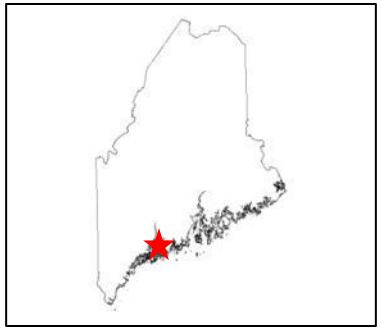
Maine Geologic Facts and Localities

November, 2007

Brunswick, Maine Patriots' Day 2007 Landslide



43° 51‘ 46.75“ N, 69° 54‘ 54.36“ W

Text by
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Introduction

On Monday, April 16, 2007, a landslide (Figure 1) and adjacent slope subsidence (Figure 2) occurred along the east shore of Buttermilk Cove in Brunswick, Maine.

Photos by Michael E. Foley

Figure 1. (Left) View of the rotational landslide looking northeast from Buttermilk Cove toward Route 24 (Gurnet Road). (Right) Bluff slope and leaning trees. Buttermilk Cove is in the background.

Brunswick Landslide

The slide occurred along a steep bluff (Bryant and others, 2002) adjacent to Route 24 (Gurnet Road) (Figure 3). The bluff top was about 30 feet above sea level (Figure 1, Right).

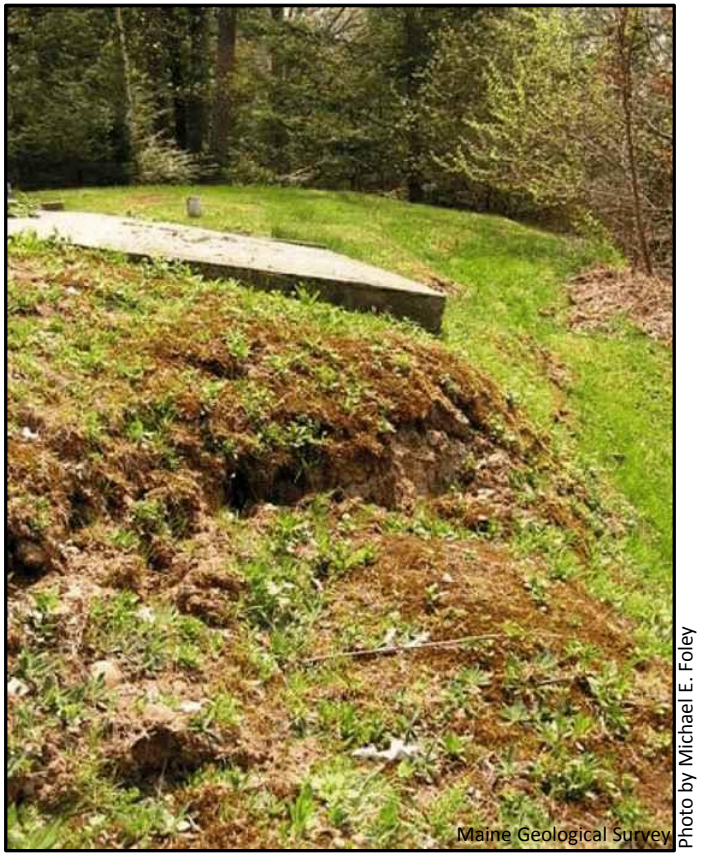

Figure 2. Backyard slumping and scarps show down-dropped sections of earth. The top of the bluff and shoreline are to the right and the house to the left.

Brunswick Landslide

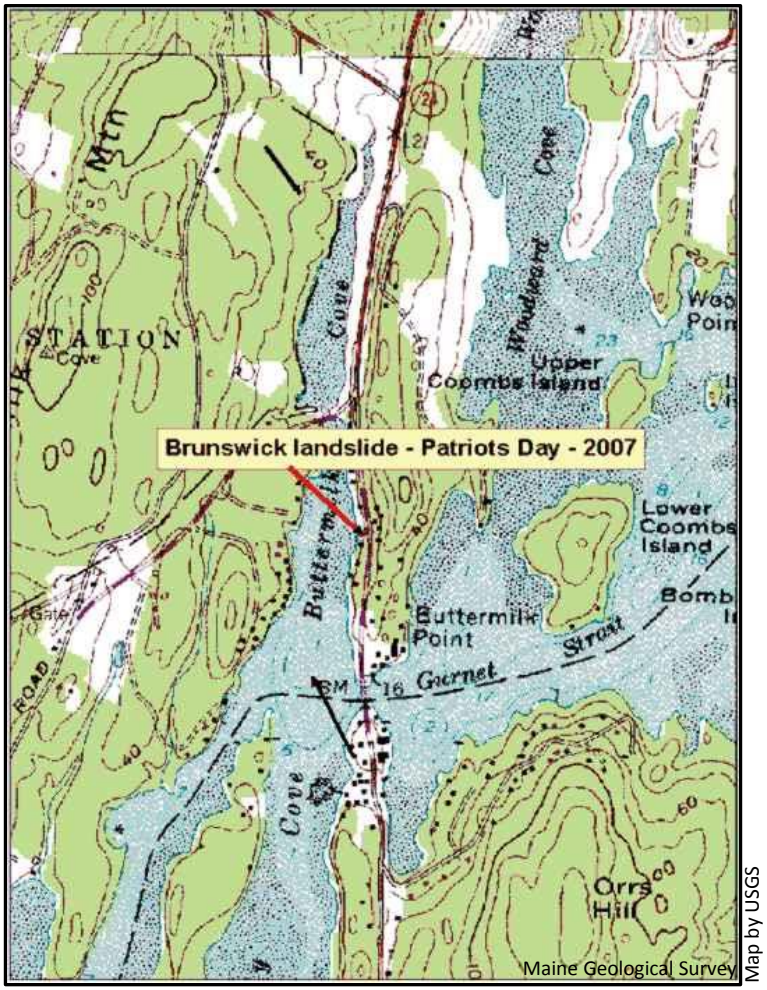

Figure 3. Topographic map showing location of the April 16, 2007 landslide in Brunswick.

Brunswick Landslide

This shoreline has been mapped by the Maine Geological Survey as a "Potential Landslide Area" (Dickson, 2001; Figure 4).

Figure 4. Brunswick landslide located in the yellow map unit, a Maine Geological Survey "Potential Landslide Hazard Area."

Site Damage

This site location has evidence of prior slope failure and subsidence. The basement and foundation walls show previous cracking due to ground subsidence (Figures 5). The most prominent crack runs along the entire length of the basement floor and resulted in a slight separation in the cement. The floor section on the west side of the basement towards the water shows subsidence and also drastic sloping down toward the shoreline.

Figure 5. (Left) Basement floor of the residence with a large crack parallel to the bluff face. (Right) Relic basement wall cracks from previous subsidence. The bluff is to the right.

Site Damage

The back yard, which is located west of the house towards the water, exhibits extensive subsidence and sloping from prior slope failure events (Figure 6). There is evidence of 2 to 3 old landslide scarps in this same area between the building and the bluff face.

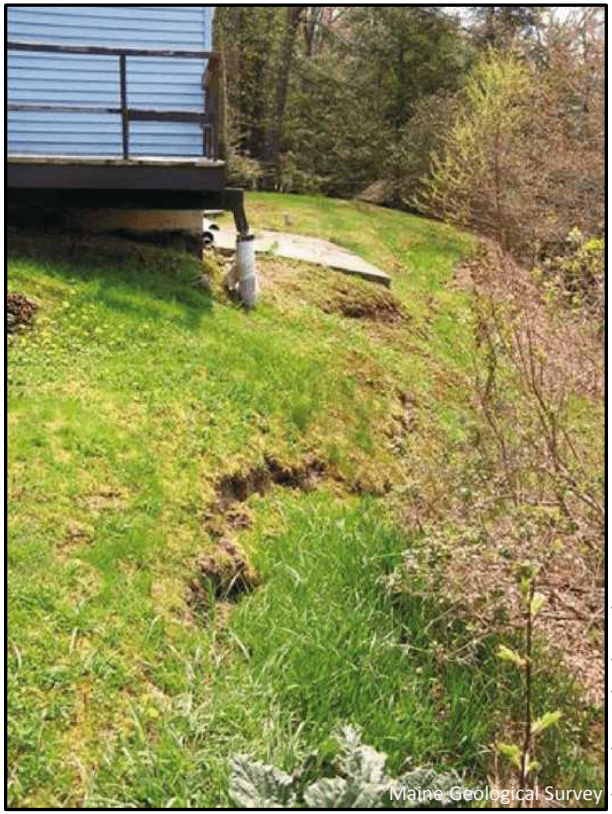

Figure 6. Back yard showing subsidence, tension cracks and small landslide scarps. The shoreline is to the right and the major landslide site is behind the photographer.

Site Damage

A cement patio, built in the early 1970's level to the ground, now exhibits a 20-degree slant towards the water (Figure 7). The patio slab is now completely broken up and cracked by previous ground movements.

Figure 7. Patio slab showing slumping, multiple cracks and uneven vertical offset. Buttermilk Cove is to the left.

Site Conditions

During a site visit by Maine Geological Survey geologists, two distinct areas of slope failures were observed (Figure 8). One, a large rotational landslide, occurred 90 feet north of the house in an area where runoff from both a cross-road culvert and the leach field drainage were focused. This rotational slide produced a distinct 30-foot long concave scarp with a tree-covered toe at the base.

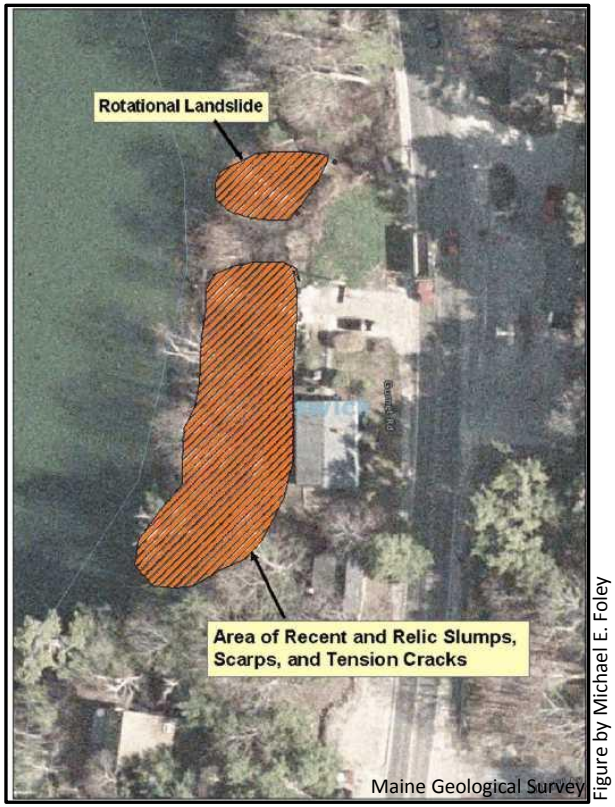

Figure 8. Aerial photograph showing areas of rotational slides and slumping.

Site Conditions

The landslide toe extended into the intertidal zone of Buttermilk Cove (Figure 9). The second area of slope movement extended from the southern edge of the main scarp, southward for approximately 90 feet. This is in the same area as the previous subsidence and slope failure on the west side of the house described above. This slope movement and subsidence consisted of fresh tension cracks and minor parallel scarps in the lawn. This movement caused the ground behind the house to slope more steeply toward the top of the bluff and water.

Figure 9. The toe of the rotational landslide moved out into the intertidal zone in Buttermilk Cove.

Site Conditions

Upon observing the exterior and interior of the house foundation, extensive floor and wall cracks (fissures) were noted, along with a drastic sloping of the basement floor, as described above. Though some of the foundation cracks are relic in nature, many new cracks and foundation offsets appeared to be due to recent failure. Most of these cracks occur in the basement walls and corners along the waterside (west side) of the house. These features suggest an ongoing history of slope movement, subsidence, and site instability.

The site has been built up and out towards the water with artificial fill (Figure 10). The north end of the site appears to be filled with a medium to coarse-grained sand which the owner thought came from a local construction site. This area is also the location of a leach field for the home's septic system. The remainder of the site is filled with a mixture of material, the majority of which consists of old tires.

Site Conditions

These tires are loosely placed and prevalent on and within the oversteepened slope (bluff face) and appear to have been placed haphazardly and not in an engineered form. Other slope materials include metal, cement, bricks, shrubs, and trees.

Figure 10. Tire fill used to level the back yard of the property. Buttermilk Cove is in the background.

Geologic Setting

The normal stratigraphic sequence (layering of earth materials) in this area is:

1. bedrock overlain by
2. a glacial till and then overlain by
3. a marine clayey silt known as the Presumpscot Formation.

Observation of the bluff toe suggests very little or no till present and Presumpscot Formation clay overlies bedrock at this site. Bedrock underlying the sediment is metamorphic rock of the Sebascodegan and Cape Elizabeth Formations (ancient rocks of Ordovician to Early Silurian age). These rocks crop out along the edge of Buttermilk Cove near the elevation of mean high tide (Figure 11). Outcrops are also located directly across Route 24 to the east of the slide area.

Geologic Setting

The depth of overburden between these outcrops is indeterminate. Further geological studies would be needed to determine the subsurface bedrock contours and overburden thickness of the till and marine clay at the site.

Figure 11. Bedrock outcrop along the high tide line at the base of the coastal bluff in Buttermilk Cove. Note the bent tree trunk caused by previous landslide movements or gradual creep due to toe erosion.

Vulnerability of the Brunswick Landslide Site for Further Slope Failure

There are two basic principles to note in determining areas at risk for landslides:

1. It is likely that landslides will occur where they have occurred in the past
2. Landslides are likely to occur in similar geological, geomorphological, and hydrological conditions as in the past.

This location fits both of these tenets. A landslide has occurred at this site, and there have been other coastal landslides in Maine that have occurred within similar geological settings.

Landslide Precursors Found at this Site and Future Site Stability

1. **Unstable soils** - leaning trees exhibiting prior slope creep and movement. The presence of large leaning trees demonstrates that earth movement has been continual over time.
2. **Foundation cracks** - extensive wall and floor foundation cracks show both prior and recent subsidence since the building was constructed.
3. **Tension cracks** - landslide scarps begin as tension cracks. Field evidence exists of prior and new tension cracks and scarps extending for 90 feet across the back yard.
4. **Slope oversteepening** - slope behind house is extremely oversteepened- a primary cause/precursor for a landslide.
5. **Overburden loading** - the area has had extensive artificial fill brought in, which can only lead to an increase in overburden stress on the underlying marine clay, increasing the risk of slope failure.
6. **Precipitation/drainage** - heavy precipitation can trigger landslides. Heavy precipitation oversaturates the soil, increasing overburden pressure, and also increases pore pressure in the sediments and thus aids in lubricating the marine clay, increasing the risk of slope failure.
7. **Bluff-toe erosion** - tidal currents and waves erode sediments at the base of the slope. Active toe erosion is present across the entire base of slope at this site. This condition leads to slope oversteepening and less support for land at the top of the bluff.

This property exhibits all of the above factors of previous slope failure (e.g., oversteepened slope, overburden loading, unstable soils, and previous subsidence). The only change in the conditions since the landslide of April 16th is in the area of the rotational slide where the slide slope has stabilized and become less steep. Although we can say with certainty that another slide or slope failure will occur at this site, it is not possible to predict when that failure would occur. It is our judgment that this site is unstable and prime for further slope failure, possibly up to Route 24.

References and Additional Information

Bryant, M., Barnhardt, W. A., Dickson, S. M., and Kelley, J. T., 2002, Coastal bluffs in the Orrs Island quadrangle, Maine: Maine Geological Survey, Open-File Map 02-201 (4.4 Mb pdf format), scale 1:24,000.

Dickson, Stephen M., 2001, Coastal landslide hazards in the Orrs Island quadrangle, Maine: Maine Geological Survey, Open-File Map 01-530 (2.6 Mb pdf format), scale 1:24000.