SLIDING DOWN COTTON BROOK, WATERBURY, VT

by

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ABSTRACT

A major landslide occurred on the south side of Cotton Brook in the Mt. Mansfield State Forest in May 2019. The immediate goals of the Vermont Geological Survey were to 1) document threats in the area, 2) characterize the site, 3) propose approximate "exclusion areas" for trails, and 4) collect baseline data so we can evaluate impacts and change.

The area of the landslide is approximately 12 acres. The landslide resulted in massive sedimentation in Cotton Brook and a large delta in the Waterbury Reservoir. A comparison of elevation data from the VTRANS drone flights on June 12 with the pre-landslide Lidar data shows approximately 200,000 cubic meters of material was excavated, 100,000 cubic meters was deposited at the base, 25,000 cubic meters are estimated in the delta, and 75,000 cubic meters remain unaccounted for (deposited along the brook, in the reservoir, or transported down the Little River). The landslide blocked Cotton Brook, leading to an impoundment upstream. Fractures formed on the wooded hillsides adjacent to the landslide scar and these are areas of potential failure.

The slope, roughly 25 degrees, is composed of fine silt and sand lake bottom sediments deposited in Glacial Lake Winooski (Wright, 2019). A slide surface of very fine silt to clay is visible and has been grooved and striated by the overriding material. Mud flows on the surface, fallen trees and boulders, new cracks on the Fosters Trail, and undercutting of the landslide material by the brook along its new channel all contribute to the site remaining hazardous and impacting water quality nearly 5 months later.

Saturation of unconsolidated material above the impermeable clay-silt layer (s), dipping slide surface, type of material (sand over clay), height (109 m), load balance, gravity, and steepness of slope are all likely factors influencing the mass failure; the causes are under investigation.

Although changes in frequency of landslides can be an indicator of climate change, we do not have many accurate historical records for landslides in Vermont. However, the Vermont Geological Survey's landslide inventory contains nearly 2000 points and will serve as a baseline going forward.

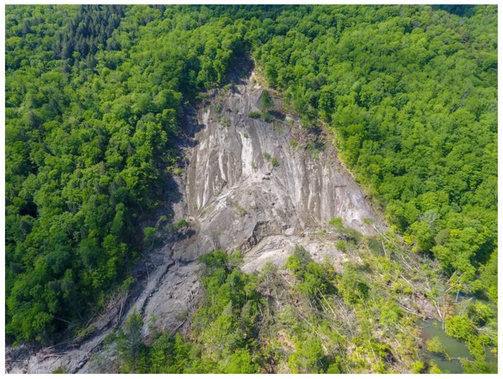
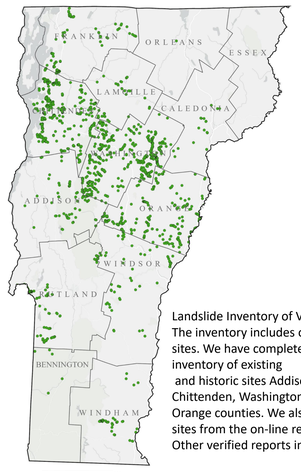


Fig 1. June 12, 2019: Drone flight by VTRANS showed 12 acres active plus 2.2 acres detached along the margins. ~100,000 cubic meters of material is in the toe deposit.

Fig. 2. June 12, 2019: Ground cracks and scarps due to rotational failure along landslide margins. Foster's Trail ended abruptly.

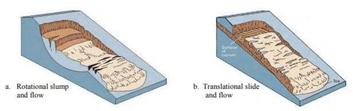
Fig 3. June 12, 2019: Downstream, a new delta formed in the Waterbury reservoir. The delta was ~2.8 acres.



Landslide Inventory of Vermont, 2019
The inventory includes over 2100 sites. We have completed the inventory of existing and historic sites Addison, Chittenden, Washington and Orange counties. We also capture sites from the on-line reporter and Other verified reports in Vermont.

Landslide Inventory Attributes

ACTIVITY Text	AREA ESTIMATE Text	ASPECT Number	BANK POSITION Text	BEDROCK CONTROL Text	BEDROCK ON SLOPE Text
CAUSE 1 Text	CAUSE 2 Text	COMMENTS Text	Create_Date Date or Time	Creator Text	CROWN ELEVATION Number	DEPTH (METERS) Number
Edit_Date Date or Time	Editor Text	FAIL DATE Date or Time	FAIL STYLE Text	FIELD VISIT Text	HEADCUTS Text	HEIGHT (METERS) Number
LANDSLIDE TYPE 1 Text	LANDSLIDE TYPE 2 Text	LENGTH (METERS) Number	MATERIAL Text	OBSERVER Text	ORGANIZATION Text
OUTSIDE MEANDER Text	PIPING Text	REMEDIATED Text	SEEPS Text	SLIDE ANGLE Number	SLOPE ANGLE Number	SOURCE Text
SOURCE PUB DATE Number	SPRINGS Text	SURF OBSERVATION Text	TALUS Text	TOE CONDITION Text	TOWN Text	VISIT DATE Date or Time



- Two Common Types of Landslides in Vermont. a) rotational slump and flow, b) translational slide and flow. From Highland and Bobrowsky (2008).

Fosters Trail Landslide

Due to an active landslide occurring on the Fosters Trail the following sections of trail will be closed until further notice:

- **Fosters Trail**
- **Cotton Brook Road from the hay shed to Kelty Corners (see map). Trail use can occur between the Cotton Brook Road gate and the hay shed.**

The landslide is still active.

FOR YOUR SAFETY DO NOT ENTER THE CLOSED AREAS

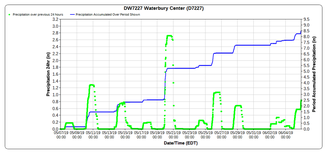
View looking upslope from Cotton Brook

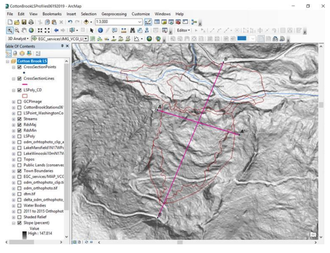
Above. The Dept. of Forests, Parks and Recreation posted signage which informs the public about the danger of the active site.
Below: Location and cumulative precipitation.

Fig. 4. October 8, 2019: View of the impoundment and the toe deposit. The pond extended upstream and encompassed approximately 1.8 acres.

Fig. 5. June 4, 2019: Grooved, striated slip surface beneath sands, silt and Debris near the base of the slope. No bedrock was exposed.

Fig. 6. June 4, 2019: Mudflows, saturated sand, boulders and trees indicated the site was still active. Water feeding the mudflows was from seeps partway down the slope, likely at a sand-silt interface or due to elevated water table.





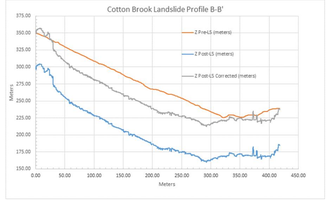


Fig. 7. Cumulative rainfall and before and after profiles of Cotton Brook landslide:
Orange line = before (from lidar)
Grey line = after (from UAS flight)

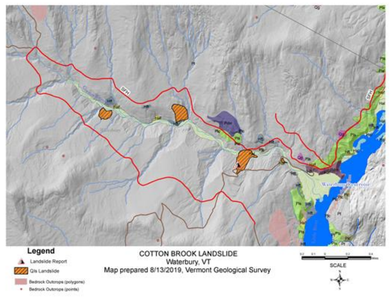


Fig. 9. Geologic map of the Cotton Brook area by Stephen Wright (2019) shows several landslides, lake deposits and till.

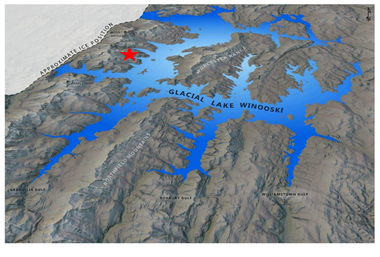


Fig. 10. Geographic extent of Glacial Lake Winooski. This was determined from mapping of landforms and identification of the sediment. The Cotton Brook landslide occurred in sand, silt and clay deposited in this lake ~14,000-13,800 years ago. ★ - Cotton Brook

Fig. 11. July 2-6, 2019: The game camera recorded a new failure and transport of a tree downslope. The brook was blocked numerous times during the past 6 months and subsequent erosion transported sediment downstream towards the reservoir and Little River. This process will likely repeat itself.

Fig. 12. By Nov. 4, till at the base of the slope was exposed beneath a dipping clay bed. We expect the site to remain dangerous due to failure of detached blocks along the sides and top of the site, trees and boulders transported on the surface, sediment and debris in the brook, saturated sand (similar to quicksand) and potential for another translational slide.

Fig. 13. Following the storm on Oct 31, significant erosion of the toe deposit resulted in an ~ 11 foot drop in water level in the pond. Below, a game camera sequence from August 4- Nov 3 shows erosion of toe deposit, likely coincident with release of water from the pond. Downstream also had significant debris, sand and cobbles which resulted in brook moving to the north.