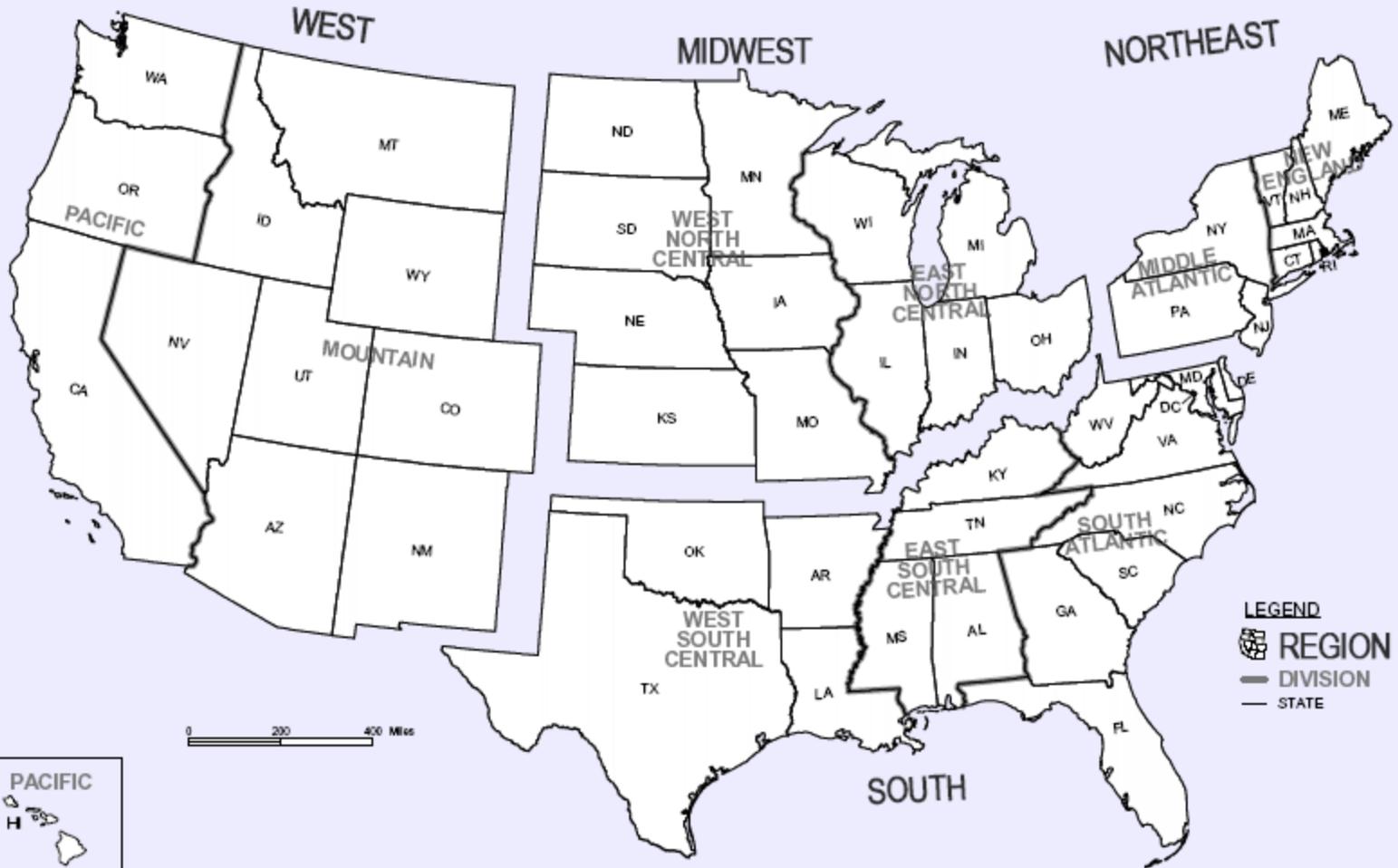


Foundations demographics

The relative impact on whole-building performance by region by foundation type.

Marc Zuluaga, CARB

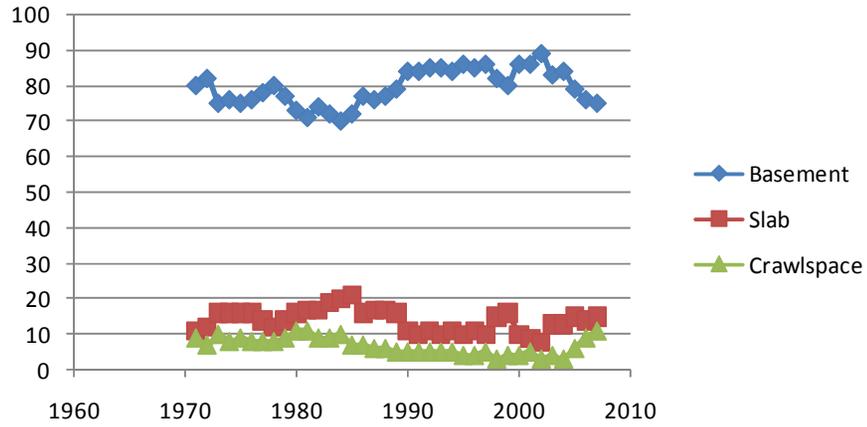
Census Regions and Divisions of the United States



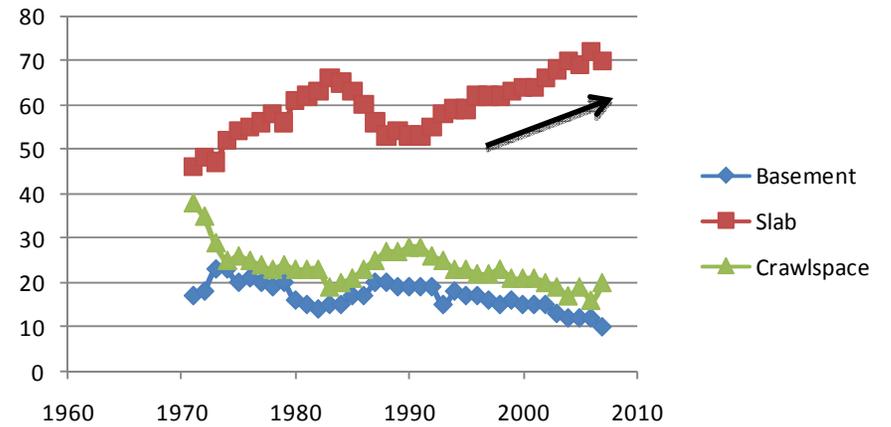
LEGEND
REGION
DIVISION
STATE

0 200 400 Miles

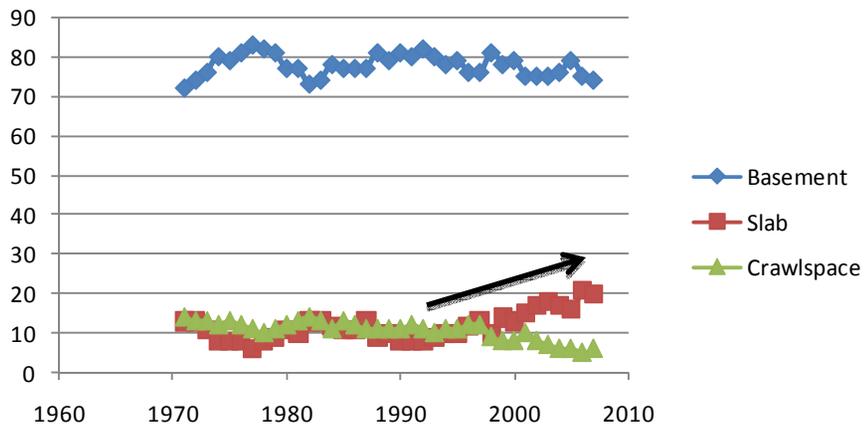
Northeast



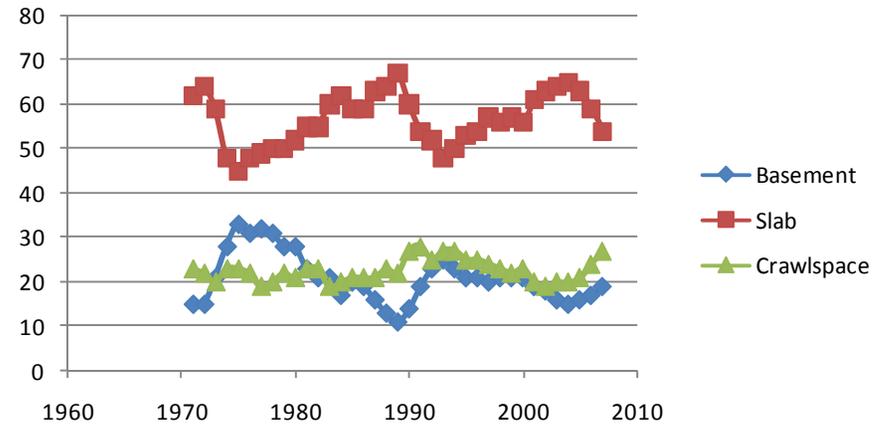
South



Midwest



West



2007 Data

Single-Family Detached										
Type of Foundation	% of New Homes									
	New Eng	Mid Atl	E N Cen	W N Cen	S Atl	E S Cen	W S Cen	Mtn	Pac	US Total
Full Basement	87.7%	89.4%	74.4%	88.2%	25.5%	15.0%	0.2%	15.2%	1.9%	28.9%
Partial Basement & Crawlspace	3.6%	4.5%	9.8%	3.4%	1.6%	2.2%	0.3%	2.8%	7.9%	3.4%
Partial Basement & Slab	0.5%	0.8%	0.2%	1.1%	0.9%	0.8%	2.3%	0.7%	1.1%	1.1%
Crawlspace, Continuous Wall	2.0%	1.6%	7.0%	2.2%	13.8%	25.3%	1.5%	22.0%	35.2%	13.9%
Slab	6.1%	2.7%	7.3%	5.0%	55.1%	56.6%	95.1%	58.5%	53.6%	51.5%
Piers	0.0%	0.9%	1.3%	0.1%	3.2%	0.3%	0.5%	0.9%	0.3%	1.3%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

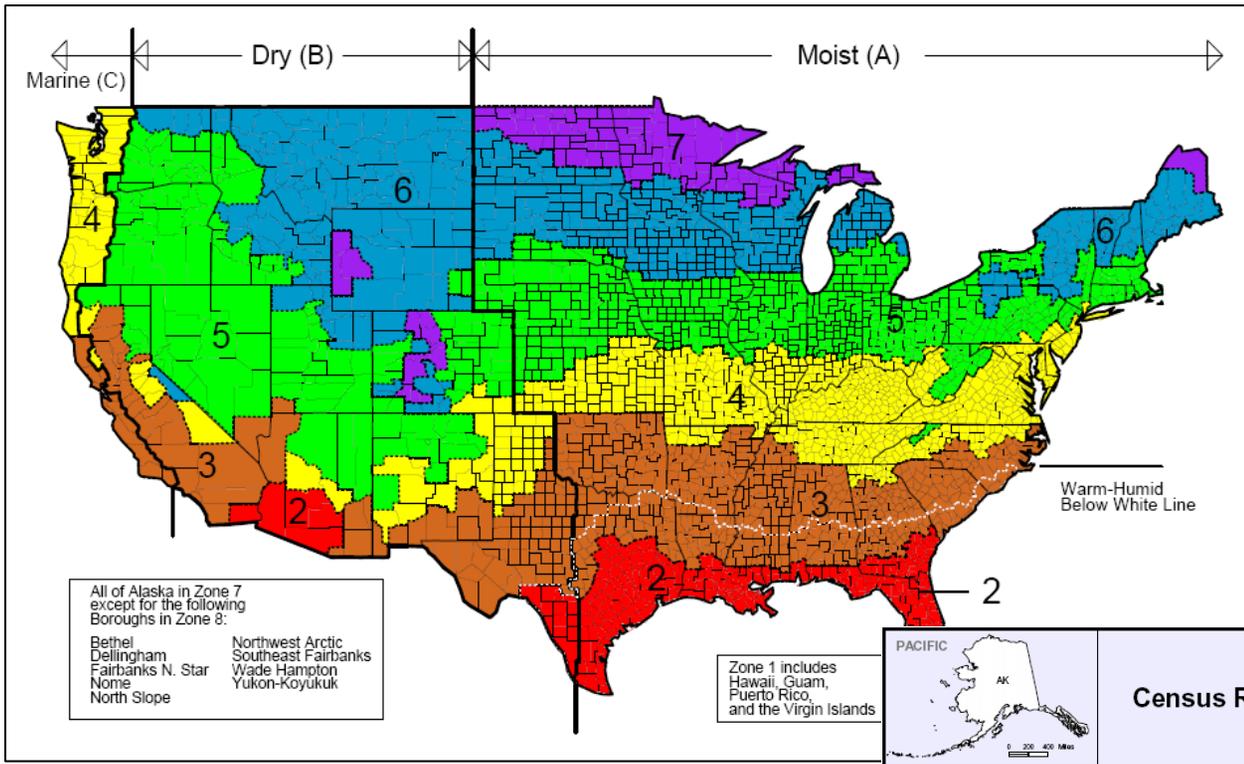
Townhouses										
Type of Foundation	% of New Homes									
	New Eng	Mid Atl	E N Cen	W N Cen	S Atl	E S Cen	W S Cen	Mtn	Pac	US Total
Full Basement	84.1%	47.3%	36.0%	50.2%	41.8%	8.0%	0.0%	31.3%	0.0%	30.1%
Partial Basement & Crawlspace	6.5%	2.7%	0.0%	0.4%	0.0%	0.0%	0.0%	0.0%	1.4%	0.6%
Partial Basement & Slab	0.0%	35.3%	6.8%	1.8%	0.0%	0.0%	0.0%	0.0%	0.0%	3.6%
Crawlspace, Continuous Wall	2.0%	0.0%	3.9%	6.2%	8.7%	10.6%	0.0%	13.8%	11.9%	6.9%
Slab	6.5%	14.7%	53.3%	25.3%	49.5%	81.4%	100.0%	55.0%	86.8%	58.0%
Piers	0.9%	0.0%	0.0%	16.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.7%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Thanks to Chris Steubie and Joe Wiehagan of NAHB-RC for this information.

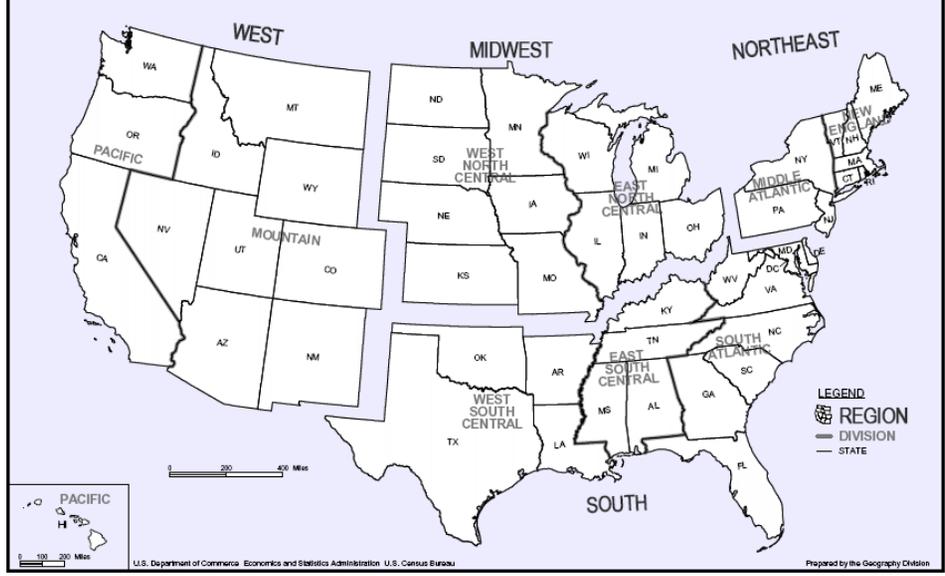
Foundations Matrix: The Starting Point

BA Foundation Specifications	Cold	Mixed Humid (Central/Upper)	Mixed Humid (Lower)	Hot Dry
Representative Cities	Boston, MA / Chicago, IL	Baltimore, MD	Atlanta, GA	Phoenix, AZ
Dominant Foundation Types*	Basement / Crawlspace	Basement / Crawlspace	Basement / Crawlspace / Slab	Slab
Finished (conditioned) Basement	R-5 EPS rigid on interior + 2x4 framing w/ R-13 unfaced FGB Insulation	R-5 EPS rigid on interior + 2x4 framing w/ R-13 unfaced FGB Insulation	R-5 EPS rigid on interior + 2x4 framing w/ R-13 unfaced FGB Insulation	NA
Unfinished Basement	R-13 polyiso rigid on interior	R-13 polyiso rigid on interior	R-6.5 polyiso rigid on interior	NA
Unvented Crawlspace Assembly	Unvented, R-13 polyiso rigid on interior	Unvented, R-13 polyiso rigid on interior	Unvented, R-10 polyiso rigid on interior	NA
Monolithic Slab-on-Grade	NA	NA	R-5 Exterior	Uninsulated
Raised Stem-Wall Slab-on-Grade	NA	NA	R-5 Interior thermal break	NA
Raised-Pier	NA	NA	NA	NA

BA Foundation Specifications	Mild	Marine	Hot Humid	Hot Humid (Coastal)
Representative Cities	San Francisco, CA	Seattle, WA	Orlando, FL / Houston, TX	New Orleans
Dominant Foundation Types*	Slab	Crawlspace	Slab	Raised Pier
Finished (conditioned) Basement	NA	NA	NA	NA
Unfinished Basement	NA	RA	NA	NA
Unvented Crawlspace Assembly	NA	Unvented, R-10 polyiso rigid on interior	NA	NA
Monolithic Slab-on-Grade	R-5 Exterior	NA	Uninsulated	NA
Raised Stem-Wall Slab-on-Grade	R-5 Interior thermal break	NA	Uninsulated	NA
Raised-Pier	NA	NA	NA	Insulated floor assembly



Census Regions and Divisions of the United States



climate zones	thermal criteria	moisture criteria
1	9,000 < CDD50°F	if P _{in} < 0.44 * (T-19.5)
2	6,300 < CDD50°F ≤ 9,000	if P _{in} < 0.44 * (T-19.5)
3A and 3B	4,500 < CDD50°F ≤ 6,300 And HDD65°F ≤ 5,400	if P _{in} < 0.44 * (T-19.5)
4A and 4B	CDD50°F ≤ 4,500 And HDD65°F ≤ 5,400	if P _{in} < 0.44 * (T-19.5)
3C	HDD65°F ≤ 3,600	Marine
4C	3,600 < HDD65°F ≤ 5,400	Marine
5	5,400 < HDD65°F ≤ 7,200	if P _{in} < 0.44 * (T-19.5)
6	7,200 < HDD65°F ≤ 9,000	if P _{in} < 0.44 * (T-19.5)
7	9,000 < HDD65°F ≤ 12,600	if P _{in} < 0.44 * (T-19.5)
8	12,600 < HDD65°F	if P _{in} < 0.44 * (T-19.5)

P_{in} = Annual precipitation in inches

T = Annual mean temperature in °F

Marine

1. Mean temperature of coldest month between 27°F and 65°F
2. Warmest month mean < 72°F
3. At least four months with mean temperature over 50°F
4. Dry season in summer. The month with the heaviest precipitation in the cold season has at least three times as much precipitation as the month with the least precipitation in the rest of the year. The cold season is October through March in the Northern Hemisphere and April through September in the Southern Hemisphere.

$$\text{importance} = (0.000075 * \text{HDD} + 0.25) * (0.004167 * P_{in} + 0.75) * (\text{foundation multiplier}) * (\% \text{ distribution of foundation})$$

where

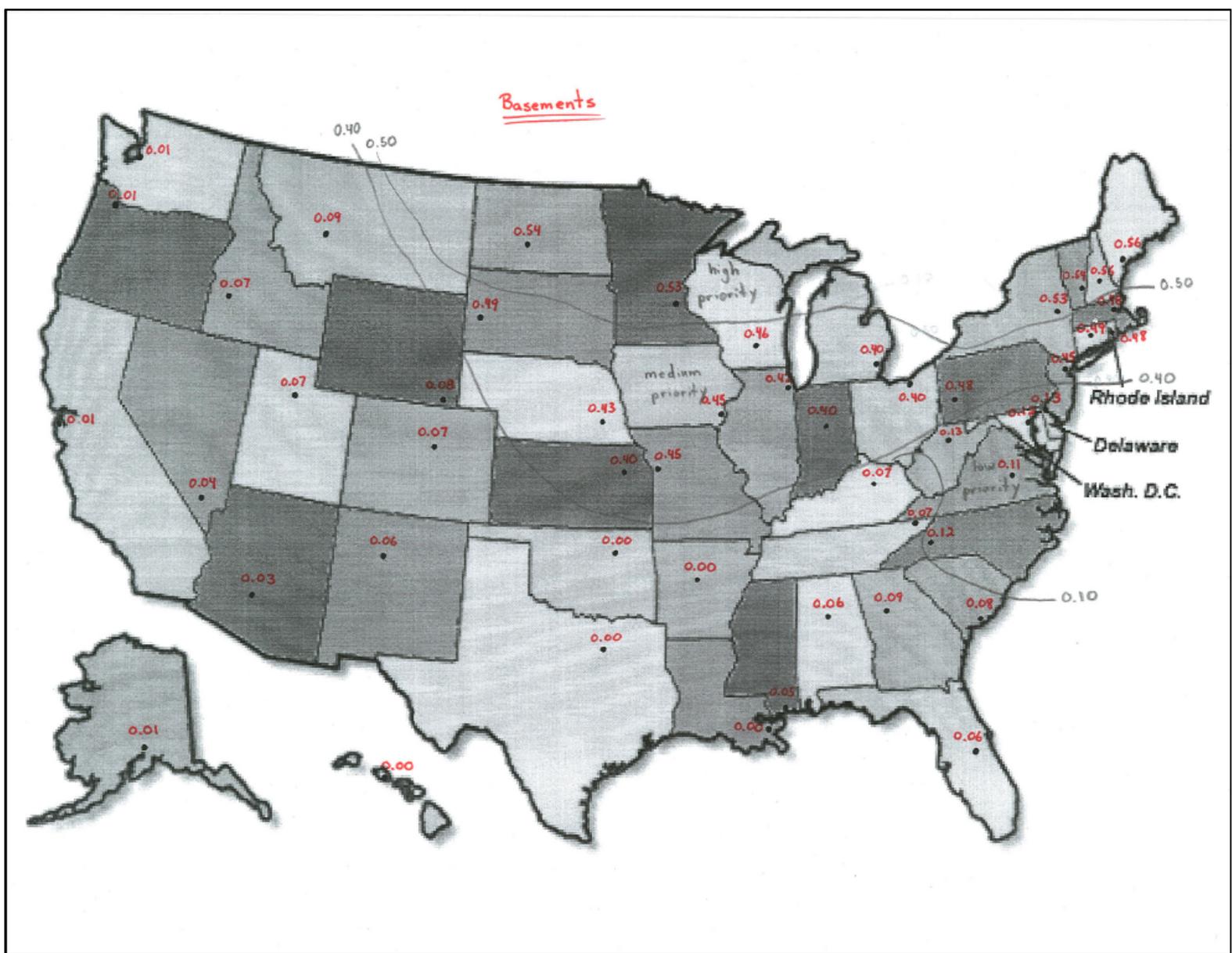
foundation multiplier:

basement	0.84
crawlspace	1.00
slab	0.78

HDD = heating degree days (base 65°F)

P_{in} = annual precipitation in inches

Basements



Slabs - on - Grade

