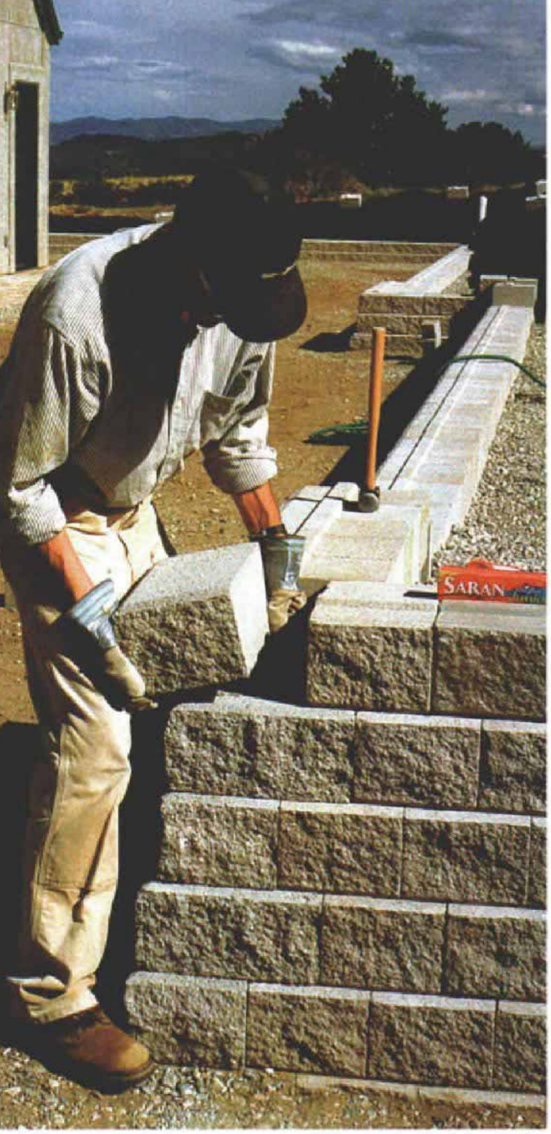
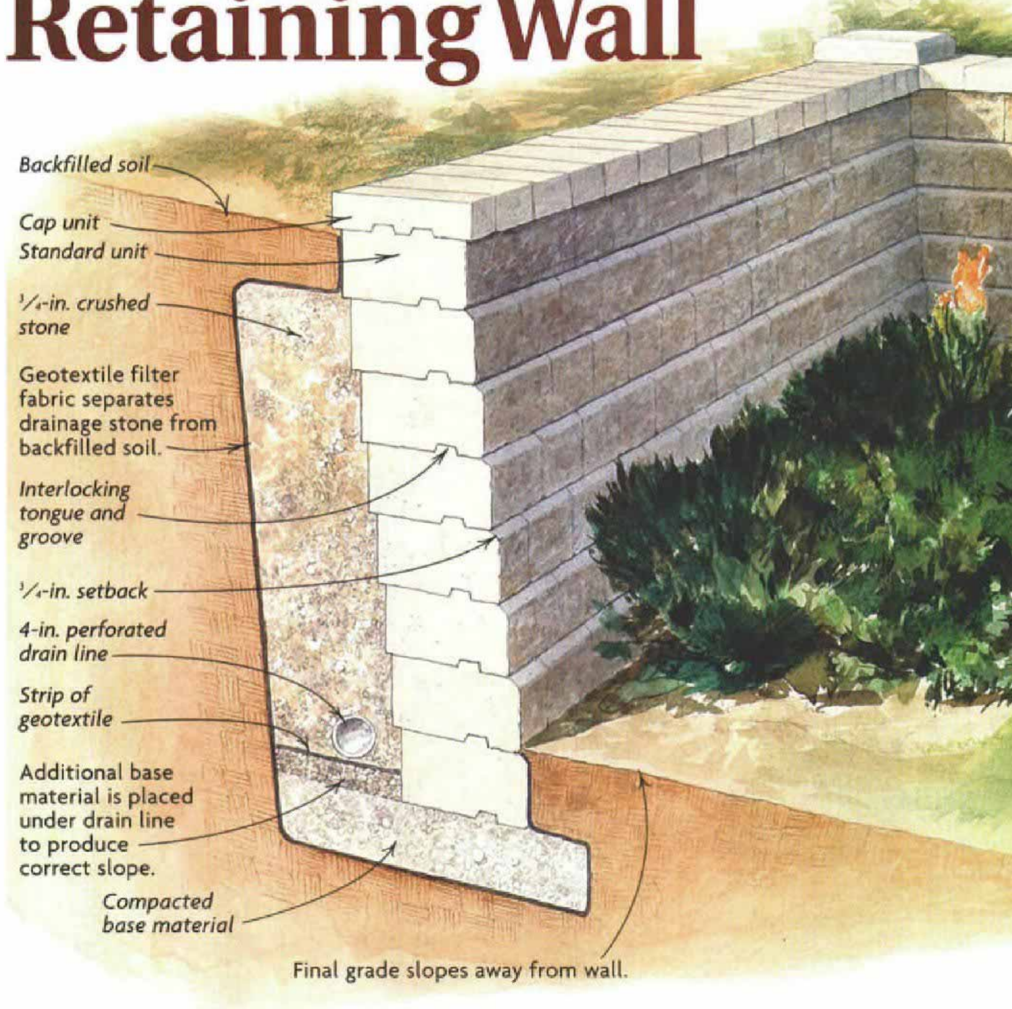


Building a Modular Retaining Wall



When my wife and I had our house built, the budget was far too tight to consider professional landscaping. When finished, the house looked as if it had been dropped on the site of a bomb blast. What was worse, any rain that fell carried silt toward the back door, and on windy days, the back of the house was scoured with airborne grit. My wife tactfully suggested that we either needed a retaining wall and a patio to keep all that soil at bay, or we might as well board up the back of the house.

She was right, but what kind of wall? I looked at several options: poured concrete, concrete with stone veneer, timber, dry-stack stone and concrete block with stucco facing. All of them have advantages, but they were either too expensive, were too time consuming to construct or didn't have the right look. I was about out of ideas when I came across something called a segmental retaining wall: basically, a wall made of interlocking pieces of cast concrete. I liked the way it looked (photo above); also, it wasn't too expensive, and construction seemed simple. Clearly, this stuff was for me.

Several companies make this kind of wall system, and they share a number of similarities (sources of supply, p. 83). A segmental wall is made of concrete blocks that stack together without mortar. Once finished, the wall has enough mass to retain the soil behind it. Each course is set back slightly from the one below, so the wall steps back into the bank as it rises. Corners, curves and stairs can be built, although specially shaped blocks may be required.

Segmental walls up to about 4 ft., like the one I planned, are considered "gravity walls," meaning they need nothing more than the force of gravity to keep them in place. (Higher walls are typically reinforced with a polyester filament geogrid that ties the wall to the compacted earth behind it.)

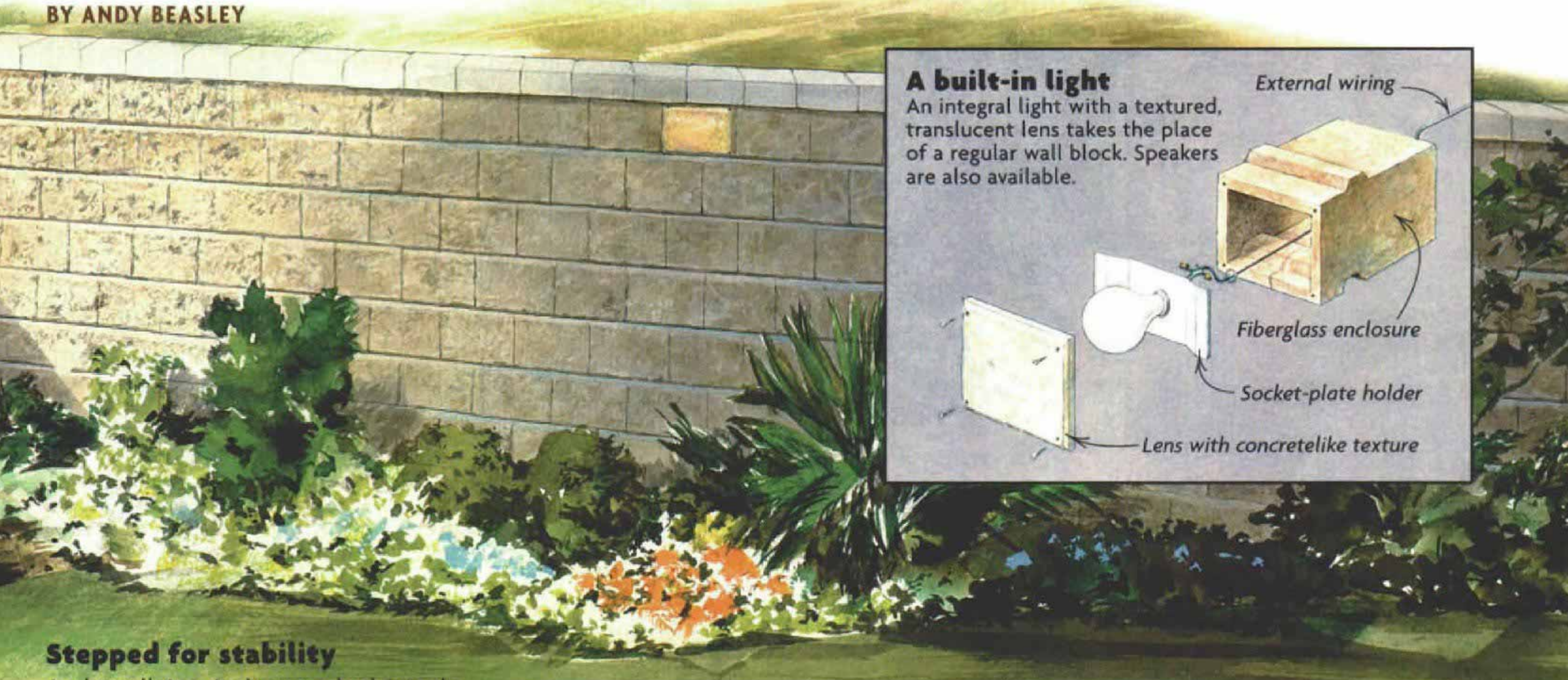
Concrete blocks may be solid or hollow and use either pins or integral lugs to align the units and lock them together. The finished faces and colors of the block vary by product line and regional manufacturer, and the weight of the individual blocks can differ significantly. I chose a product called PISA II from Risi Stone Systems. The solid blocks have a rough-finished face and are 6 in. high, 8 in. wide and 12 in. deep, weighing 45 lb. each. PISA also offered accessories, including a built-in light I liked enough to incorporate in my plans. Just as important, I was sold on the strong reputation of McKinney Concrete (800-332-8512), the regional manufacturer that makes the blocks for Risi. Excluding shipping, blocks and cap pieces cost about $4.50 per sq. ft. of wall face.

Wall begins with a good foundation

My plans called for a total of 220 ft. of wall with a series of jogs and one recessed section in the middle for a pair of large planters. You may think that instructions are for sissies, but I found Risi's material invaluable in

Stacked on a stable base, interlocking concrete blocks offer a mortarless solution to common landscaping problems

BY ANDY BEASLEY



A built-in light
An integral light with a textured, translucent lens takes the place of a regular wall block. Speakers are also available.

Stepped for stability
As the wall rises, it also steps back into the bank for more stability. An interlocking tongue-and-groove pattern automatically steps each course of block back from the course below. A layer of geotextile, or filter fabric, prevents silt from packing the crushed stone behind the wall and interfering with water drainage.

helping me to avoid layout and construction problems that would have been difficult to fix midway through the project. If I had requested it, engineering support also would have been available from Risi.

I began with a trench about 30 in. wide and roughly 12 in. deep. That depth allowed room for 6 in. of compacted base material and one block below finished grade (drawing above). Because the foundation is well above the frost line in my area, I installed drains to carry away water that would freeze and heave the wall. And because the wall is not mortared, it can handle minor seasonal movement. One point to remember before putting away the backhoe is to make sure the excavation is sloped back at least enough to accommodate the lean of the wall. In my case, the wall stepped back $\frac{3}{4}$ in. for each course, or a total of $5\frac{1}{4}$ in. over the wall's 4-ft. height.

After compacting the soil in the trench, I laid geotextile material (Mirafi; 888-795-0808) across the bottom of the trench and up the bank behind the wall. This heavy-duty polyester fabric allows water but not fine aggregates or silt to pass through. It serves two purposes here. First, it isolates the base material that goes in the bottom of the trench from the surrounding soil, which I think will help to keep the foundation layer more cohesive over time. Second, the fabric keeps the crushed drainage stone behind the wall from becoming clogged. On top of the fabric in the trench, I compacted a 6-in. layer of road-base material that was available locally (top photo, p. 80). Road-base material is a mixture of fine crushed rock and gravel that compacts well but is still porous enough to allow water to drain through.

To make sure my foundation layer was level, I drove pieces of rebar into the ground and aligned the tops of these pins with a

Correcting mistakes early is easier in the long run

Like the best-laid plans, the blocks will sometimes go awry. To keep the wall stable and attractive, the top surface of each course should be level and straight. Errors do creep up, and they can compound into real problems unless they are fixed.

How much error is too much? That's a subjective issue. I usually fixed any misalignment of adjacent blocks more than $\frac{1}{32}$ in. Generally, correcting errors was easy. My first step was to remove the block and check for interference from gravel or concrete chips underneath. Next, I tried switching blocks because individual blocks may have slight variations. These two steps corrected the vast majority of problems. If, however, I still wasn't satisfied, I would temporarily stack a few blocks of the next row above the problem area, which sometimes showed the problem was canceled out. If so, I would forget about it and move on.

If these steps were hot enough, I'd resort to shims to level the row. Shims can be almost any material, but they should be something that will neither erode nor decompose. I used thin strips of aluminum when necessary. In the extremely rare cases where a shim would only compound the problem, I removed the irregularities by taking light passes with my trusty circular saw with a diamond blade. A grinder would also work.
—A. B.

Drawings: Gary Williamson

A solid wall needs a solid base. After digging a 12-in. deep trench 30 in. wide, the author compacts a layer of locally available road-base material over a layer of filter fabric to serve as the wall's foundation.

A level start is crucial. Rebar pins driven into the ground on 6-ft. centers act as reference points to level the compacted base material.

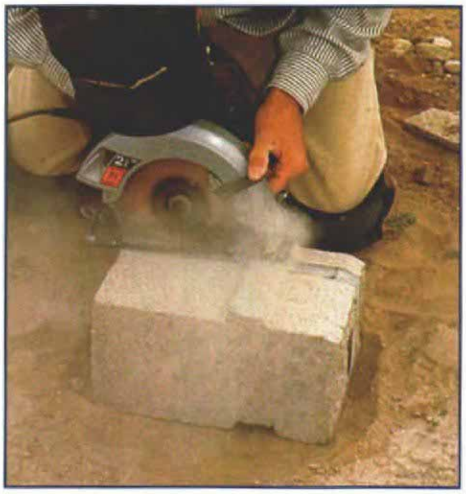
Inside corners are woven. The author sets an inside corner on the first course of block, establishing the spacing for a woven pattern to give the corner interlocking stability.

Modified for the job. A simple jig allows this torpedo level to straddle the lug cast into the top of each block so that it can be leveled front to back.

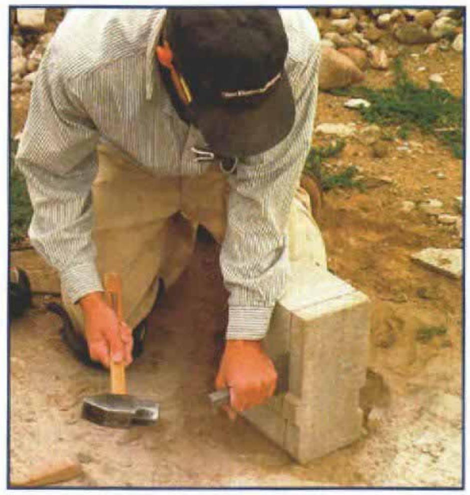
Clean cuts in concrete block

There's no way to avoid cutting block, and I got plenty of practice in the course of building 220 ft. of wall. Renting a block saw or a hand-held concrete saw would have made the work go much faster. But because I didn't work on the wall steadily, it would have cost a small fortune in rental fees to keep one of those saws on hand. Instead, I made all my cuts with a circular saw fitted with a low-cost (around $20) diamond blade. I found that pencil marks quickly disappeared in the cloud of concrete dust, so I used strips of duct tape to guide my cutline around the four sides of the block (photo left). A good respirator, safety glasses and hearing protection are essential. I cut block in three passes to the full 2½-in. depth of the blade (photo center). Once I'd cut all the way around the block, I used a 2½-in. masonry chisel to separate the pieces (photo right). I cleaned the excess material from the break at the center of the block by sweeping the sawblade from side to side to make light cuts.—*A. B.*

Tape marks the line.



Cut block in three passes.



Finish it with a chisel.

builder's level. Once I brought the base material to the tops of the rebar, I knew the foundation would be level, essential for a successful wall (photo bottom left, facing page).

Get the base course right

If there's one thing I learned from this project and from studying other retaining-wall jobs, it's that getting the first course level is difficult but crucial. Because the block faces are rough-textured, I kept things on course with a string along the back of the units. I placed each block next to the one previously set, tapped it with a hammer to settle it on the base and leveled it both side to side and front to back.

The blocks rarely lined up perfectly on the first attempt, so it became a process of setting a block, checking to see how it lined up with its neighbor, removing the block to adjust the base material, resetting and rechecking the block and so on until it was level and exactly aligned. I used a modified torpedo level (photo bottom right, facing page) to adjust each block front to back and a 6-ft. level to align the block with its neighbors in the row. I sighted along the bottom of the long level and knew a block needed correction when I could see daylight between the level and the block. Any difference greater than 1/32 in. had to be corrected (sidebar p. 79). That may seem overly fussy, but variations greater than 1/32 in. meant succeeding rows would not sit as firmly as I liked. And errors—especially in the first course—have a way of magnifying as you move upward.

To form outside corners, I used specially designed blocks that have textured faces on two sides. To form inside corners, I used standard units in alternating directions so that corners interlocked (photo center right, facing page).

The base course also is the time to think about objects that will be built into the wall later, such as speakers, lights or water lines (photo bottom right, p. 82), that may have to pass through. Planning and adjusting the base course accordingly can prevent headaches farther up the wall.

Drains and clean aggregate direct water away from the wall

One of the greatest enemies of any retaining wall is the buildup of hydrostatic pressure from groundwater behind the wall. So a well-constructed drainage system is essential to managing the flow of water.

Due to site constraints, I was forced to install fairly long runs of drain, so I took extra time to make them efficient. Starting at the drain outlet, I sloped and compacted additional road-base material behind the first two courses of block. On top of this slope (about 1/8 in. per ft.), I laid a strip of geotextile the width of the trench to separate the base material from the larger aggregate to come. Next, I put 4-in. perforated drain pipe on top of the fabric. I added clean-out risers with caps every 50 ft. and leaned them backward to ensure that they wouldn't interfere with the slope of the wall (photo left, p. 82). After testing the lines, I carefully covered the pipe with clean 3/4-in. crushed stone behind the blocks and tamped it in place.

As the wall grew higher, I continued to fill and tamp crushed stone in the 12-in. wide channel behind the wall (photo top right, p. 82). In addition to channeling water safely away from the back of the wall, the drain system should also minimize efflorescence, a white powder that forms when water leaches minerals out of the concrete. To stabilize and protect the foot of the wall, I folded the front of the trench fabric back toward the blocks, trimmed the excess, and tamped and sloped soil away from the top of the base course.

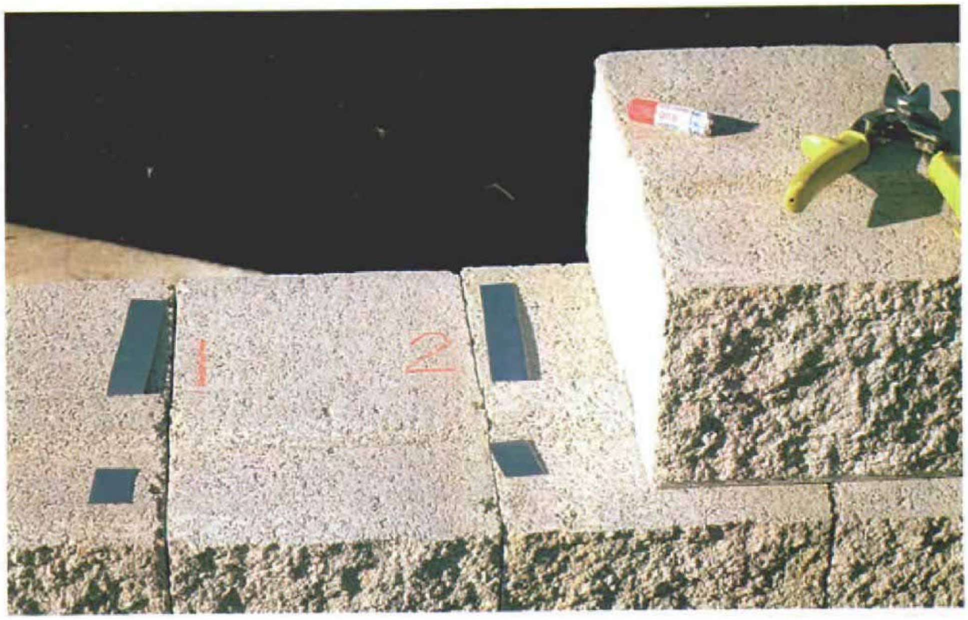
Laying block is plain hard work

Years ago, I was working on a simple but physically demanding job when a friend said, "We have just what this job needs: strong backs and weak minds." I often thought of his remark as I worked through the simple process of raising the wall. Working outward from a corner, I'd start by sweeping all dirt and debris from the top of an existing row

Plumb is not what you want. Clean-out risers for the subsurface drains behind the wall must be pitched back at the same angle as the wall. Over the wall's 4-ft. height, the face tilts back a total of **5¼** in.

First the block, then the stone. After laying a course of block, the author brings up the level of crushed stone behind the wall and tamps it by hand.

Make way for water. A circular saw with a diamond blade makes the narrow channels for these water lines. Grooves are patched with mortar and buried during final grading.



Weatherproof shims handle minor adjustments. For long stretches of wall, the author finds the work goes quickly (photo left). But slowdowns are inevitable. When the tops of adjacent blocks deviate by more than 1⁄32 in., adjustments may be required. When blocks have to be shimmed, the author uses narrow pieces of sheet aluminum that won't corrode, rot or wash away over time (photo above).

and then begin laying new block in *a* running bond, a pattern in which each block overlaps the one beneath it by half its width (photo above). Aligning the groove on the bottom of each block with lugs cast into the tops of the blocks on the course below kept each course straight and stepped back evenly. I was often able to work long sections of wall without hitting a snag, but adjustments were made to keep the wall straight and level.

Even though the blocks are consistent in width, it was often necessary to cut blocks to maintain the running bond pattern from course to course. I used my circular saw and diamond blade to get predictable results (sidebar p. 81). Once I completed a row of block, I backfilled and tamped the drainage stone up to the top of the blocks. Wherever the initial excavation had left a sharply defined bank, backfilling was easy: It meant placing crushed stone between the back of the wall and the fabric-covered face of the dig. But in areas where the excavation sloped back too much, I used a temporary plywood divider next to the geotextile to maintain the slope. The plywood kept the size of the drainage channel fairly consistent and let me backfill dirt behind the fabric at the same time I was adding crushed stone in front of it.

Mortarless design means flexibility

As I got close to finishing individual sections of the wall, I found that being able to dry-stack blocks was a real blessing. Instead of pouring a concrete wall and then wishing it were higher or lower, I tried different arrangements and then assessed the wall's appearance. Once my wife and I chose the final heights for different sections, it was easy to make the top row step up or down. I simply ended a row at any point with a corner block so that the rough face showed on two sides.

With the blocks in place, I leveled crushed stone one row below the top of the wall. I then folded the geotextile forward over the stone and up the back of the top row of block (drawing p. 78). With the excess trimmed off, the exposed fabric was covered with soil. Although I could just have sloped the grade to the top of the wall, I formed a healthy swale behind the wall and planted it with native grasses to help control water runoff.

The easiest part of the project was installing the cap. The standard PISA Revers-A-Cap is a trapezoid-shaped piece that can be laid in an alternating pattern to form a straight wall, or arranged in the opposite way to form a curve. After placing and cutting the caps to fit a section of wall, I aligned their front edges with a string and then glued them in place with a flexible adhesive (Set 'N Stone, Sashco; 800-289-7290). Four quarter-size dabs of adhesive are all it took to set each piece. Finally, I used cast-stone pier caps in a contrasting color to accentuate each corner in the wall. □

Andy Beasley, a retired Air Force instructor pilot, is completing his house near Hillside, CO. Photos by the author.

SOURCES OF SUPPLY

GeoWestern Retaining Walls
2701 W. Mansfield
Englewood, CO 80110
(303) 761-0883
www.geowestern.com

Anchor Block Co.
2300 McKnight Road
North Saint Paul, MN 55104
(763) 425-9779
www.anchorblock.com

Keystone Retaining Wall Systems
4444 W. 78th St.
Minneapolis, MN 55435
(800) 891-9791
www.keystonewalls.com

Risi Stone Systems
8500 Leslie St.
Suite 390
Thornhill, ON
Canada L3T 7M8
(800) 626-9255
www.risistone.com

Versa-Lok Retaining Wall Systems
6348 Highway 36, Suite 1
Oakdale, MN 55128
(800) 770-4525
www.versa-lok.com