BLUFF STABILIZATION DRAINS

GILLEN
COMPANY

PROTECTING YOUR SHORELINE INVESTMENT

IS YOUR PROPERTY IN DANGER?

A Startling Loss

Imagine being awakened at night by the sound of your shoreline bluff collapsing. That's what happened to the owner of this residential property on Lake Michigan near Grafton, Wisconsin.

In early 2006, a section of bluff that stretched 1,000 feet along the lake and 60 feet inland collapsed and fell 42 feet straight down. The collapse left the bluff's edge only 19 feet from the home on this property.

An Innovative Solution

The Gillen Company successfully installed a series of drains to reroute groundwater away from the bluff's unstable internal sand layers and into the lake. After bluff drain installation, a contractor replaced earth in front of the home. This solution stabilized the bluff and helped prevent further failure and loss of property.

BLUFF FAILURE

AN AGE-OLD PROBLEM

Bluff motion has been a problem for property owners for more than a century. Roughly 13,000 years ago, glacial activity created the unstable soil and sand layers that we see today along much of Lake Michigan.

Within the bluffs about 50 feet above the lake water level are sand layers left from beaches that existed during glacial changes. Groundwater flows through the sand layers toward the lake and causes these mostly clay bluffs to slide over the sand layers. As water continues to build up, the increasing weight and water cause the bluff to slide further and eventually collapse.

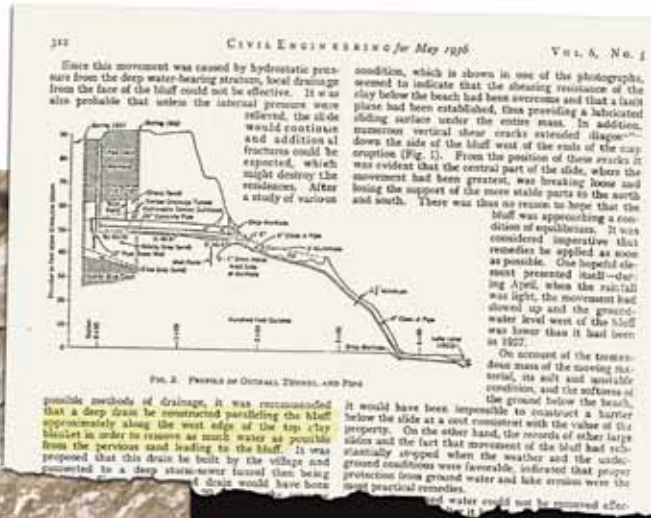
In 1927 in Whitefish Bay, Wisconsin, this action caused 500 feet of Lake Michigan bluff — along with the mansions on it — to move lakeward at a staggering average rate of four inches per day. In 1936, a tunnel was dug by hand 50 feet below ground surface and 400 feet behind the bluff crest to intercept groundwater flowing toward the bluff. That bluff has been stable since 1936.

Bluff Drains Protect Your Investment

Since the 1930s, more practical solutions have emerged. In the late 1990s, special drains were being used in highway embankments to prevent failures.

Along Lake Michigan, bluff failure is still a problem and endangers the investments and safety of property owners, both private and public. An unstable lakeside property could lose hundreds of thousands of dollars in value overnight!

The Gillen Company has more than 100 years of experience working along Lake Michigan's shoreline. We recognize the need for innovative new solutions to stabilize bluffs, and are proud to offer this exciting, effective technique.



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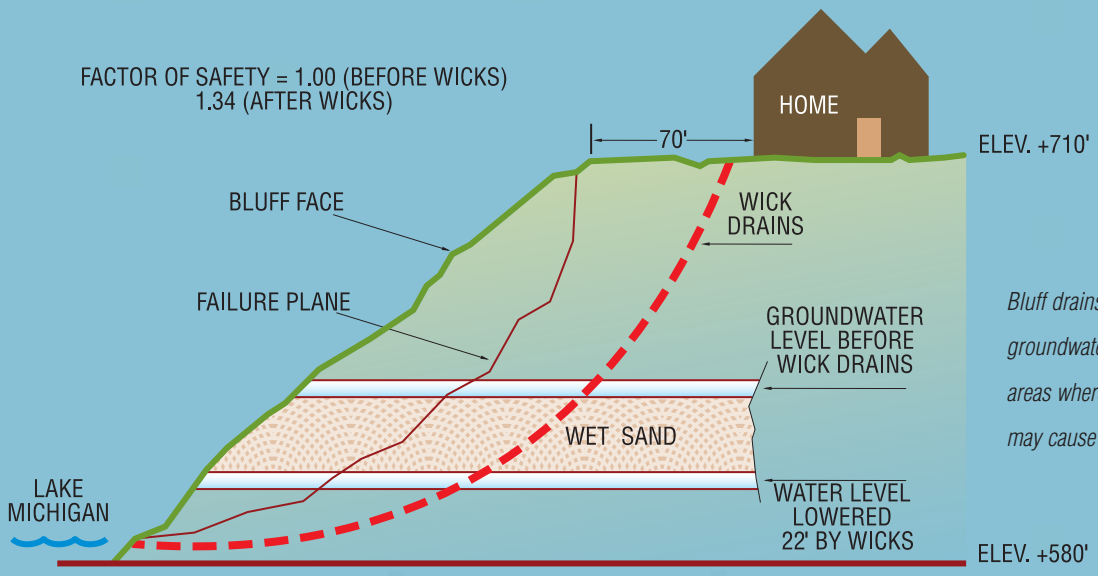
Since this movement was caused by hydrostatic pressure from the deep water-bearing stratum, local drainage from the face of the bluff could not be effective. It was also probable that unless the internal pressure were relieved, the slide would continue and additional fractures could be expected, which might destroy the residences. After a study of various possible methods of drainage, it was recommended that a deep drain be constructed paralleling the bluff approximately along the west edge of the top clay blanket in order to remove as much water as possible from the pervious sand leading to the bluff. It was proposed that this drain be built by the village and connected to a deep storm-sewer tunnel then being constructed. The drain would have been

condition, which is shown in one of the photographs, seemed to indicate that the shearing resistance of the clay below the beach had been overcome and that a fault plane had been established, thus providing a lubricated sliding surface under the entire mass. In addition, numerous vertical shear cracks extended diagonally down the side of the bluff west of the ends of the excavation (Fig. 1). From the position of these cracks it was evident that the central part of the slide, where the movement had been greatest, was breaking loose and losing the support of the more stable parts to the north and south. There was thus no reason to hope that the bluff was approaching a condition of equilibrium. It was considered imperative that remedies be applied as soon as possible. One hopeful element presented itself—during April, when the rainfall was light, the movement had slowed up and the ground-water level west of the bluff was lower than it had been in 1927.

On account of the tremendous mass of the moving material, its soft and unstable condition, and the softness of the ground below the beach, it would have been impossible to construct a barrier below the slide at a cost consistent with the value of the property. On the other hand, the records of other large slides and the fact that movement of the bluff had substantially stopped when the weather and the underground conditions were favorable, indicated that proper protection from ground water and lake erosion were the most practical remedies.

Sand layers left from glacial activity (left) are still visible in bluffs along Lake Michigan shores.



Bluff drains safely reroute groundwater away from unstable areas where seepage and pressure may cause bluff collapse.

THE BLUFF DRAIN PROCESS

HOW IT WORKS

We understand that each property is different and requires a unique solution to prevent bluff failure. Through wise use of technology, such as horizontal directional drilling (HDD) and innovative drain materials, Gillen invented a system that adapts well to many bluffside properties.

Gillen consults with licensed professional geotechnical engineers to analyze each particular situation. These experts use their knowledge of the area and methods such as soil borings to determine the best solution. Bluff drains are sometimes used in combination with a stone shoreline revetment to stabilize bluffs.

Whether used alone or with other techniques, our patented bluff stabilization drains offer an extremely efficient and cost-effective solution to remove internal groundwater, preventing further soil movement to help stabilize your property.

Major Benefits of Adding Bluff Drains

Bluff drains offer significant benefits to you as a property owner:

Effective. These drains have a successful track record of increasing bluff stability.

Efficient. This drain process is typically the only solution.

Cost-effective. Other methods may require regrading the slope, time delays, obtaining permits, or digging trenches into the bluff…all of which may add unnecessary costs.

Addresses the cause of the problem. Unless bluff drains are installed, groundwater will continue to build up and cause erosion which other solutions do not prevent.

Maintains the integrity and value of your land, helping you protect your investment.

Low environmental impact. Trees, shrubs, brush and plantings remain intact during the process.

Maintains soil structure. Draining process does not cause further compaction of the soil.

Highly adaptable. Bluff drains can be inserted under existing buildings and utilities without affecting them.

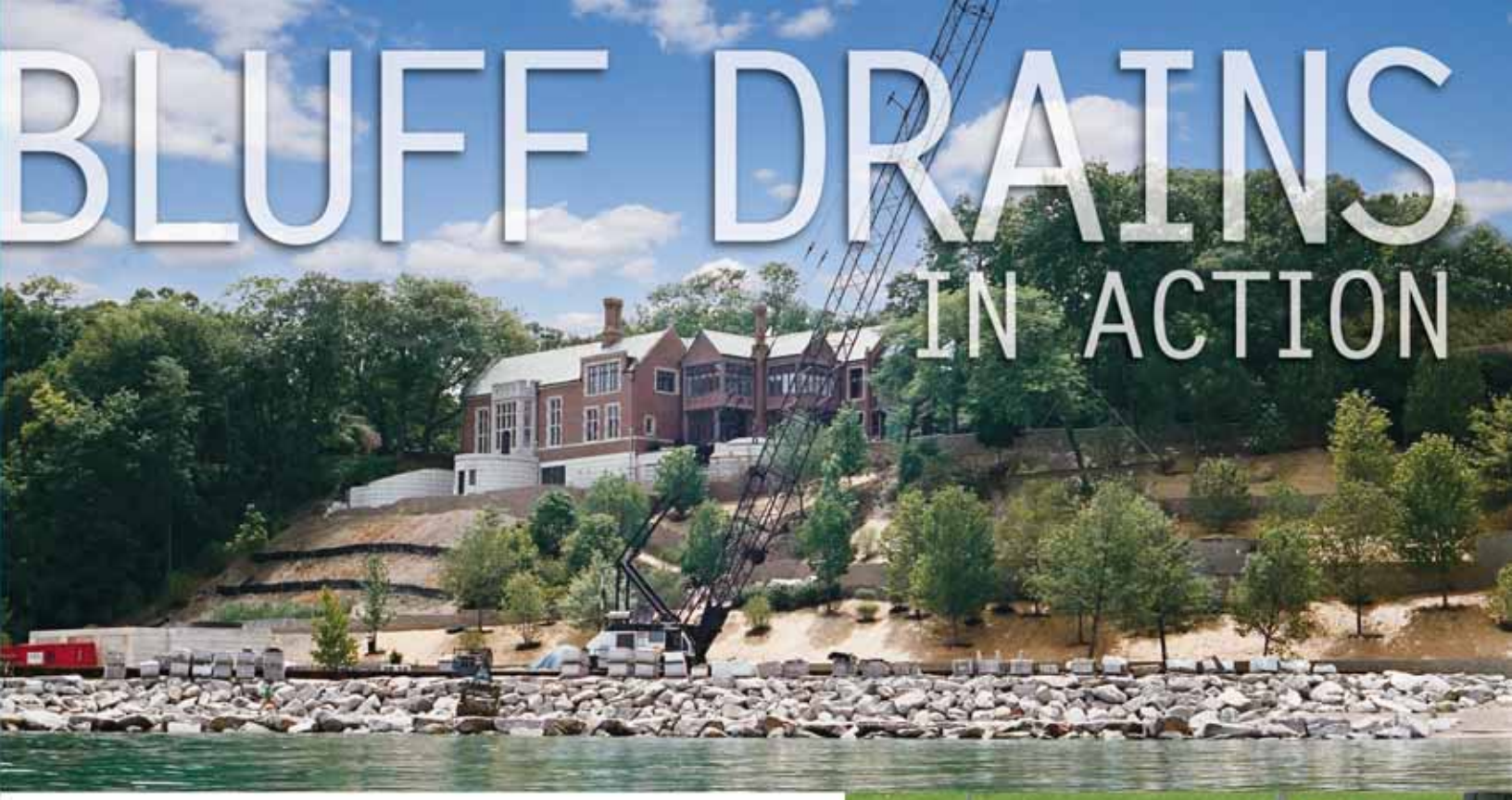
Relatively short installation time. Process typically takes days, not months as with other methods.

Little or no maintenance. Bluff drains are encased in filter cloth which prevents clogging and allows draining by gravity, requiring no maintenance on the part of the property owner.

Accepted by local government entities as a viable solution, with no permit required.

Diverted groundwater drains into Lake Michigan 10 feet above the beach at rates of as much as 120 gallons per hour, helping to prevent bluff failure.

BLUFF DRAINS IN ACTION



Gillen has installed bluff stabilization drain systems for public and private properties.

Residence, Lake Forest, IL (above) – This large estate was receiving bluff landscaping and installation of contoured walks when a massive landslide demolished walks and threatened the stability of the entire bluff. The Gillen Company installed drains and the bluff was stabilized in 2002.

Residence, Fox Point, WI (drawing, facing page) – A homeowner there experienced Lake Michigan bluff slides. Tests showed the bluff could fail at any moment. Gillen installed bluff drains, reducing the likelihood of failure. Two weeks after completion, the area received a record rainfall, but the bluff remained stable. Ultimately, this solution lowered the water level by 22 feet and increased the bluff's safety factor by 34%.

Bender Park, Milwaukee County Park System (below) – Gillen installed a successful drain system in the park's 160-foot-high bluff to stabilize the area, which had been damaged by severe erosion.

Contact the Gillen Company for a consultation to see if bluff stabilization drains might be the best solution for your property. **Call (414) 769-3120**.

United States patent number #6,948,886.

Golden elevator boat lifts safely raise boats above the dangerous waves of Lake Michigan

"The Beachlauncher™" self-propelled boat launching systems

Fleet of six tugs and 20 barges

Lake Forest Beach

Offshore water intake

Docks located in Milwaukee, WI and Waukegan, IL

The Gillen Company also specializes in:

- Deep foundations – piles and caissons (drilled piers)
- Earth retention systems
- Marine structures
- Boat piers on Lake Michigan
- Shore erosion projects
- Submarine crossings
- Marinas and dredging
- Prestressed earth anchors
- CHANCE® piers and tiebacks
- Soil nailing
- Ground densification
- Amphibious beach launcher

Our Commitment to Customer Service

Founded in 1894, the Gillen Company has built a reputation for dependable work, timeliness, innovation and cost-effectiveness throughout the Milwaukee/Great Lakes region. We work closely with engineering and geology experts who know this area well. Together, we're dedicated to continuing our high levels of customer service and success that multiple generations of Gillen staff have worked hard to achieve.

Gillen received the U.S. Army Corps of Engineers "Contractor of the Year" Award in 1993, chosen from over $2 billion worth of Corps contracts worldwide.

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