

LANDSLIDES IN HAMILTON COUNTY

Prepared by Robert E. Sheets, P.E., Geotechnical Engineer, Hamilton County Soil & Water Conservation District

HISTORICAL PERSPECTIVE

Since the early development of Cincinnati and Hamilton County, landslides have been a problem, no doubt predating the written record of them. Early quarrying operations on East Price Hill, and the spoils wasted over the eastern flank, caused historical landslide problems in that area, some of which recur to this day. Early cut and fill road construction along above the Ohio River caused problematic landslides, which include areas along River and Delhi Roads to the west, and Eastern Avenue and Columbia Parkway to the east. In fact, there are ample records of landslides across Hamilton County and the Greater Tri-State region.

Landslides in Hamilton County are not limited to those areas disturbed by our early pioneers. Problems with landslides have continued to this day. In fact, one of the most expensive retaining walls constructed in the United States sits at the base of Mount Adams. The retaining wall supports a slope which failed as a result of the construction of the I-471 cloverleaf near the southeast corner of downtown Cincinnati. The wall appears as a row of rather rough, vertical concrete cylinders (called “drilled piers”) extending up out of the ground, with what appear to be steel “top hats” extending from their sides. These “top hats” are actually caps for steel tendons, which extend to and are anchored in a tunnel behind the wall and deep in the earth below Mount Adams. These steel tendons hold or “tie-back” the top of the wall. The retaining wall system, known commonly as a “tied-back drilled pier retaining wall”, provides lateral support to the toe of the hillside, which in turn supports the entire slope and structures above. In fact, the drilled pier method of retaining wall construction is native to the Cincinnati area.



The Mt. Adams Retaining Wall.

In the 1970's and 80's, the problem and severity of landsliding in Hamilton County came to the forefront. A 1980 publication of the U.S. Geological Survey entitled "Estimating the Costs of Landslide Damage in the United States" indicated that Hamilton County, Ohio had the highest annual per-capita cost resulting from landslide damage in the entire nation. In fact, during the period of study (1973-1978), the cost of landslide damage exceeded \$5 million annually. This amounted to \$5.80 per person per year, more than four times the same figure for the nine-county San Francisco Bay region. It is noteworthy that the cost for the Mt. Adams landslide repair was specifically excluded from the total cost figure. Inclusion of the \$22 million Mt. Adams repair would have substantially increased the total and per-capita cost figures.

JUST WHAT IS A LANDSLIDE?

A landslide is defined as the downward and outward movement of earthen materials (soil and rock) that comprise a hillside or slope. Landslides are considered "slope failures" because, at a point in time and for a variety of reasons, the earthen materials which comprise the slope cease to have the necessary strength for internal support and the slopes "fails" under the force of gravity. At such time a mass of soil will come free and move downward and outward away from the slope, causing damage to most anything which it supports or which is in its path.

From stories on the nightly news, one may be familiar with the catastrophic, rapid mudslides that occur in southern California and elsewhere around the world. Such mudslides, usually triggered by periods of heavy rain, have the potential for destruction of property and loss of life.

While we in Hamilton County do experience rapidly-moving mudslide-type landslides (as are reported spilling onto Columbia Parkway most spring seasons), typical landslides here are best represented as slow-moving masses of clayey soil, in many instances only noticeable by cracks in the ground near the upper limit (called the "scarp") and by bulging soil at the lower limit (called the "toe") of the moving soil mass.

The rate of movement of these landslides (often after a more rapid initial "slump") is quite slow, varying from inches per day to inches per year, barely distinguishable as movement. Yet these landslides can continue for years, causing slow destruction of any man-made structures of which they come in contact. Houses, apartment buildings, streets and roadways are no match for the forces associated with such a landslide.



Photo of a small but typical residential landslide. Note the ground cracking at the top (scarp), and ground bulging at the bottom (toe), and the general downward and outward movement of earth.

WHY HAMILTON COUNTY?

Hamilton County is situated within a very unique topographic and geologic setting. Many natural factors combine to make the hillsides of Hamilton County particularly susceptible to landslides. Add to this the large population and the accompanying amount of land development activity and conditions become prime for troublesome, costly and destructive landslides.

At the base of Hamilton County's geologic setting is the bedrock native to the area, which is comprised of Ordovician age (about 450 million years old) shale and limestone. Of particular interest with respect to landslides is a formation known as the Kope. The exposed Kope formation is roughly 200-ft thick, extending up from the general level of the Ohio River, forming the valley walls that surround many of the County's deeper river and stream valleys. The shale portion of the Kope weathers easily to a rather weak soil, so that where the Kope is exposed, it develops a "skin" of soil, known as "colluvium", which is highly prone to slippage and landslides.

Next is the fact that Hamilton County has experienced three major glacial advances through its geologic history. Prior to the advance of these glaciers, a large, ancient river called the Teays flowed north through Hamilton County. The earliest glacier to advance into Hamilton County (the Kansan) occurred about 1.2 million years ago. Glaciers are continental sheets of ice as much as two miles thick, which gouge the earth and move great quantities of earth and rock. On their retreat, these glaciers melt, creating rivers of muddy water which erode and carve the landscape and carry and deposit large quantities of rock, gravel and earth. This earliest glacier dammed the ancestral Teays River and its tributaries, creating great lakes where fine sediments were able to settle and deposit themselves. These deposited sediments, called "lakebed clays", are known to be troublesome, forming a soft base over which overlying soil is particularly

susceptible to slippage. These “lakebed clays” were subsequently buried by the action of future glacial advances and retreats.

Two more such glaciers advanced and retreated from the region: the second (the Illinoian), was present about 400,000 years ago and the most recent (the Wisconsinan) about 70,000 years ago. When the ancient lakes finally broke free west of Cincinnati, the current course of the Ohio River and the general landscape that we know today was largely in place.

The study of the geologic history of Hamilton County can occupy many courses of study. However, in very simple terms, the bedrock of the area in conjunction with the glacial history, have created both a geology (that is, the soil and rock which underlie the area) and a topography (the surface form of the land, including the many steep hillsides) that make the region particularly susceptible to landslides.

The final piece of the puzzle is the fact that Hamilton County is a center of population. In preparing land to accept roads, houses and structures, man cuts and fills the hillsides, altering the natural topography and affecting the natural surface and subsurface drainage patterns. In doing so, it is man who in many instances tips the critical balance of forces and unknowingly triggers or sets the stage for future earth movement.

HOW ARE WE AFFECTED?

Landslides would likely not be considered substantial problems except for the simple fact that they damage and destroy the works of man. In Hamilton County, landslides typically do not cause death. The most common problem caused by landslides is damage to property - roads, houses, apartment buildings and commercial structures to name just a few. Landslides may interrupt utility lines and cause service outages. Where they are known or suspected, landslides affect the value of properties due to the threat of future problems.

As was stated earlier, Hamilton County is among the most affected areas of the country as a result of landslides. The cost estimates made back in the 1970's considered only direct costs, that is, the cost of the physical damage and/or the restoration cost to structures and land, on the property immediately affected by landslides.

Not considered were the indirect costs of landslides, which include relocating buildings or roadways, constructed works undertaken to protect against potential future or adjacent landslide damage, as well as a decrease in the market value of affected or neighboring properties and the tax revenue lost as a result of these decreased values, again just to name a few.

The intangible consequences of landslides, their impacts on people's lives and livelihoods, must be considered. Whether it is a house or a business that is affected, such troublesome and costly damage poses certain consequence to the quality of life of many people.



Typical residential landslide (left). Engineered repair of same (right).

As a result of a very wet and rainy spring season of 2008, about 35 landslides were reported in Hamilton County (excluding the City of Cincinnati) in that year. Many of these were considered relatively modest in terms of the resulting damage (many affecting only yard areas and not encroaching on any structures); however, even the least of these certainly had considerable impact on the people involved and on the values of the properties affected.

Of the three generally considered the most severe, one necessitated the construction of a \$250,000 retaining wall to reestablish support for a single residential property. A second caused the complete destruction of a large, upscale apartment building, half of another building and required a \$2.5-million retaining wall to stabilize the property. The third was a failure of a slope bounded by a retail strip mall at the top and a condominium community at the bottom and did not outwardly affect any of the structures involved. Nonetheless, due to the threat of damage and unsafe conditions, the landslide resulted in the closing of six to eight local businesses, with undoubted financial impact to those businesses that remained open. The condominiums which neighbored the landslide were also undoubtedly affected in terms of value as well as saleability, in addition to the personal burden to the owners. In the three years following its occurrence, this last described landslide had not been repaired. A slope repair is currently in progress, estimated at roughly \$2- to \$4-million.



Results of a residential slope failure (left). Engineered repair of same (right).

The cost for and implementation of all three of the slope repairs outlined above were managed privately. It is likely that many of the others reported in 2008 have not been repaired due to the substantial costs and effort associated with repairing even the most modest landslide.

It is well worth noting that there is little if any financial assistance available to homeowners and others to assist with the repair of landslides or landslide damage. Unless a costly landslide policy was in place prior to an occurrence, insurance policies will generally not cover damages resulting from earth movement. Because of the slow-moving nature of Hamilton County landslides, disaster relief funds (which cover only a limited number of rapidly-occurring events) are, with only a couple past exceptions, essentially non-existent with respect to landslide remediation efforts. Such slow-moving events regardless of the level of damage are simply not considered “disasters”.

As can be seen, the costs and negative effects associated with the problem of landslides in Hamilton County are many and substantial, while the options for assistance in addressing the problem are relatively few.

SO WHAT DO WE DO?

Because the 1970's and 80's saw a greater recognition of the magnitude and costs associated with the problem of landslides in Hamilton County, in 1982 an Earth Movement Task Force (EMTF) was adopted by the Hamilton County Commissioners. The purpose of the EMTF was to “evaluate current and future problems in Hamilton County attributable to land and mud slides and to make recommendations for dealing with short and long term aspects of those problems”. Members of the Task Force included a diverse group of people from government, academia and the private community (developers, homebuilders and affected or concerned citizens).

The Task Force touched on many items and in their Final Report of September 1982, discussed such items as various types of financial assistance to those affected by landslide damage (which

are, as previously discussed, very limited), continuation of the development by the Federal Government and others of geologic data and mapping to identify landslide-prone areas and lastly, to mitigate landslide damage in undeveloped areas by the adoption of earthwork regulations. It was noted by the Task Force that “hazards such as flooding and fire are regulated and controlled and all development is reviewed in terms of these hazards, so certainly the threat to property posed by landsliding should be regulated and controlled for all new development.”

The City of Cincinnati had adopted similar earthwork regulations in 1974. In Hamilton County, the problem continued to be studied and debated until finally in 1990 a comprehensive set of Earthwork Regulations were adopted.

The Hamilton County Earthwork Regulations set certain criteria under which it is required that earthwork development take place in conjunction with and under the guidance and expertise of a registered professional geotechnical engineer. In very general terms, if an earthwork operation is to involve cut or fill thicknesses in excess of 5-ft, is to take place on land with an existing slope of 5H:1V (ratio of 5 units horizontal to 1 unit vertical, or 20 percent) or steeper, or create final slopes of 3H:1V (33 percent) or greater, or be done within an area of known landslide or other geologic hazard, the Earthwork Regulations would be in force.

Such regulations aid substantially in reducing and managing the problem of landslides associated with new development. However, regulations alone will not completely eliminate the problem of landslides associated with new development in Hamilton County, nor will they serve to improve any existing problems or potential hazards that were present prior to their enactment. Developers, contractors and citizens need to be aware of these Earthwork Regulations and the important reasons behind them, as well as the magnitude of the problem of landsliding in this region in general. Attention must be given to such things as illicit and improper cutting and filling of hillside areas; past or current dumping over hillsides or into ravines; excessive streambank erosion near the base of steep slopes; large-scale denuding of hillside areas; seepage water seen emanating from the face or near the toe of steep slopes and cracks in the ground near the top or bulges near the bottom of hillside slopes. All these (and many other) items may result in or indicate the presence of unstable slope conditions and the potential for landsliding.

CLOSING

There will always be landslides in Hamilton County. Developers, builders and citizens should be aware of the risks associated with building or buying on hillsides. Contact the Hamilton County Soil & Water Conservation District with questions or to report problems – we will be happy to offer assistance to the extent we are able. Or better yet, make contact with a local geotechnical engineer. These individuals are trained and experienced in assessing and dealing with landslides and other soil-related conditions and stand ready to provide a professional level of service to you.

Further Reading:

Durrell, R.H., undated.

A Recycled Landscape, Educational leaflet published by the Cincinnati Museum of Natural History.

Fleming, R.W., 1975.

Geologic Perspectives – The Cincinnati Example, U.S. Geological Survey, Box 25046 Denver Federal Center, Denver, Colorado 80225

Fleming, R.W., and Taylor, F.A., 1980.

Estimating the Costs of Landslide Damage in the United States. U.S. Geological Survey Circular #832

Geological Society of America, 1981.

Engineering Geology of the Cincinnati Area, Cincinnati Meeting, 1981 Geological Society of America, 1200 New York Avenue NW, Suite 700 Washington, DC 20005

Geological Society of America, 1992.

Guidebook No. 9 – Cincinnati's Geologic Environment: A Trip for Secondary School Science Teachers, Annual Meeting, 1992, Geological Society of America, 1200 New York Avenue NW, Suite 700, Washington, DC 20005

Liebing, R.W., and others, 1982.

Final Report – Earth Movement Task Force, submitted to the Hamilton County Board of Commissioners, September, 1982.