instead of wall-to-wall carpeting.
- Place electrical outlets to avoid contact with water .
- Place electronics on higher shelves or off the floor.
- Use plastic storage for records, place higher than floor.
- Most homeowners insurance does not cover flooding.
Spending \$1 for mitigation saves \$4 in damages.
- For more information visit www.floodsmart.gov

Sources: Insurance Institute for Business & Home, National Institute of Building Sciences, Multihazard Mitigation Council, Mitigation Saves Study 2005



THE NEW YORKER 1947

Practice Disaster Preparedness:

Emergency Supplies:

Food for 2 weeks or a month

Safe Water source available

Heat source available / warm clothing

Cell phone & flashlight with extra batteries

Prescription Medications



Courtesy of Bison Pumps

Items needed for Baby?

Back-up power source?

Fuel source available?

Emergency shelter available?

CT Guide to Emergency Preparedness

www.ct.gov (Floods & Hurricanes)

http://www.ct.gov/dph/cwp/view.asp?a=3126&q=389000

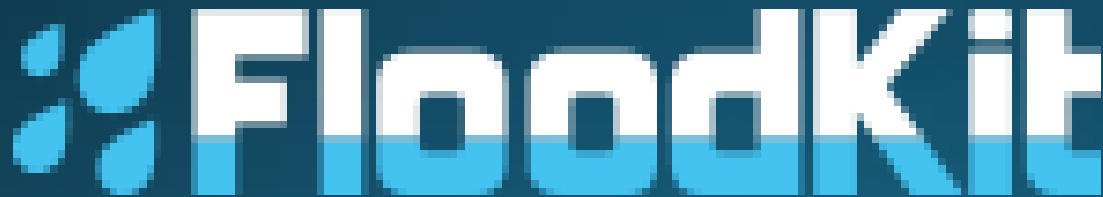
Others:

www.Ready.gov

Stay Tuned for New Products???

<http://floodkit.co.uk/floodkit-products>

Toilet plug,
Shower plug, etc.





Questions?