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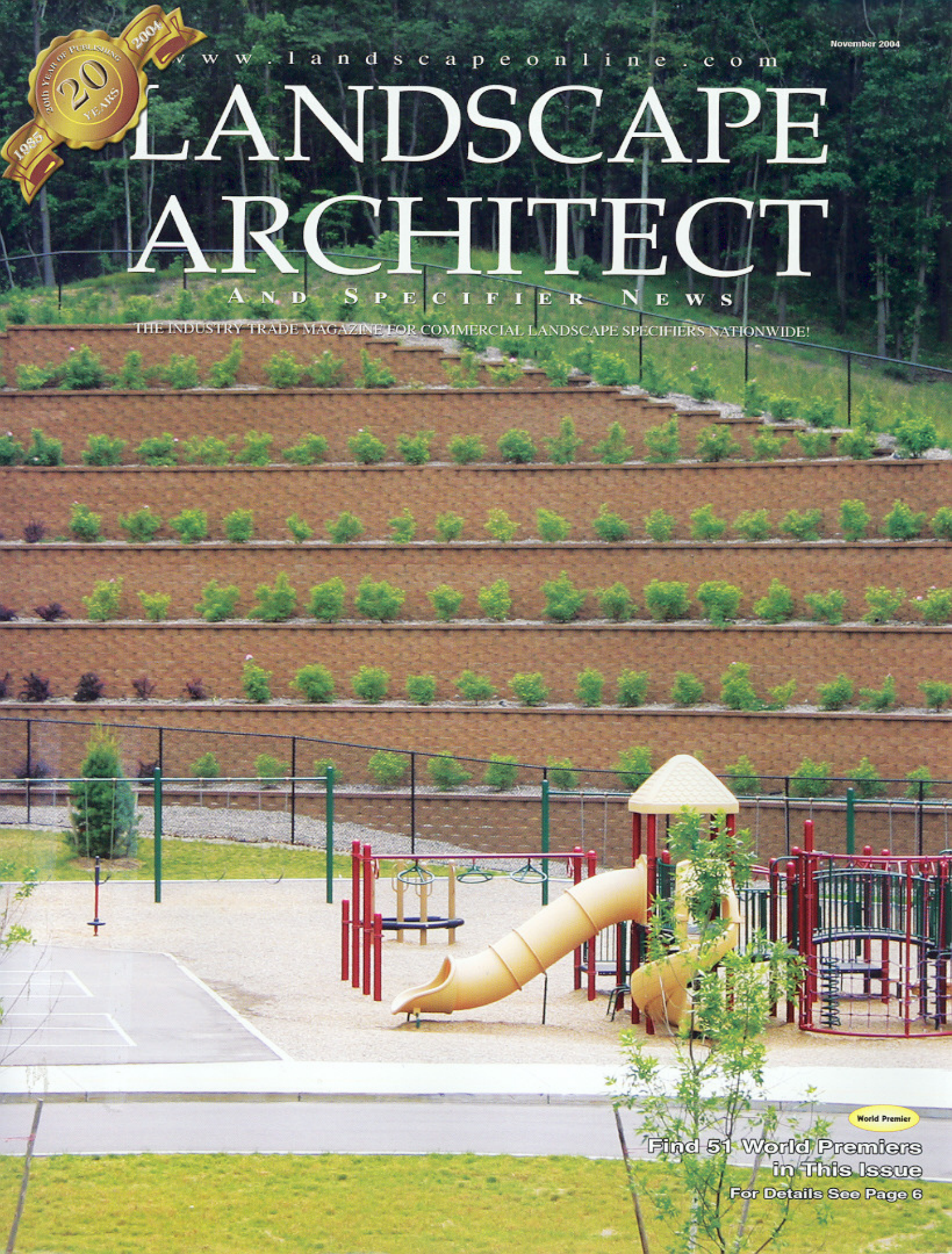

World Premier

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For Details See Page 6

A Michigan RETAINING WALL

The massive **wall** at Knapp Forest Elementary School in Grand Rapids keeps an unstable, sand-soil hillside in **place** while preserving open **space** and creating usable **land** for school facilities.

The Forest Hills School District obtained the land through a donation, and now the architects were facing some tough choices. The Grand Rapids, Mich. community wanted to open an elementary school by Sept. 2003, but the site was sitting in a bowl surrounded by hillsides that geologists said were prone to slide.

Above: The stepped retaining wall at Knapp Forest Elementary School in Grand Rapids, Mich., is close to 50-feet tall in spots and boasts one uninterrupted 875-foot section, making it one of the largest and most ambitious erosion-control structures in the region. The 32,000-square-foot wall let builders create space for a playground and bus loop/drop off area without claiming the hilltop forest and open space.

PROTECTS & PRESERVES

By Erik Skindrud, regional editor & Scot French, Rockwood Retaining Walls

It would have been cheaper to cut the hillsides back and stabilize them with erosion-resistant cover. But the local zoning commission required the district to leave a green belt between the school and an adjacent county park and trail system intact. At the other extreme, the design team could have chosen a near-vertical retaining wall, but aesthetic and safety issues prohibited that course of action.

"We knew we had some significant design challenges," landscape architect Woody Isaacs of O'Boyle, Cowell, Blalock & Associates recalled. "Without the wall, we would have had to excavate much further (back) on the hillside. That would have had a much greater environmental impact, so we decided very early that a stair-stepped retaining wall was the way to achieve our goals."

The wall cost the district close to $520,000.

Overcoming Obstacles

To contain the 50-foot-high slope, Walltek, a builder and designer of retaining walls, helped to isolate and control soil erosion on the big hillside adjacent to Knapp Forest Elementary School. In the process they were also able to effectively maximize land space near the school that was not originally available. A retaining wall would need to be built to contain the hillside soils and offer a solution to the problematic site.

The green belt requirement meant that the wall had to be built so that it would not severely disturb the existing hillside. The green belt at the top was covered with pine trees. In the process of excavation, some of them needed to be removed so construction could progress.

The first concern that developer Barnes Management Inc. expressed was the need to retain the existing hillside slope that loomed near the school. The company knew the hillside was an area that would be vulnerable to erosion and it was immediately identified as a problem that needed to be controlled. Soils at the site were sandy, which made the removal of the native soil for the back cut uncomplicated. However, extensive excavation was required to accommodate grid layers that would extend back approximately 40-feet behind the wall face, near the bottom of the wall. Michigan-based Walltek took the first step—removing a substantial portion of the hillside to permit installation. Of course, the 40-foot section was much less than would have been removed if no wall was built.

Another concern expressed during the initial design process was the soil stability issue that would develop as a result of seven multiple tiers being placed on the project site. Careful consideration was given to these individual walls, as there was no room for error. The multi-level walls would not only retain the slope, they would also provide additional space for a parking lot and recreational play structures at the foot of the wall.

Right: This photo, taken during construction, shows a wide staircase originally planned for the wall's center portion. Designed to link the campus with a county park and trail system above, school officials later chose to block the stairs with shrubs and fences to help guarantee student safety.

Public safety was a big concern. Walltek designed and engineered the wall to exceed specifications under this stress. Each tier measures 7-feet in height and each is spaced 5-feet apart—as independent walls. At the highest point, the wall's height is an imposing 42 feet. Much lower sections of the wall run the perimeter of the school grounds.

Aesthetic and Safety Concerns

The wall's brown color compliments the school building, but planners knew that placing shrubs on the multilayered terraces would soften its appearance and help the wall blend into the forested landscape. When it came to selecting species, the design team chose barberry and pyracanpha, among others, for their thorny texture.

"Part of the intent was to keep kids off those terraced areas," Isaacs said.

(Continued on page 66)

Left: This view from the top shows the wall's seven terrace levels. Designers wanted a multi-level design that would eliminate any danger of students climbing and falling. Students are forbidden to climb the terraces and deterred from doing so by barberry and pyracanpha–chosen for thorny growth. Though small in this view, the shrubs will soon fill in to discourage climbing.

"Without the **wall**, we would have had to **excavate** much further (back) on the **hillside**. That would have had a much greater **environmental** impact, so we decided very early that a **stair-stepped** retaining **wall** was the way to **achieve** our goals."

–landscape architect Woody Isaacs

"The result of this **cooperative** effort is an **intricate** segmental-sloped retaining **wall** that **rises** 42 feet above the **playground** and walkways."

–International Union of Bricklayers and Allied Craftworkers

This section of wall might look inviting to rock climbers, but the school has scheduled no PE classes here and students are forbidden to climb. The retaining wall's higher sections (where a fall could result in serious injury) are kept off limits by chain-link fences.

Retaining Wall: *(continued from page 64)*

When it came down to specifying materials, the team picked close to 20,000 Classic 8 blocks manufactured by Rockwood Retaining Walls of Rochester, Minn. The blocks were dry-stacked without mortar by the contractor for a grand total of 32,000 square feet of retaining wall surrounding the school's perimeter. An anchor bar on each block ensures high shear resistance and creates the connective strength needed for safety and durability. From a design standpoint, the beveled face creates a high degree of continuity between the landscape and the school.

Stone columns that are created when the blocks are set side-by-side were filled with drainage rock to enhance the strength and performance of the wall. The porous drainage material creates the space necessary to help alleviate water pressure from behind the wall and also helps create a positive frictional force that increases the strength and overall performance of the wall.

Coupled with these stone columns, layers of geogrid support structure were placed at intervals in the wall to stabilize the soil mass behind it and to ensure that the wall's integrity would not be affected by the weight of heavy earth-moving equipment or the shear load that is associated with a wall of this magnitude. During construction, geotextile was used to prevent fine material from migrating in the drainage zone, or for that matter, through the face of the retaining wall.

Another interesting aspect of the design is a section of the wall that has a "concrete waterfall" that seems to cascade over the face of the wall. Originally, the wall had been designed with a series of stair steps between the separate tiers. For safety reasons, the stair steps were removed and the wall was reconstructed as an outcropping on the wall. It now appears as a unique segment of the wall. Incorporated in the wall design, this unplanned embellishment creates a unique focal point on the wall face. *(Continued on page 68)*

Left: The retaining wall created a flat open area that landscape architect O'Boyle, Cowell, Blalock & Associates filled with turf playing fields, Christmas-tree-sized white pines (at the wall's base), a playground, concrete basketball courts and a school-bus dropoff circle. The hilltop retains its crown of oaks and maples.

Right: Children enjoy some play time near the wall's base in this view. (Note the chain-link fence in the background keeps the retaining wall out of bounds.) Loose, sandy soil at the hillside school site made a retaining wall essential to prevent landslides and ensure safety.

Retaining Wall:
(continued from page 66)

An Award-winning Finish

Upon completion, the 32,000-square-foot wall surrounded the entire school grounds. Separate walls independent of the tiered wall create a visible border to signify the perimeter of the school and help to ensure continuity in the design. The unruly hillside that had previously caused problems in soil erosion is contained behind the wall's seven tiers. Moreover, the unique multi-tiered design created space that was not formerly available. A parking lot situated to the side of a school and several recreational structures now occupy a space between the school and the unique wall structure.

The project is now recognized as one of the largest retaining walls in the Midwest. Knapp Forest Elementary School demonstrates the ability of a retaining wall to securely hold a massive earth formation, to reclaim valuable space and to prevent soil erosion.

Fittingly for its large scale and groundbreaking design, the International Union of Bricklayers and Allied Craftworkers, or BAC, recognized the project with a 2003 Craft Award for Best Landscape Project. The team of planners, contractors and landscape architects combined "resourcefulness and skills," the BAC noted, that "helped to insure the massive wall's stability."

The wall will stand as a monument to their efforts for a long time to come.