LANDSLIDES AND FLASH FLOODS IN THE GREAT BROOK WATERSHED, PLAINFIELD, VERMONT

A presentation by George Springston, Norwich University, 2016

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Vermont Geological Survey

Department of Environmental Conservation

1 National Life Dr.

Montpelier, VT 05602

Landslides and Flash Floods in the Great Brook Watershed, Plainfield, Vermont

Flash Flood Damage in Plainfield, May 2011

Freshly Eroded Landslide, Upper Great Brook, Plainfield, September, 2011

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Department Presentation, February 19, 2016

Outline

Introduction
Landslides, gullies, and mapping of the Landslide Hazard Zone
Tour of watershed from headwaters to Plainfield Village
Rainfall and stream runoff studies in the watershed
Summary

Right: Landslide at Site GB-3, Great Brook, Plainfield. 4/26/2012. George Springston.

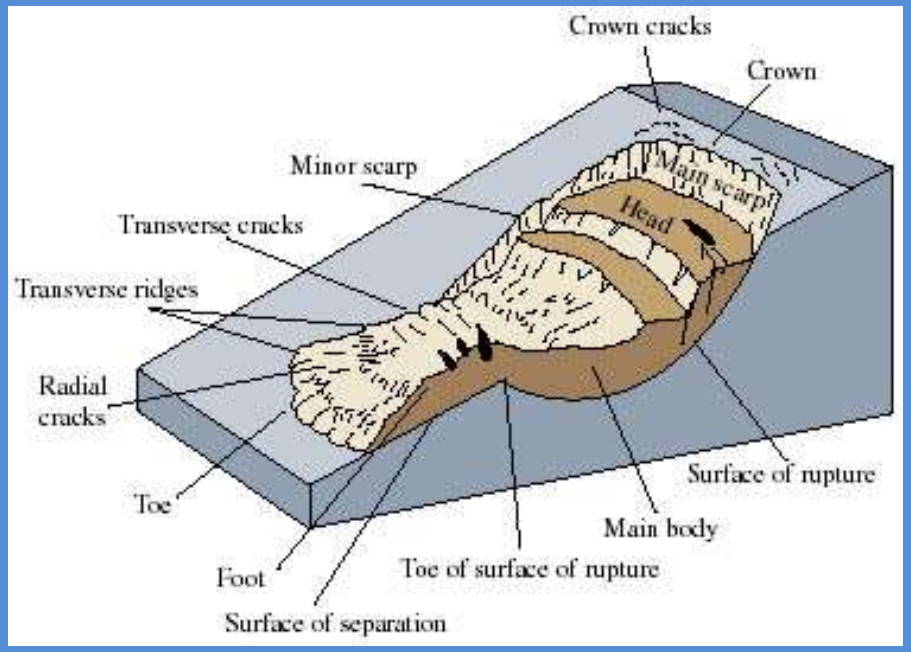


Figure from USGS Fact Sheet 2004-3072 http://pubs.usgs.gov/fs/2004/3072/fs-2004-3072.html

Landslide on Winooski River, Cate Farm, Plainfield, 2009

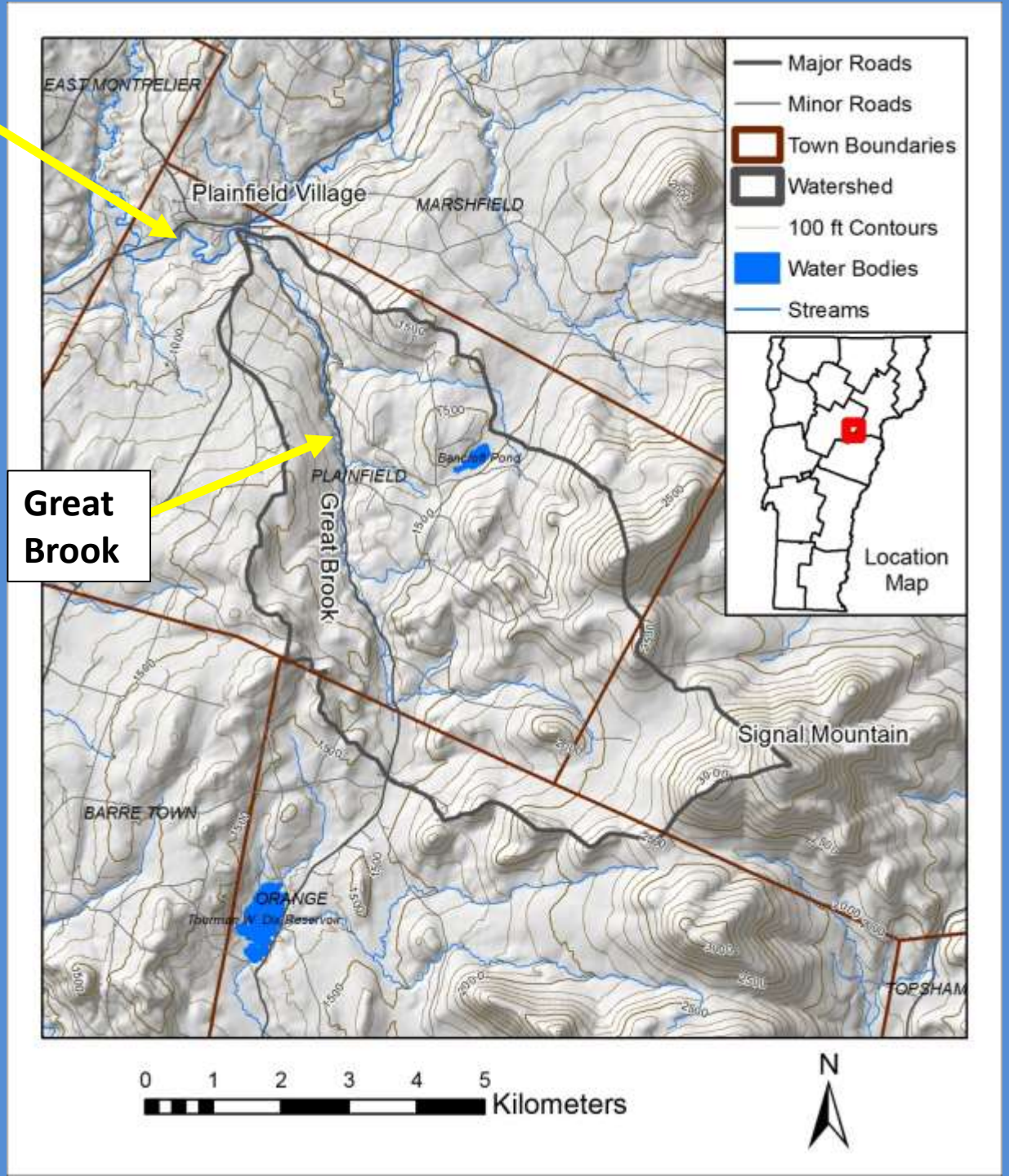
- "The downslope movement of soil, rock and organic materials under the influence of gravity and also the landform that results from such a movement" (The Landslide Handbook, USGS Circular 1325, p. 4).
- Landslides are sometimes called "Mass Failures"

Some Causes of Landslides in Vermont

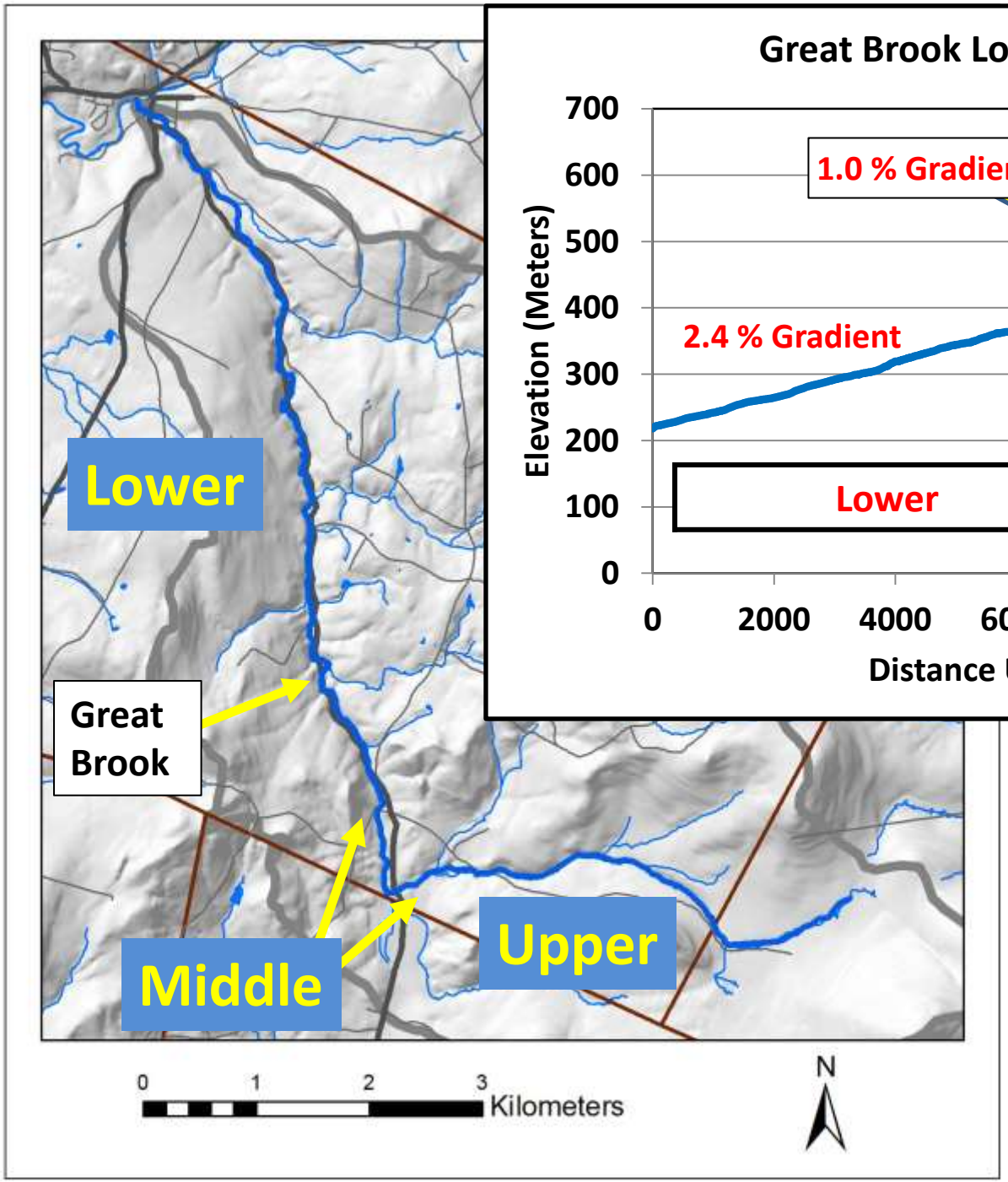
- **Stream erosion resulting in over-steepening of the base of a slope.**
- **Heavy rainfall or snowmelt causing saturation of soil and increase in pore pressure.**
- **Adding excess load onto slopes, such as by dumping of fill onto a slope.**
- **Excavation of base of slope, resulting in over-steepening.**
- **Reduction in strength of materials due to physical and chemical weathering of soil.**

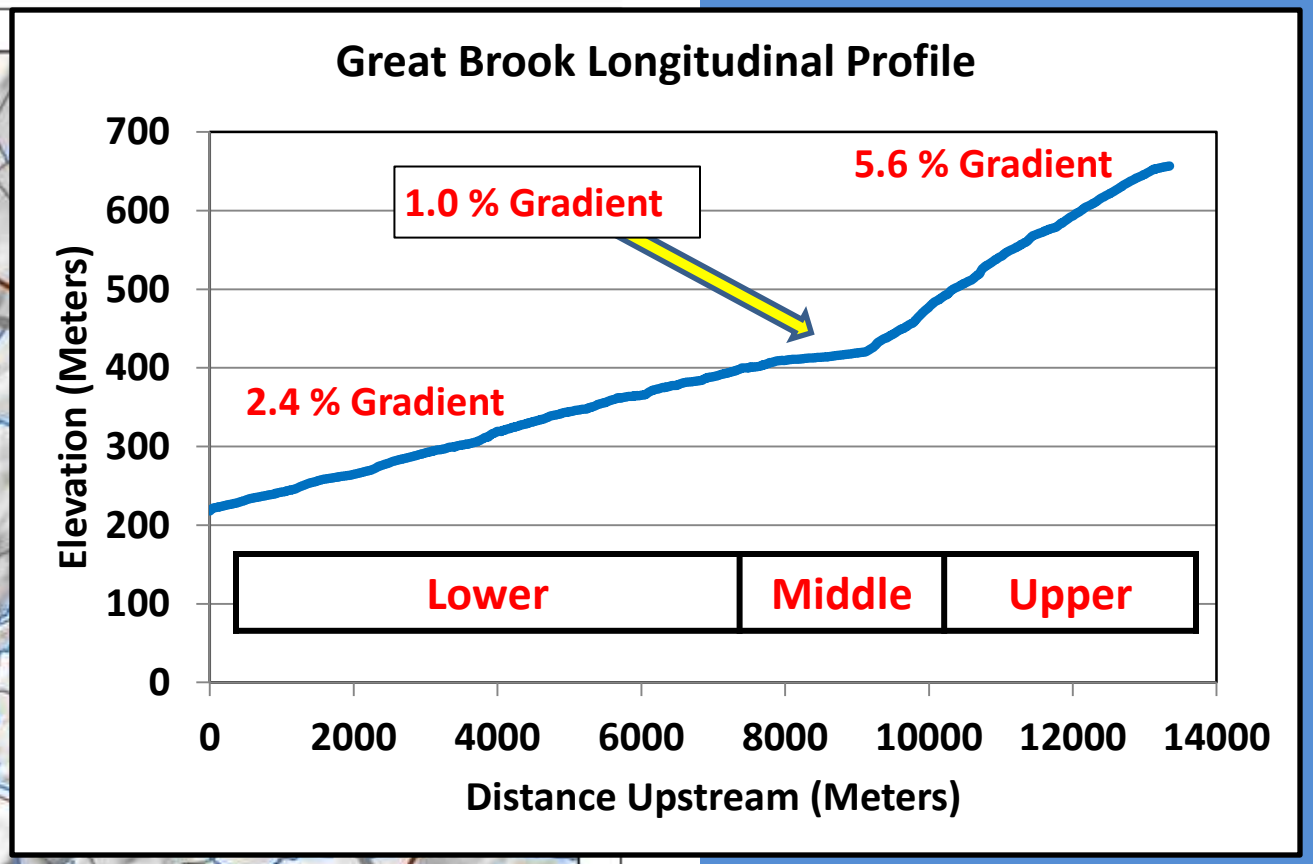
Winooski River

Great Brook watershed in Plainfield, Groton, and Orange, central Vermont.

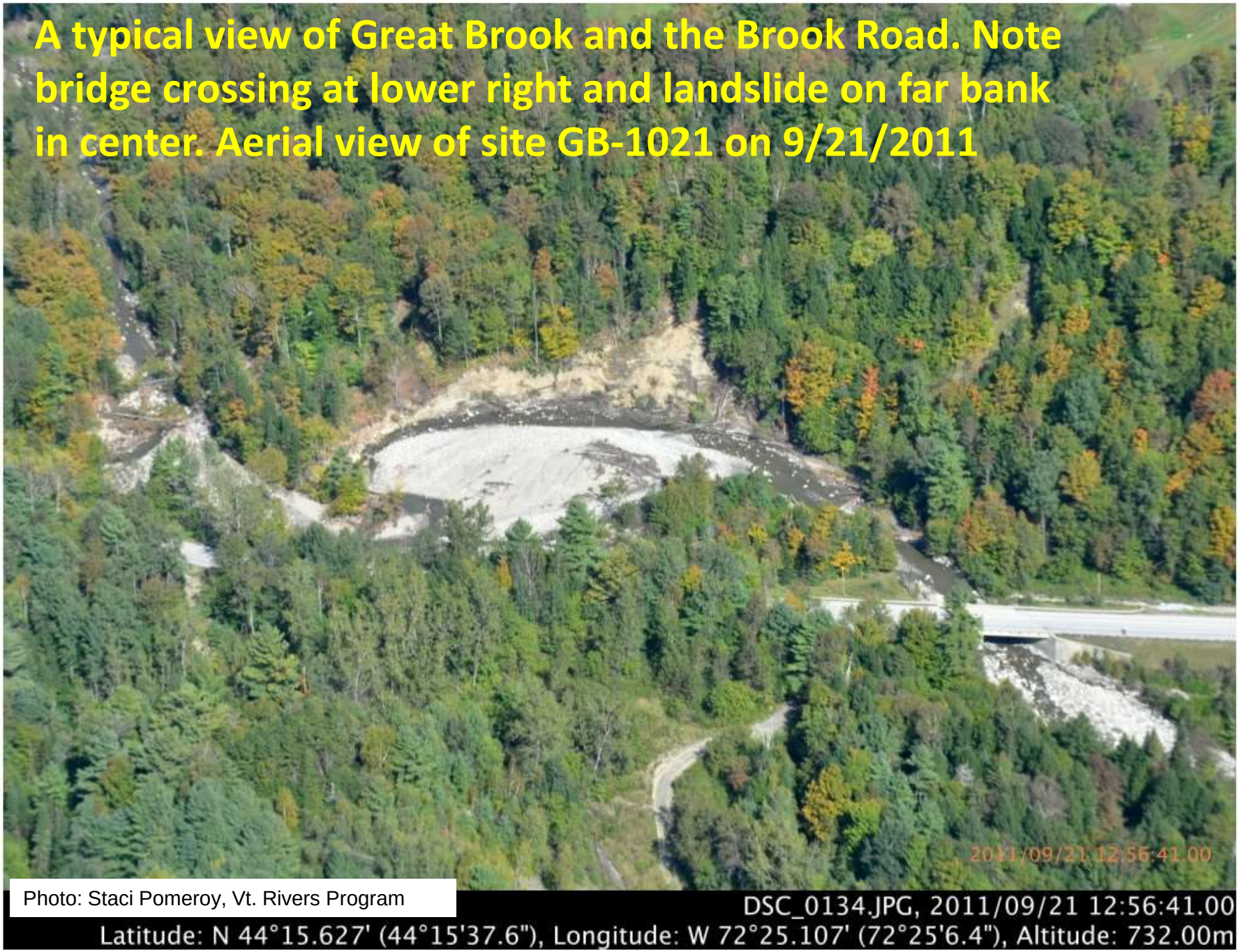


Drainage Area = 14.5 sq. miles. Channel length 8 miles. Elevations range from 3352 feet on Signal Mountain down to 712 feet at the Winooski River.





The longitudinal profile can be divided into three segments: Upper, Middle, and Lower.

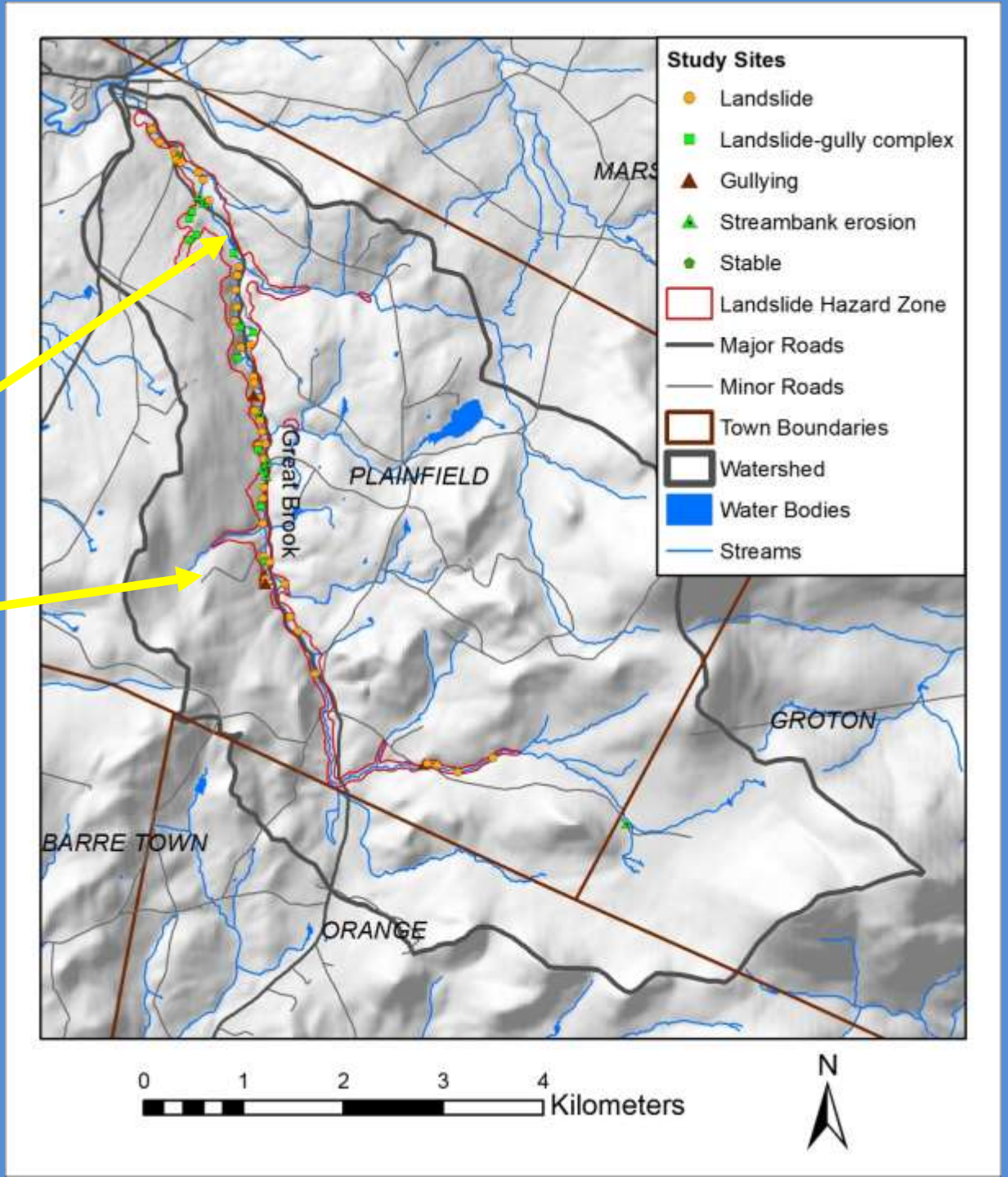

A typical view of Great Brook and the Brook Road. Note bridge crossing at lower right and landslide on far bank in center. Aerial view of site GB-1021 on 9/21/2011
2011/09/21 12:56:41.00
Photo: Staci Pomeroy, Vt. Rivers Program
DSC_0134.JPG, 2011/09/21 12:56:41.00
Latitude: N 44°15.627' (44°15'37.6"), Longitude: W 72°25.107' (72°25'6.4"), Altitude: 732.00m

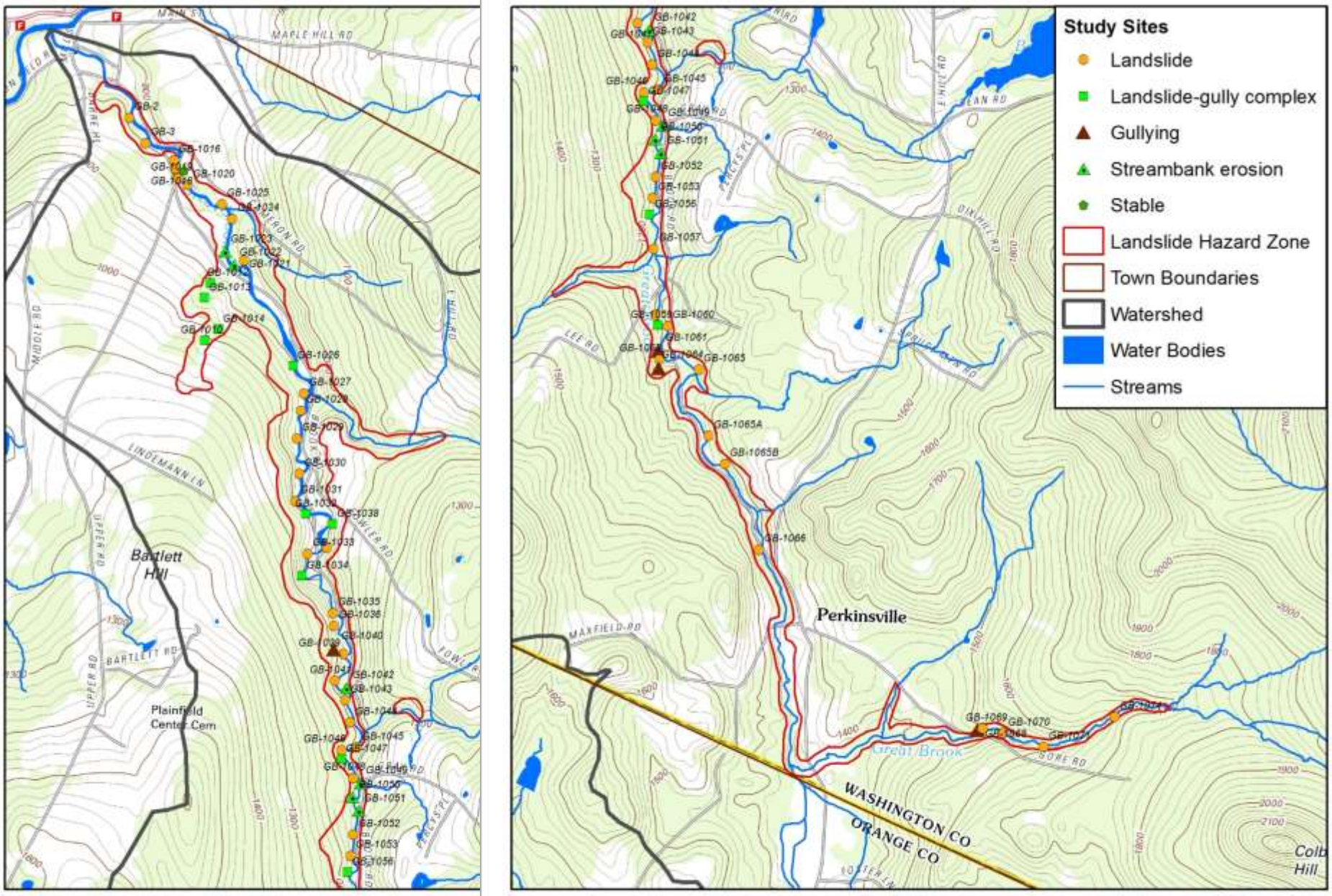
General map of landslides, gullies, and Landslide Hazard Zone.

Brook Road

Lee Road

Study identified 47 active landslides, 3 inactive ones, 7 streambank erosion sites, and 15 sites with gullying.

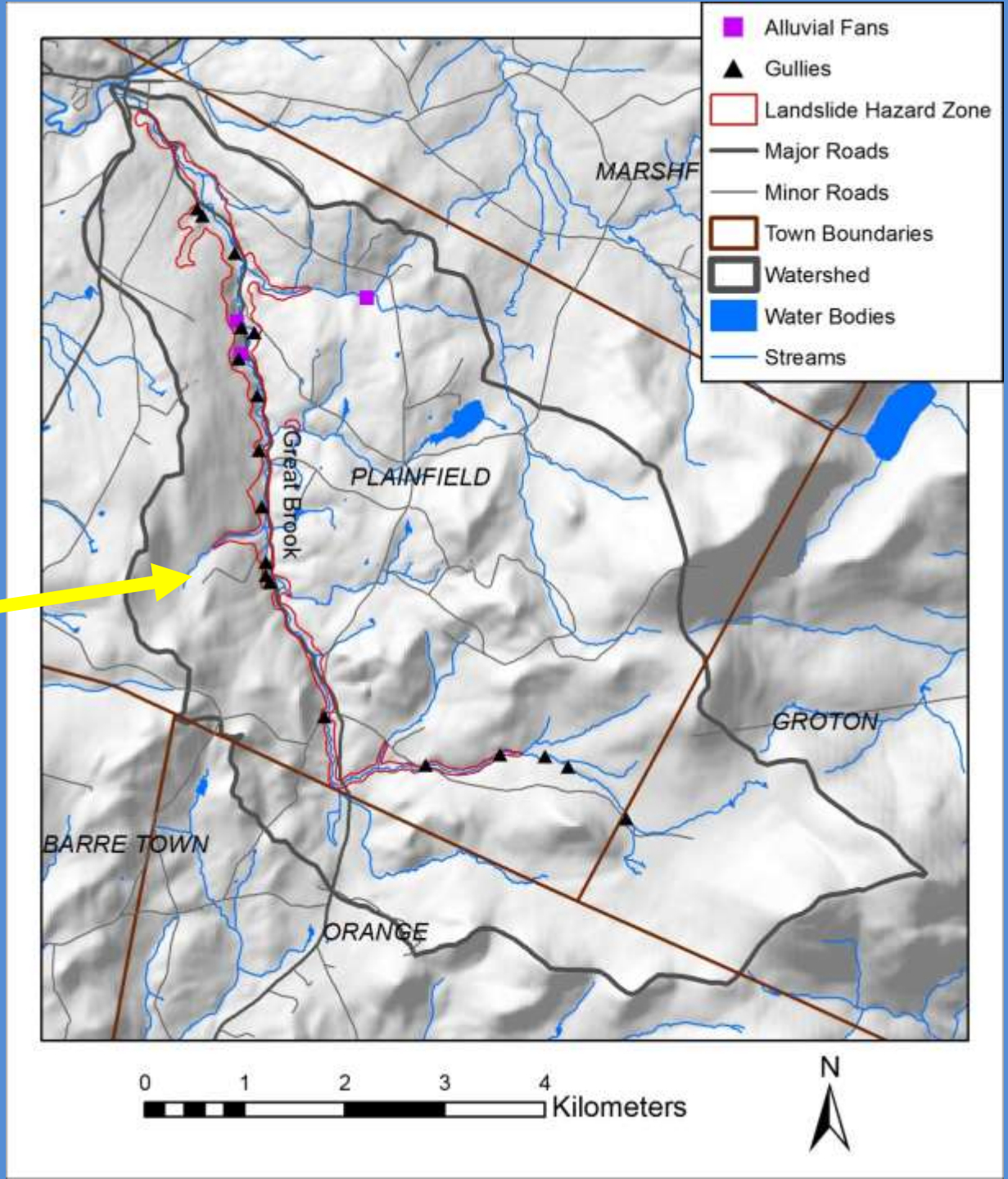




Landslide Hazard Zone outlined in red: Left, northern; right, southern reaches.

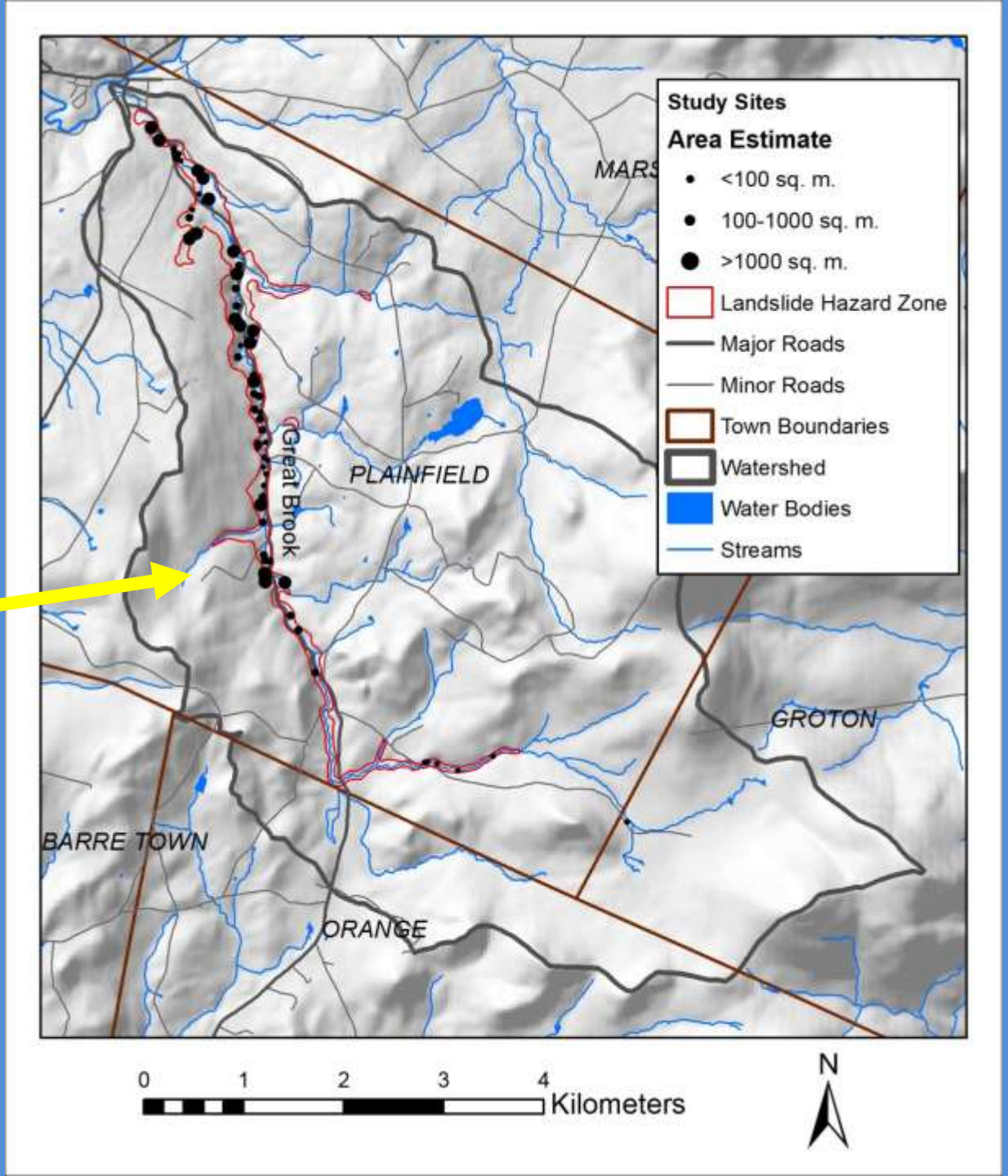
Alluvial fans and gullies.

Lee Road



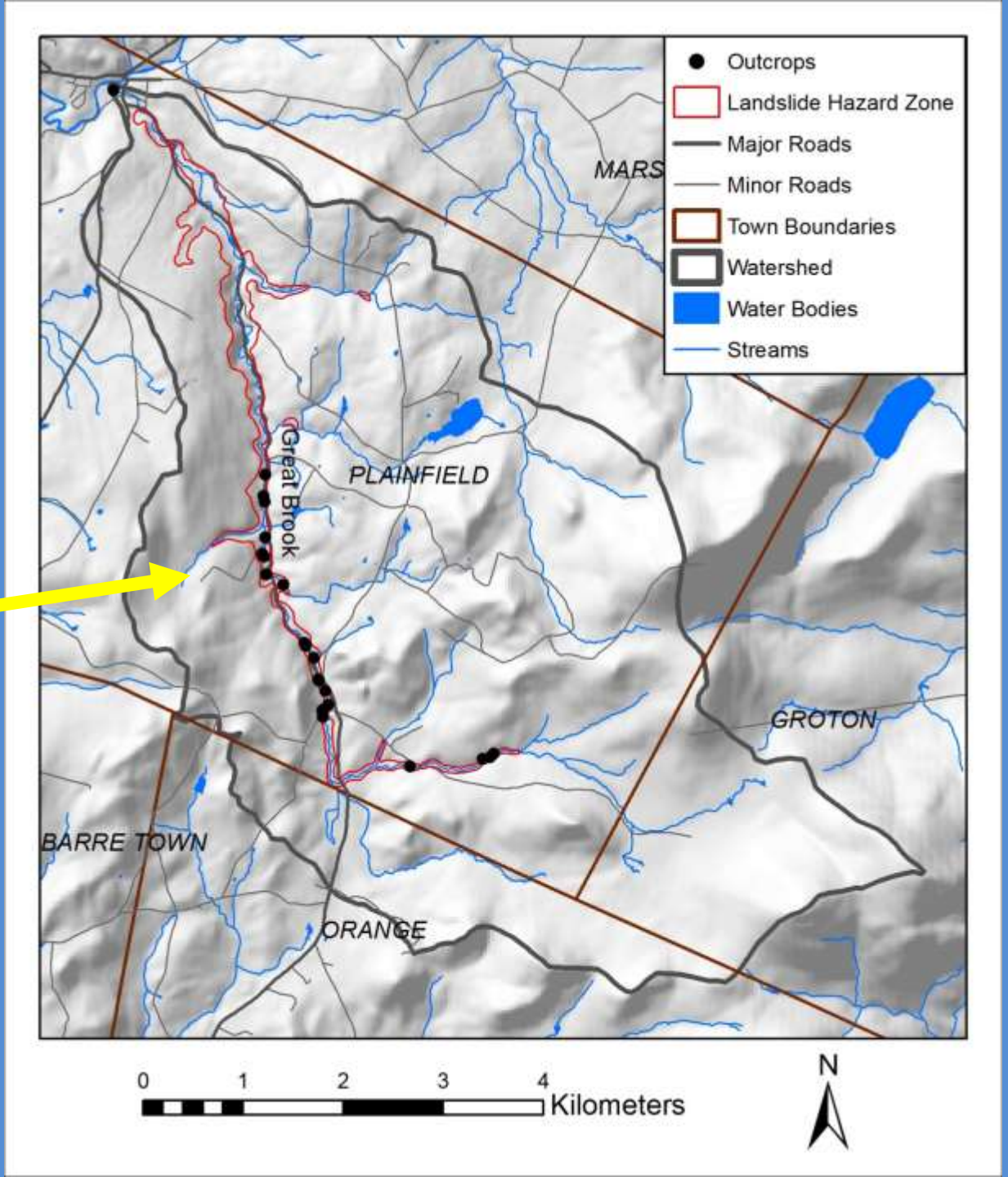
Size of Landslides. Note that most of the largest ones are in downstream reaches below Lee Road.

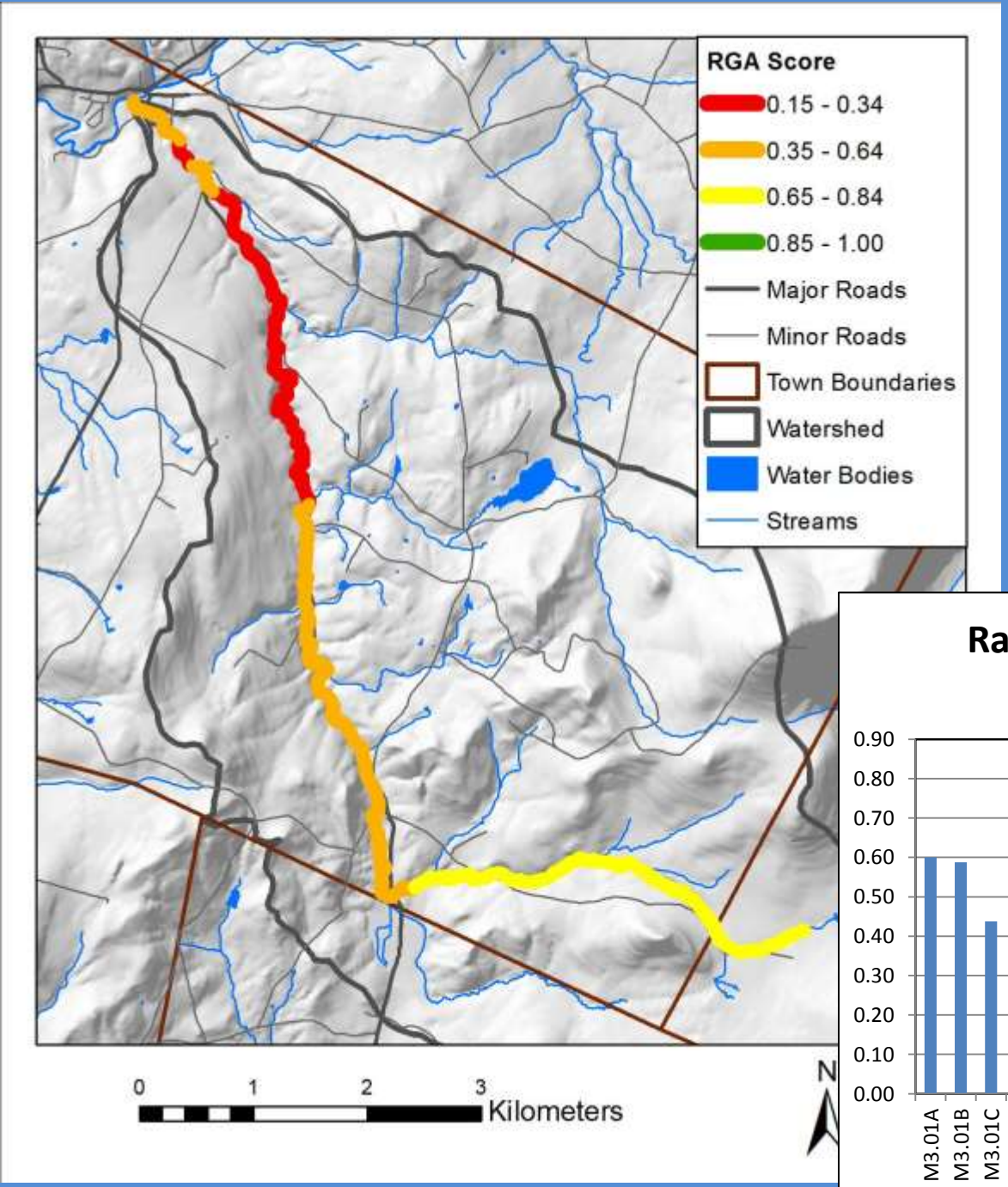
Lee Road



Bedrock outcrops in channel. Note that most are in the upstream reaches above Lee Road.

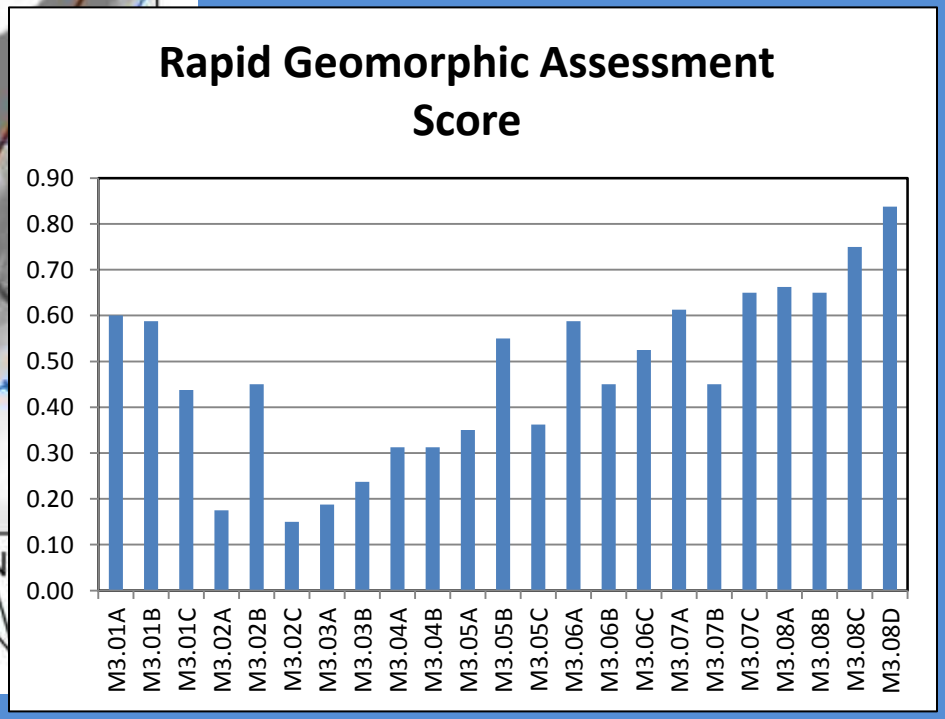
Lee Road





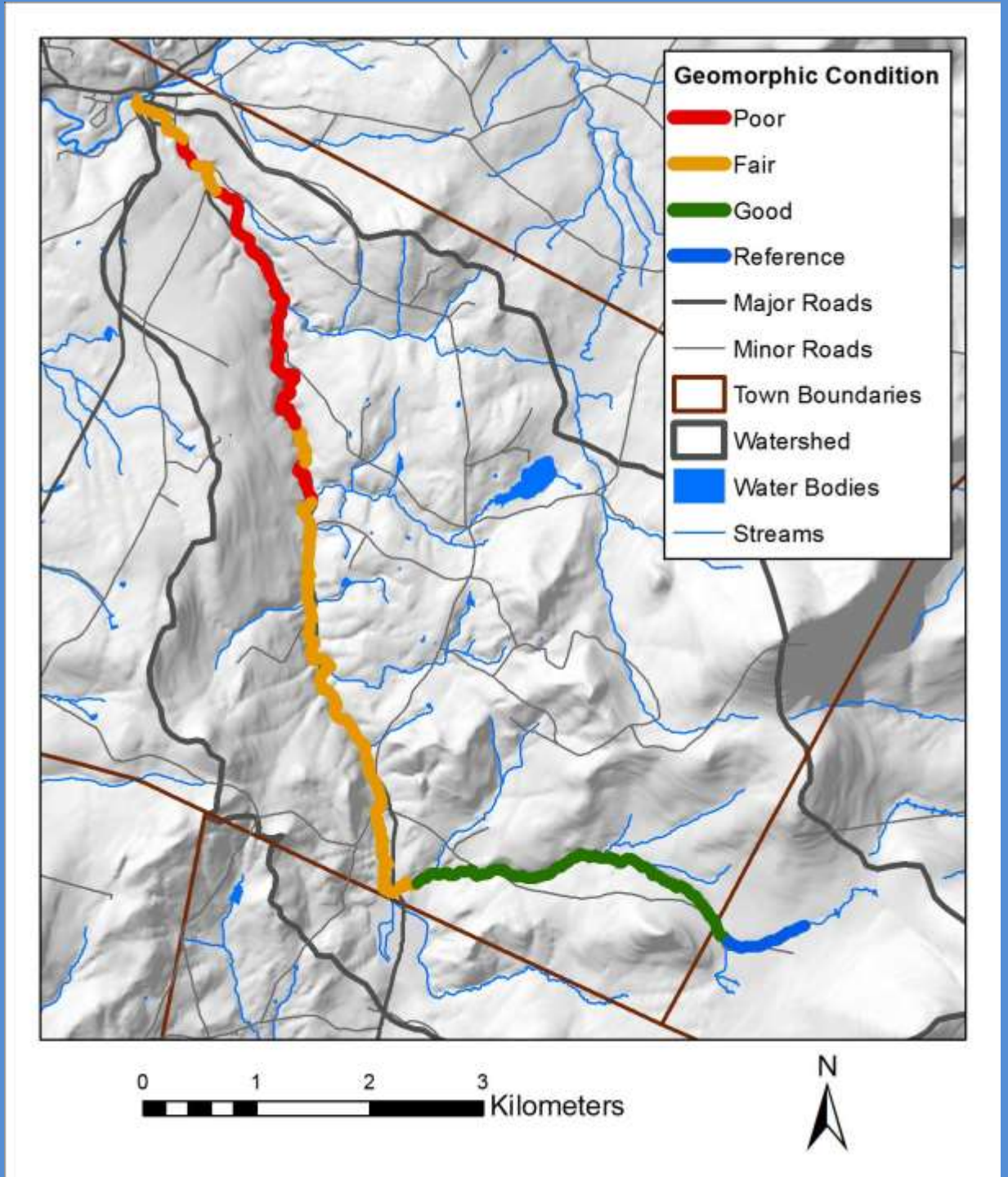
Rapid Geomorphic Assessment Results for Great Brook.

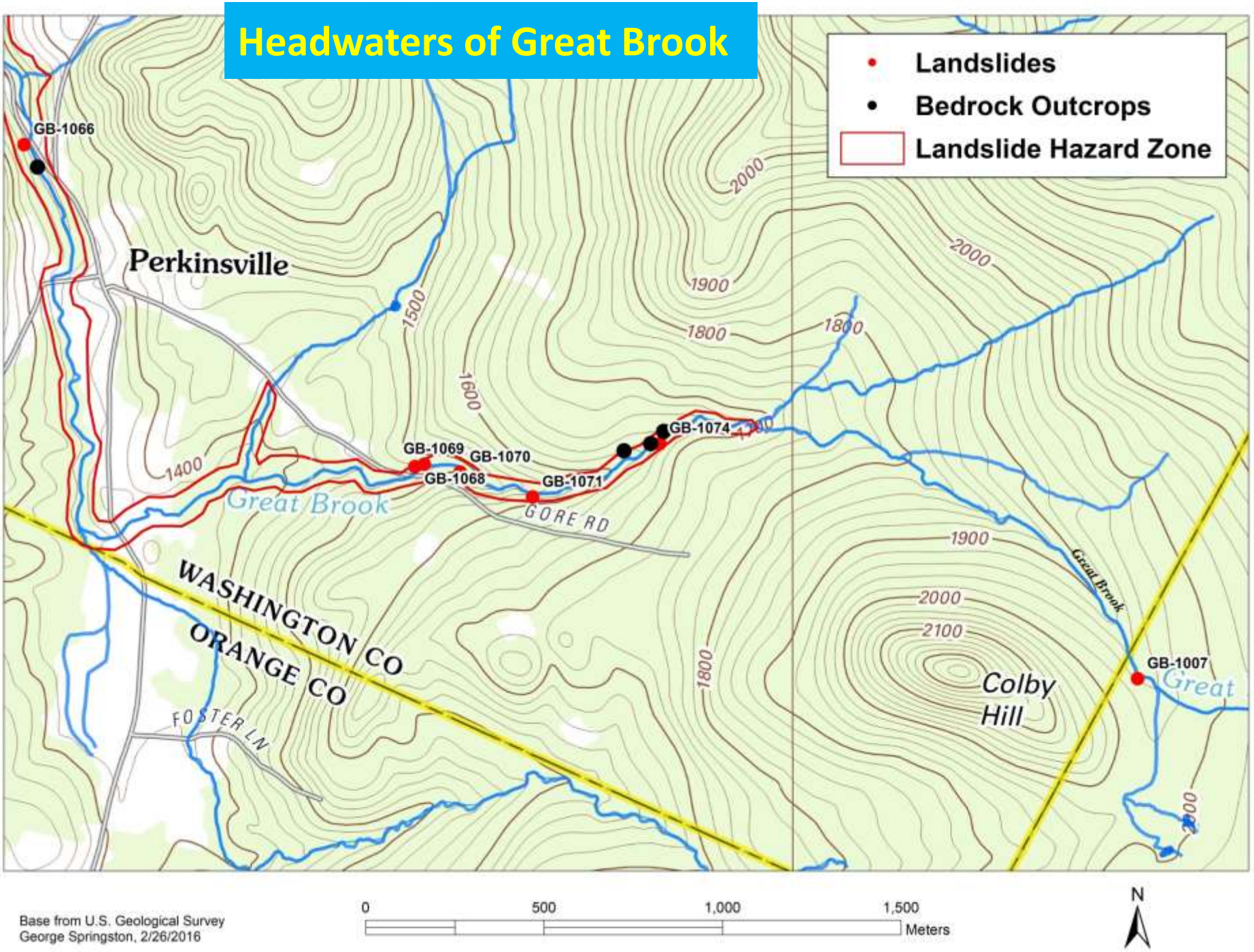
Data from Bear Creek Environmental (2013)



Overall Geomorphic Condition of Great Brook.

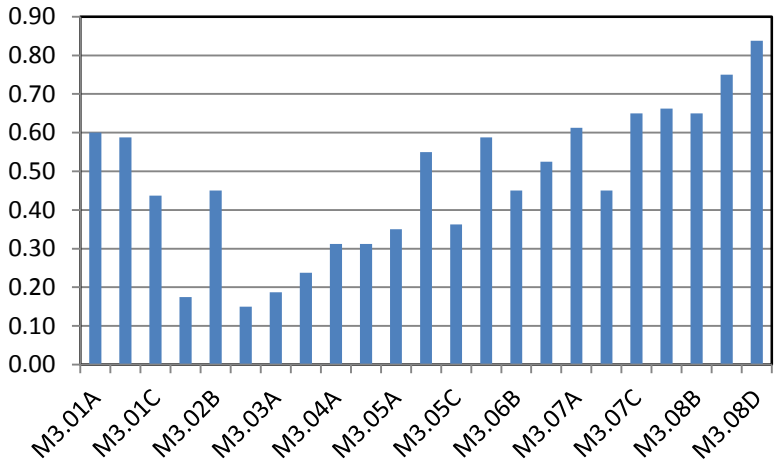
Data from Bear Creek Environmental (2013)



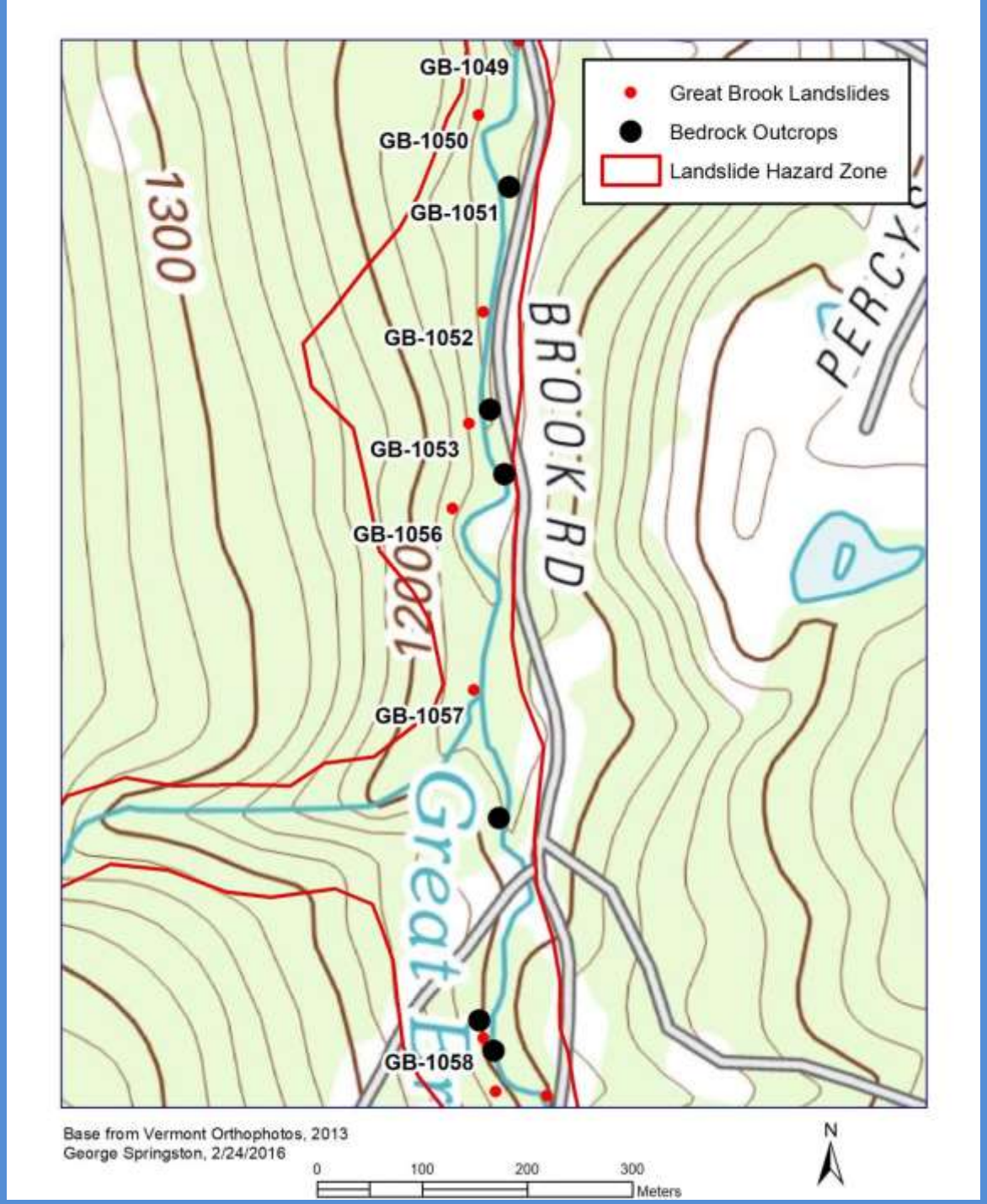

Headwaters of Great Brook
Landslides
Bedrock Outcrops
Landslide Hazard Zone
GB-1066
Perkinsville
GB-1069
GB-1070
GB-1068
GB-1071
GB-1074
GB-1007
Great Brook
GORE RD
WASHINGTON CO
ORANGE CO
FOSTER LN
Colby Hill
1400
1500
1600
1800
1900
2000
2100
Base from U.S. Geological Survey
George Springston, 2/26/2016
0
500
1,000
1,500
Meters
N

Headwaters of Great Brook

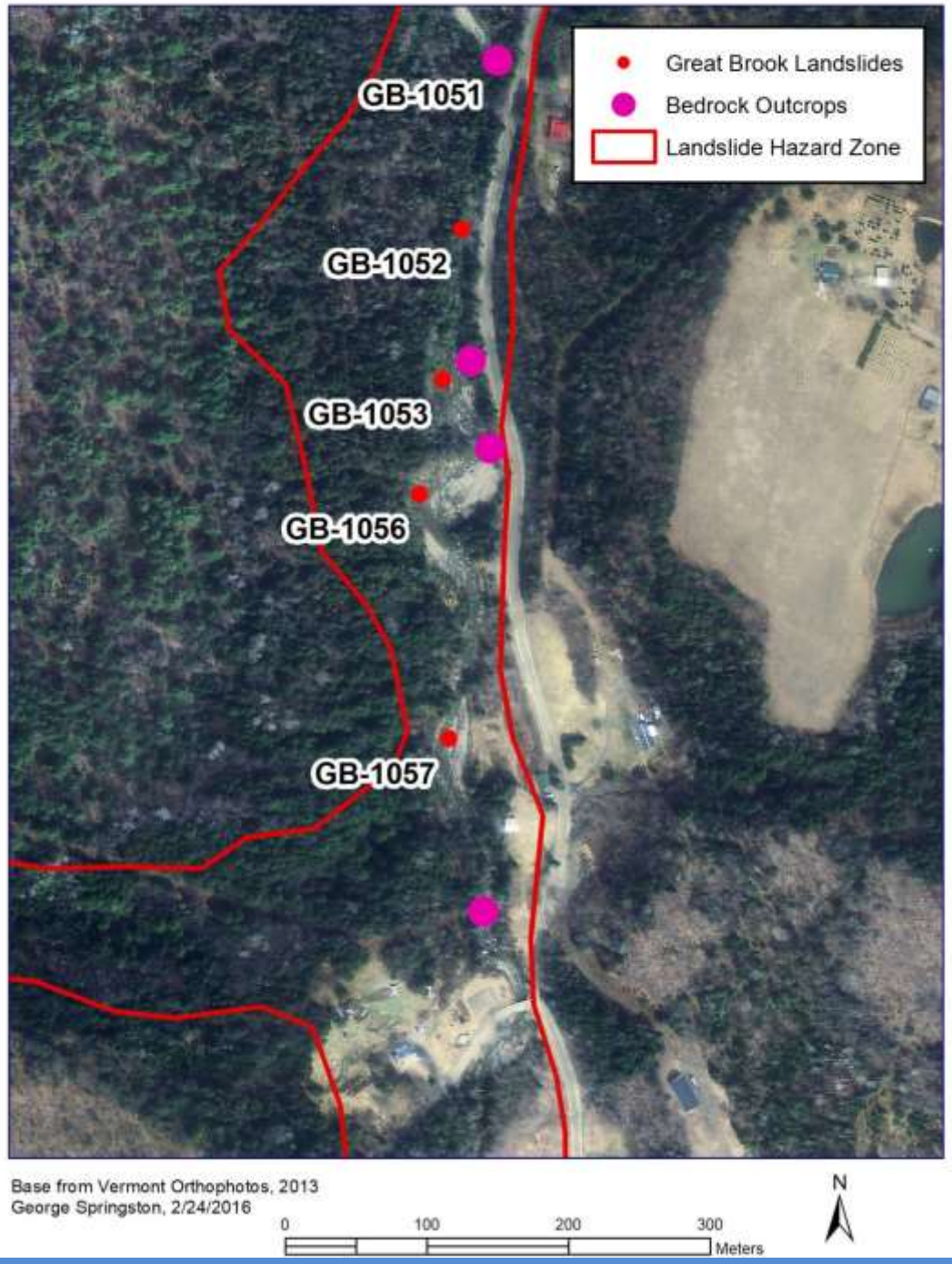
Rapid Geomorphic Assessment Score



Site GB-1053

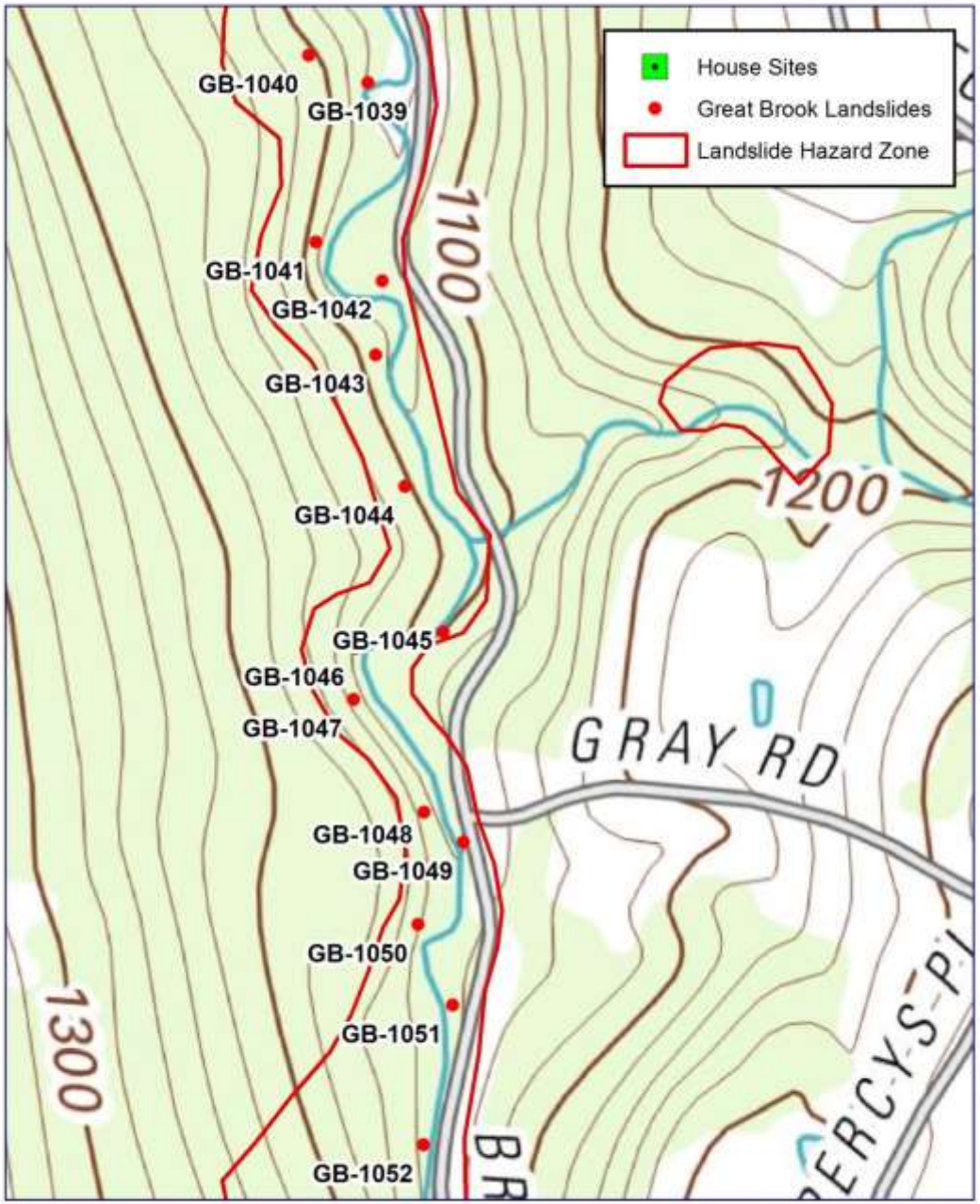

GB-1049
GB-1050
GB-1051
GB-1052
GB-1053
GB-1056
GB-1057
GB-1058
Great Brook Landslides
Bedrock Outcrops
Landslide Hazard Zone
1300
1200
BROOK RD
PERCY
Great Ex
Base from Vermont Orthophotos, 2013
George Springston, 2/24/2016
0
100
200
300
Meters
N

Site GB-1053


Great Brook Landslides
Bedrock Outcrops
Landslide Hazard Zone
GB-1051
GB-1052
GB-1053
GB-1056
GB-1057
Base from Vermont Orthophotos, 2013
George Springston, 2/24/2016
0
100
200
300
Meters
N

Site GB-1053, looking downstream. Note bedrock exposed on right bank at pack. Landslide on left bank. George Springston, 8/6/2013.

Sites GB-1050 and GB-1043



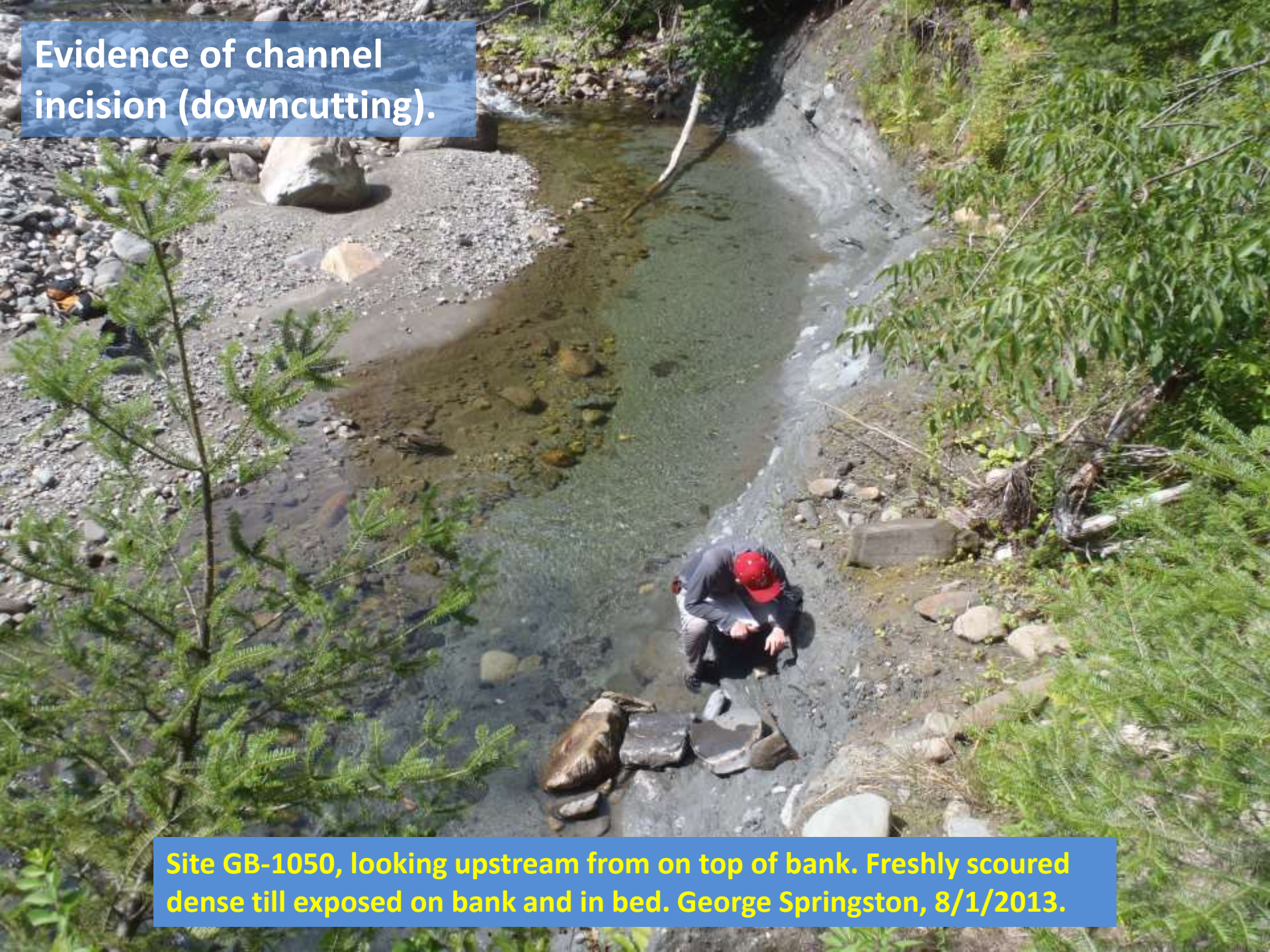
Sites GB-1050 and GB-1043

Site GB-1050, looking downstream. Freshly scoured dense till exposed on bank and in bed. George Springston, 8/1/2013.

Typical small landslide in till at Site GB-1043.

Left: Landslide in dense, massive, gray, silt-matrix till, nearly two years after Irene.

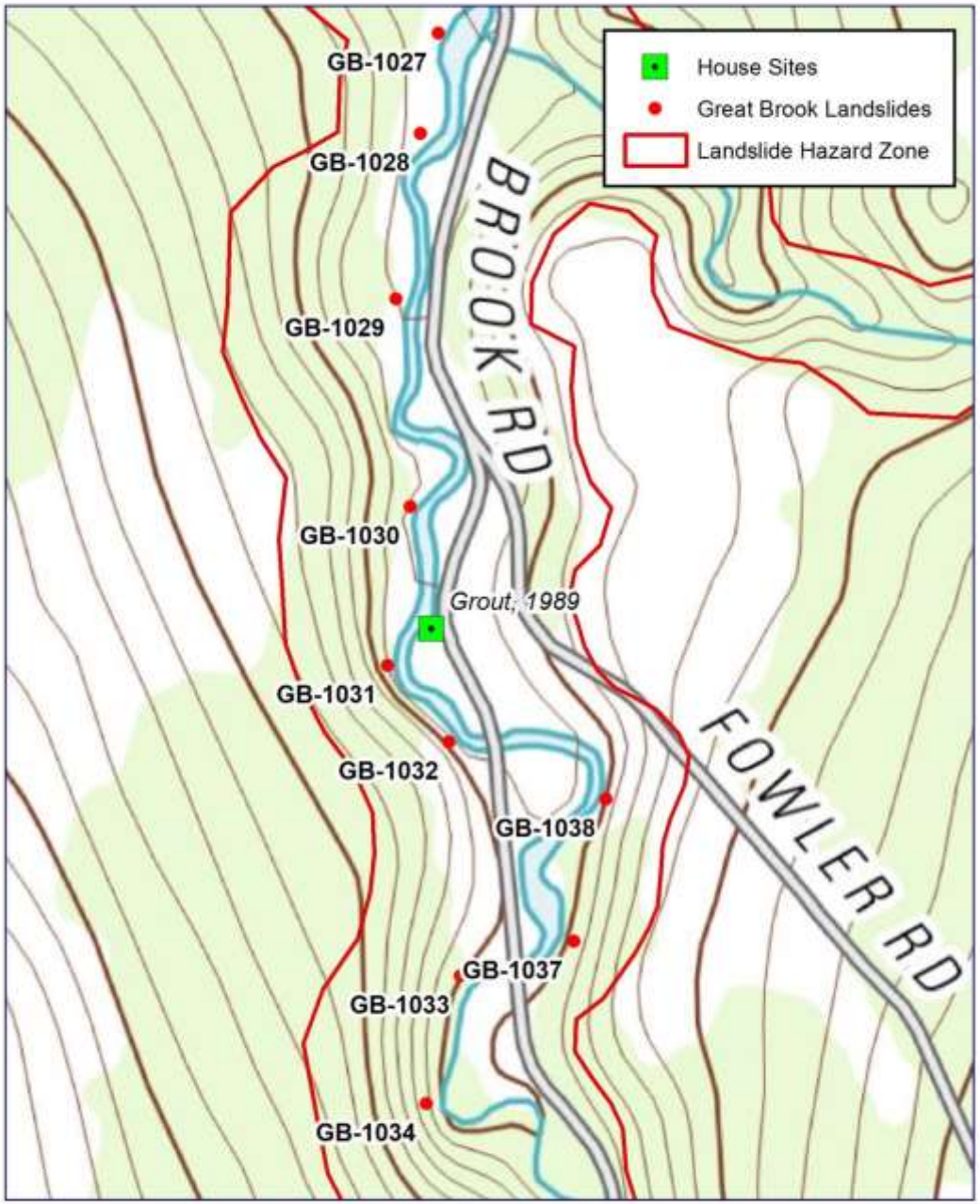
Right: Weathering of the till is leading to detachment of irregular blocks. George Springston, 8/1/2013.


Evidence of channel incision (downcutting).
Site GB-1050, looking upstream from on top of bank. Freshly scoured dense till exposed on bank and in bed. George Springston, 8/1/2013.

Sites GB-1036

Typical large landslide in till at Site GB-1036, 7/30/2013, Post-Irene. George Springston.

Site GB-1032


House Sites
Great Brook Landslides
Landslide Hazard Zone
GB-1027
GB-1028
GB-1029
GB-1030
GB-1031
GB-1032
GB-1038
GB-1037
GB-1033
GB-1034
BROOK RD
FOWLER RD
Grout, 1989
Base from Vermont Orthophotos, 2013
George Springston, 2/24/2016
0
100
200
300
Meters
N

Site GB-1032

House Sites
Great Brook Landslides
Landslide Hazard Zone
GB-1027
GB-1028
GB-1029
GB-1030
Grout, 1989
GB-1031
GB-1032
GB-1038
GB-1037
GB-1033
GB-1034
Base from Vermont Orthophotos, 2013
George Springston, 2/24/2016
0
100
200
300
Meters
N

Changes at Site GB-1032, Photo 1 of 4
Glacial till freshly exposed at Site GB-1032 in a landslide on Great Brook, two days after May flood. Note overhangs at base and fallen blocks of till. George Springston, 5/29/2011.

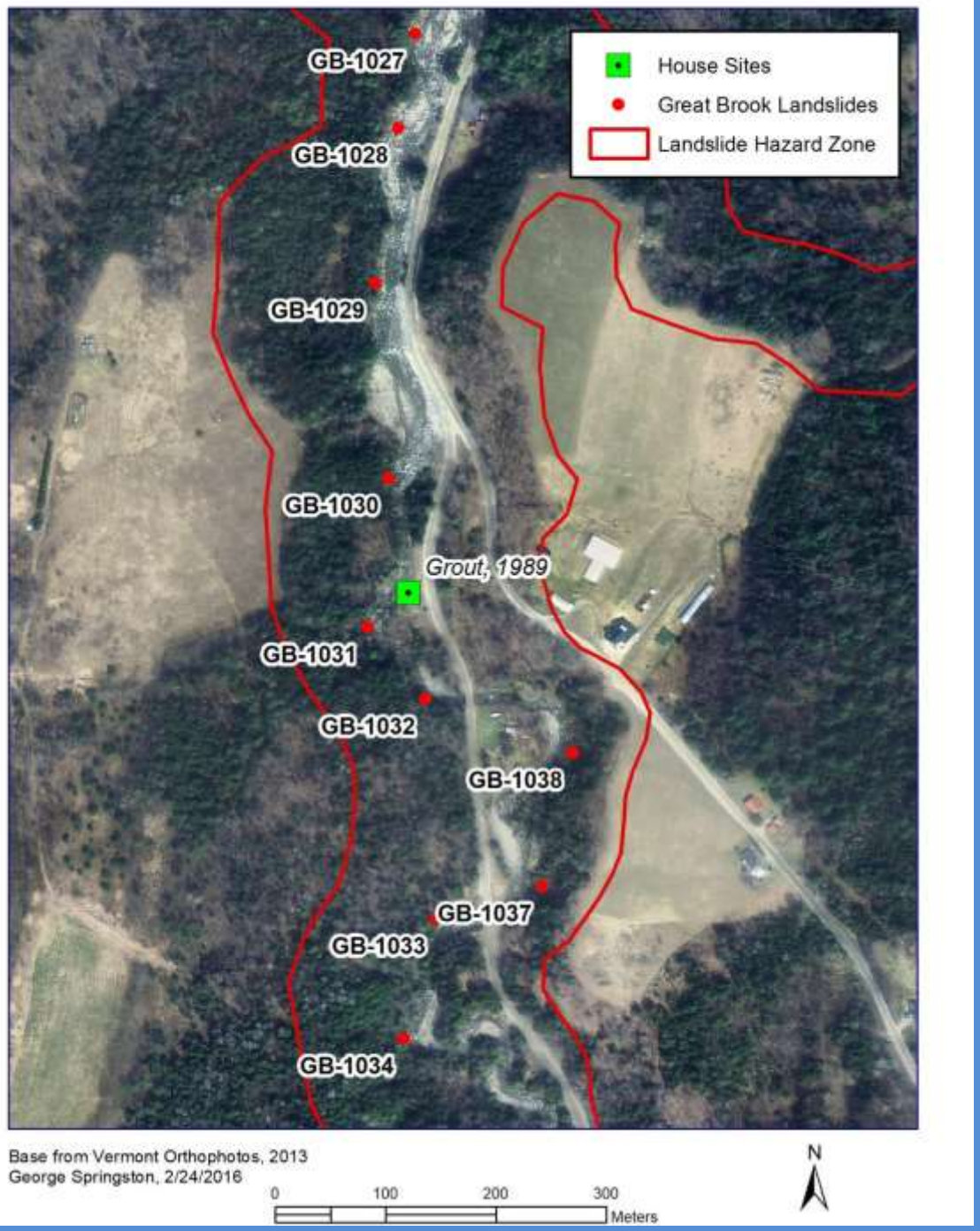
Changes at Site GB-1032, Photo 2 of 4
Site GB-1032, 9/14/2011, Immediately Post-Irene. George Springston.

Changes at Site GB-1032, Photo 3 of 4
Site GB-1032, 4/26/2012, Post-Irene. George Springston.

Changes at Site GB-1032, Photo 4 of 4

Site GB-1032, 10/18/2012, one year after Irene.
Photo courtesy of Bear Creek Environmental.

Site of the Grout House, destroyed in the 1989 Flood.



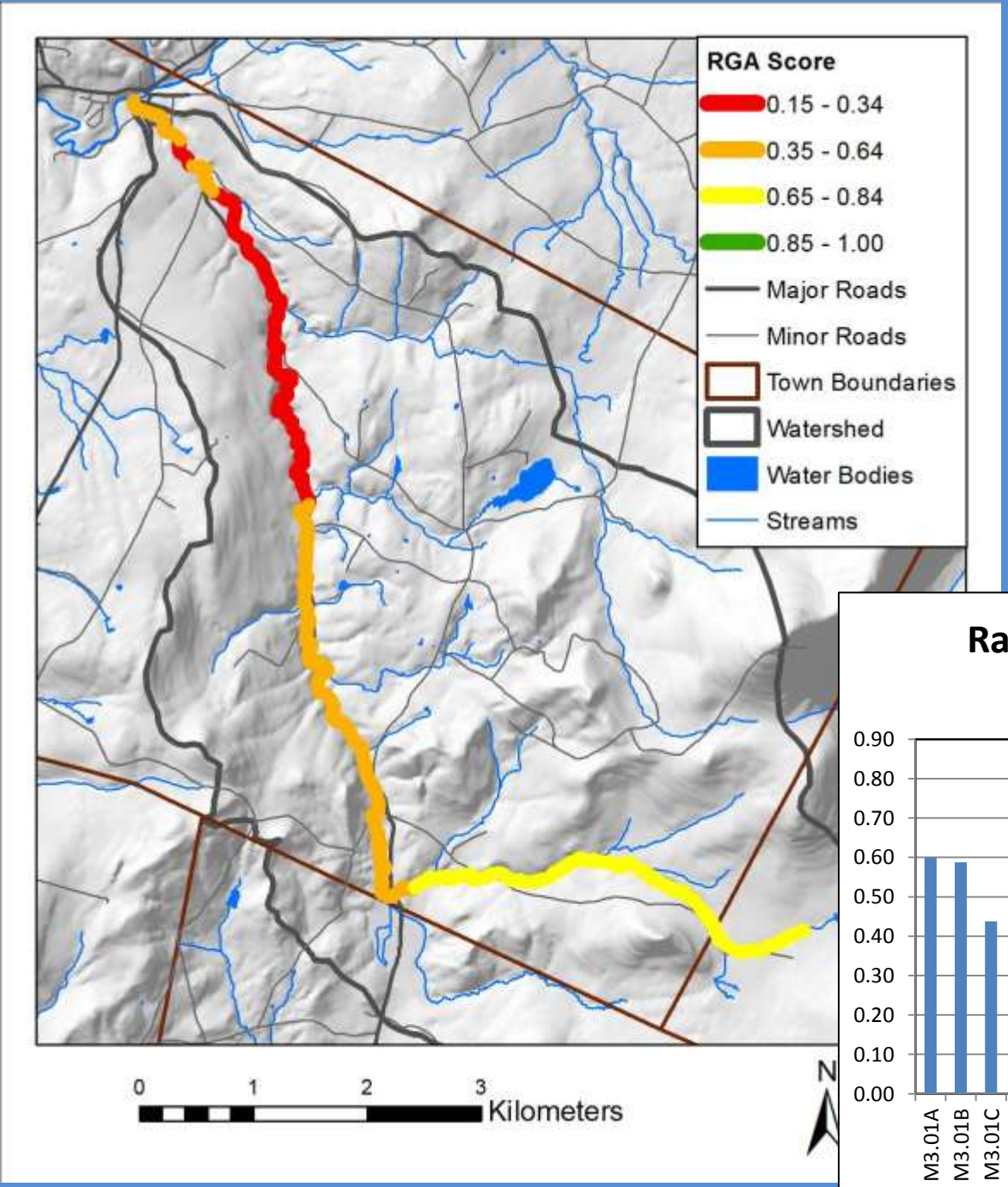
Grout House, 1989 Flood

Ed LeTourneau

Location of the Gauthier House, destroyed in the 1984 Flood

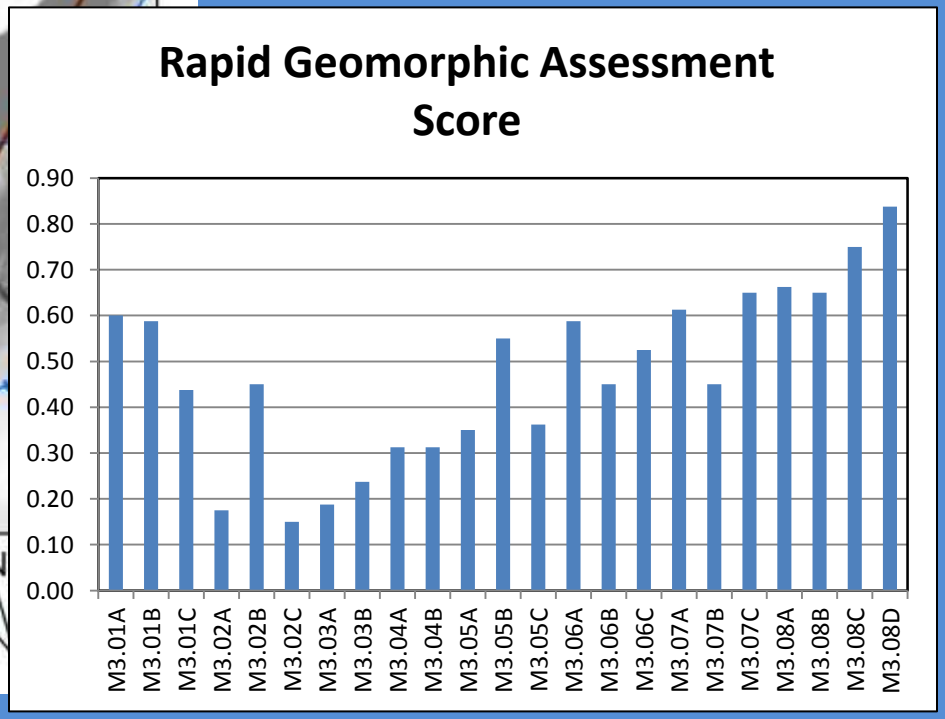
Site of the Gauthier House, destroyed in the 1984 Flood. All that was left was the well casing (center of photo).

Ed LeTourneau

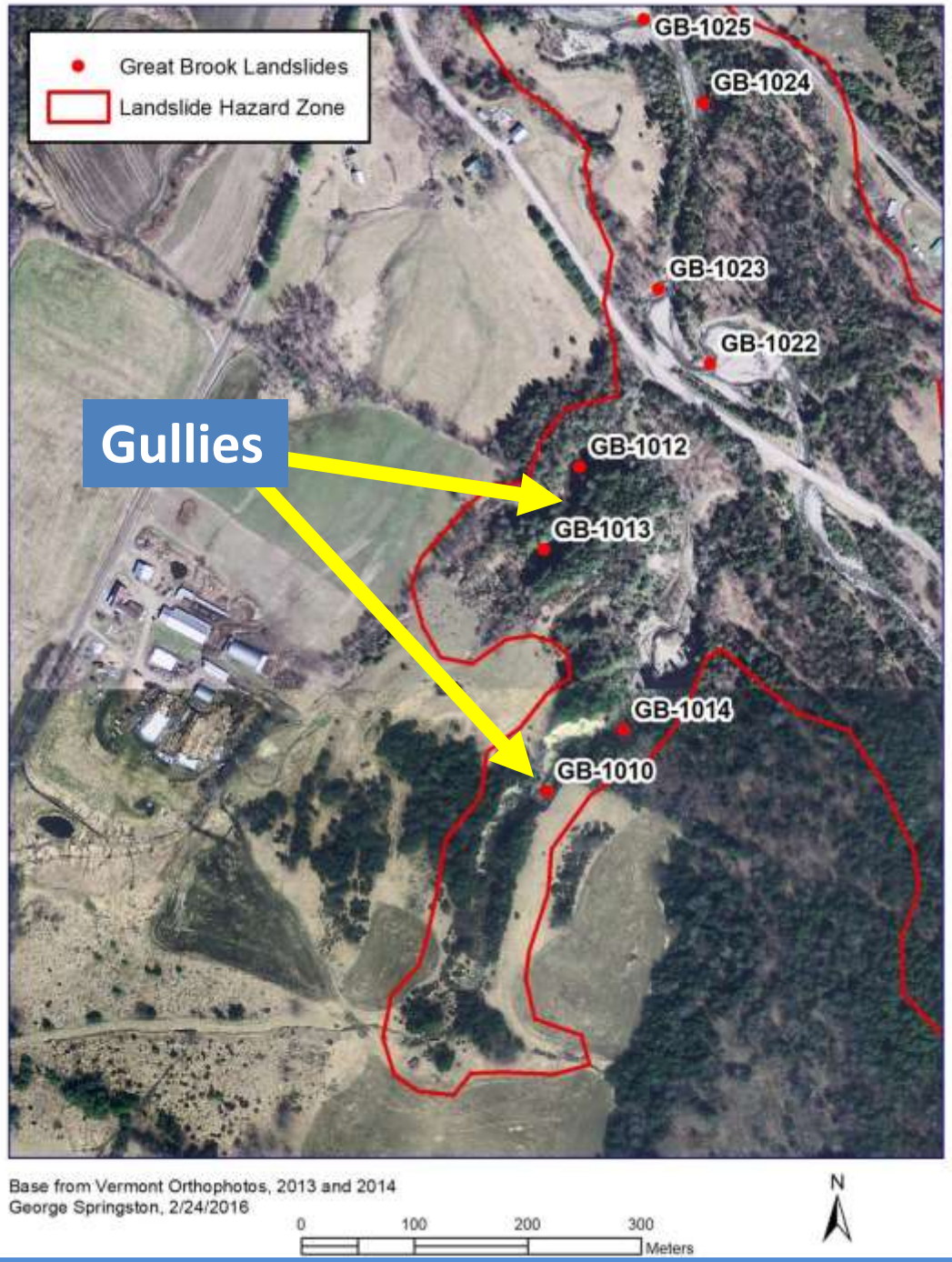


Rapid Geomorphic Assessment Results for Great Brook.

Data from Bear Creek Environmental (2013)



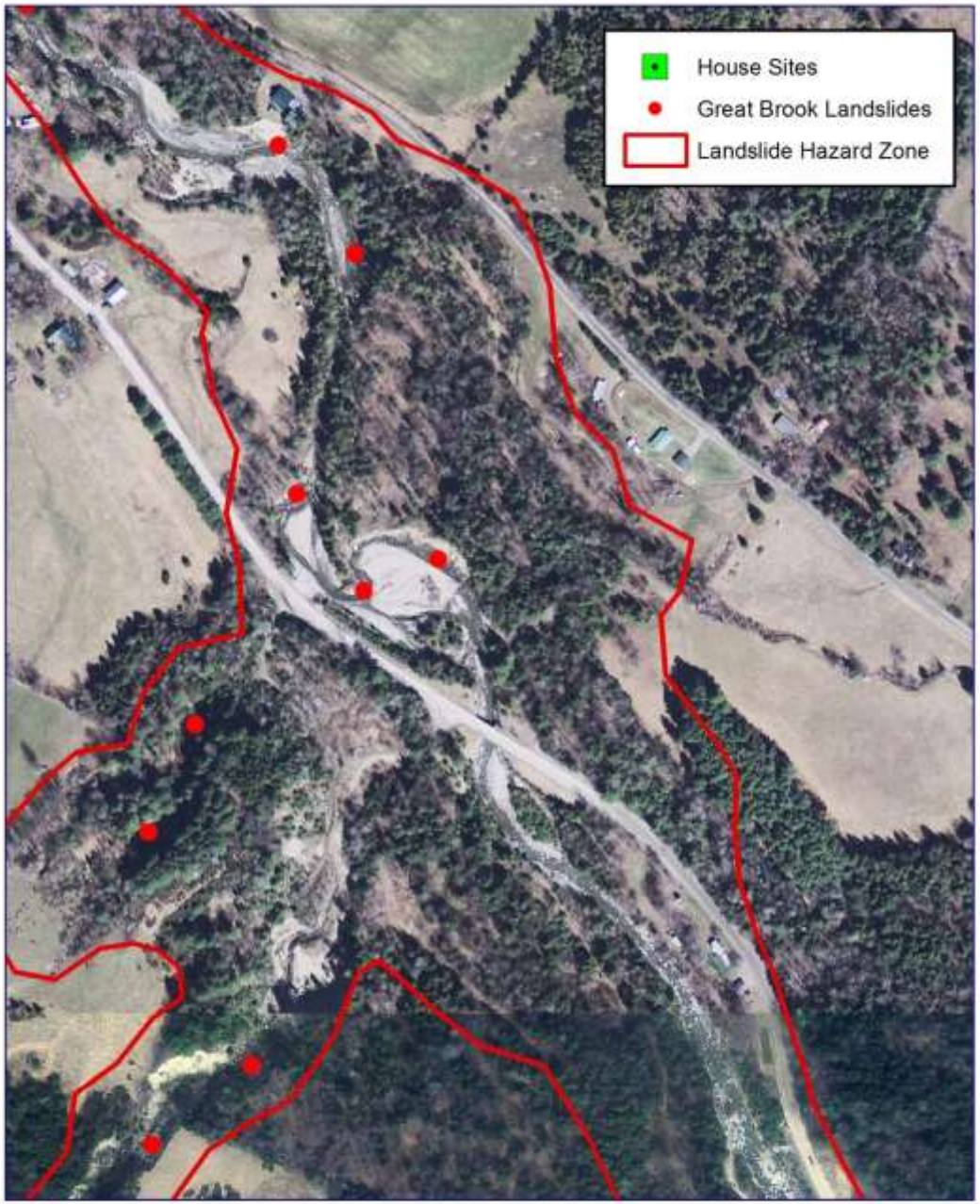
Large gullies in highly erodible sand and silt at the MacLaren Farm and Fowler sand pit.



Site GB-1010, looking down MacLaren-Fowler gully. Material is ice-contact fine to very fine sands and silt with gravel lenses. George Springston, 7/16/2013.

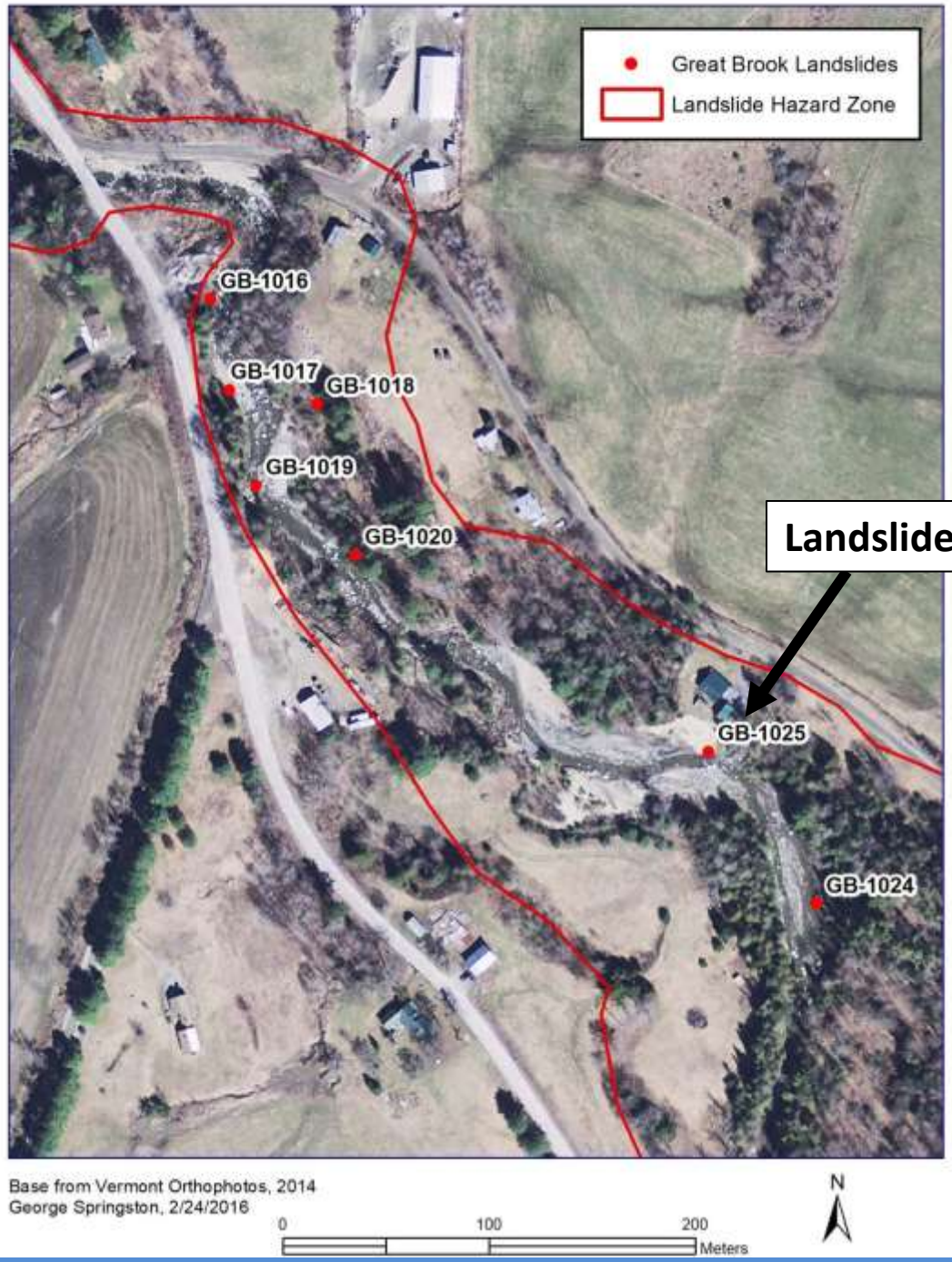
Site GB-1010, looking up MacLaren-Fowler gully. Note active scour at base of slope on left. George Springston, 7/16/2013.

Site GB-1023


House Sites
Great Brook Landslides
Landslide Hazard Zone
Base from Vermont Orthophotos, 2013, 2014
George Springston, 2/24/2016
0
100
200
300
Meters
N

Typical landslide in stream terrace deposits at Site GB-1027, looking downstream. Stream terrace gravel exposed on left bank. George Springston, 7/29/2013.

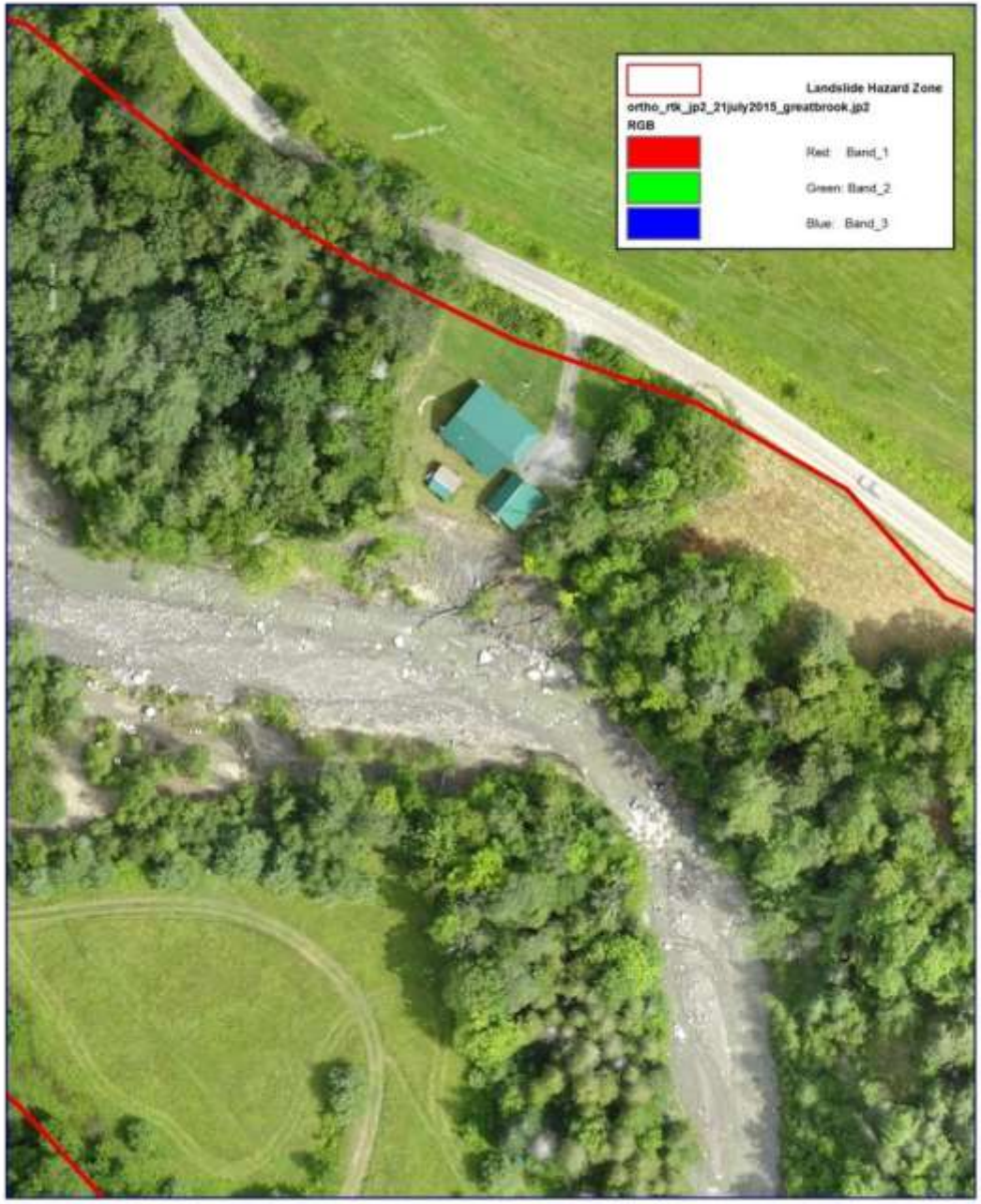
Example of a house site that is threatened by an imminent slope failure. Site GB-1025.



Active landslide west of Cameron Road on Great Brook.
Photo taken after Tropical Storm Irene, September, 2011.
Photo: Staci Pomeroy, Vt. Rivers Program
DSC_0136.JPG, 2011/09/21 12:56:47.00
Latitude: N 44°15.770' (44°15'46.2"), Longitude: W 72°25.214' (72°25'12.8"), Altitude: 727.00m

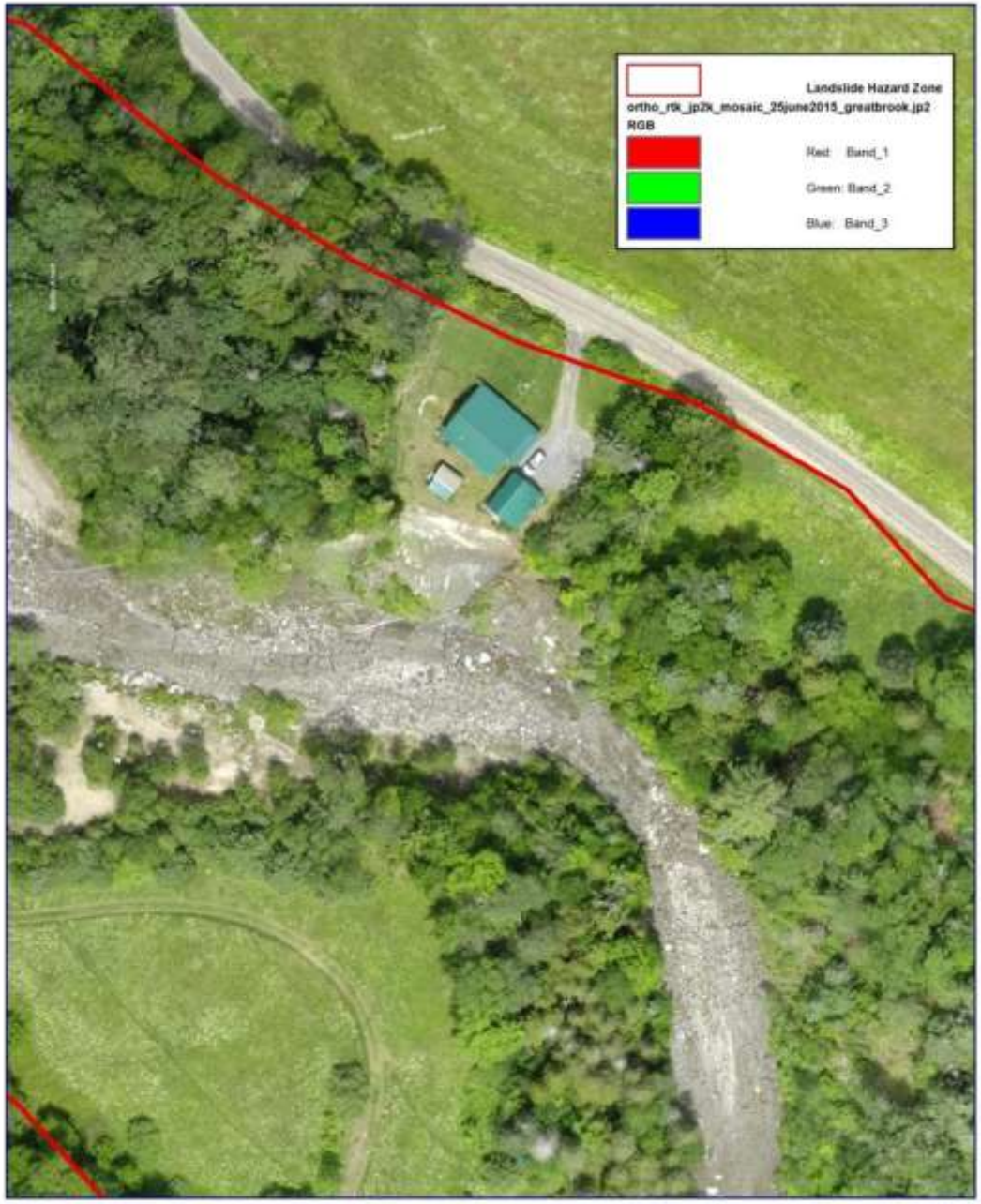
Site GB-1025, looking across at right bank. Note peak of garage roof at top. Slope is 56 feet high and slope angle is 49°. George Springston, 7/29/2013.

Site GB-1025, July 21, 2015. Top of landslide is very close to back of garage.



Imagery courtesy of Jarlath O'Neil-Dunne of the University of Vermont Spatial Analysis Lab.

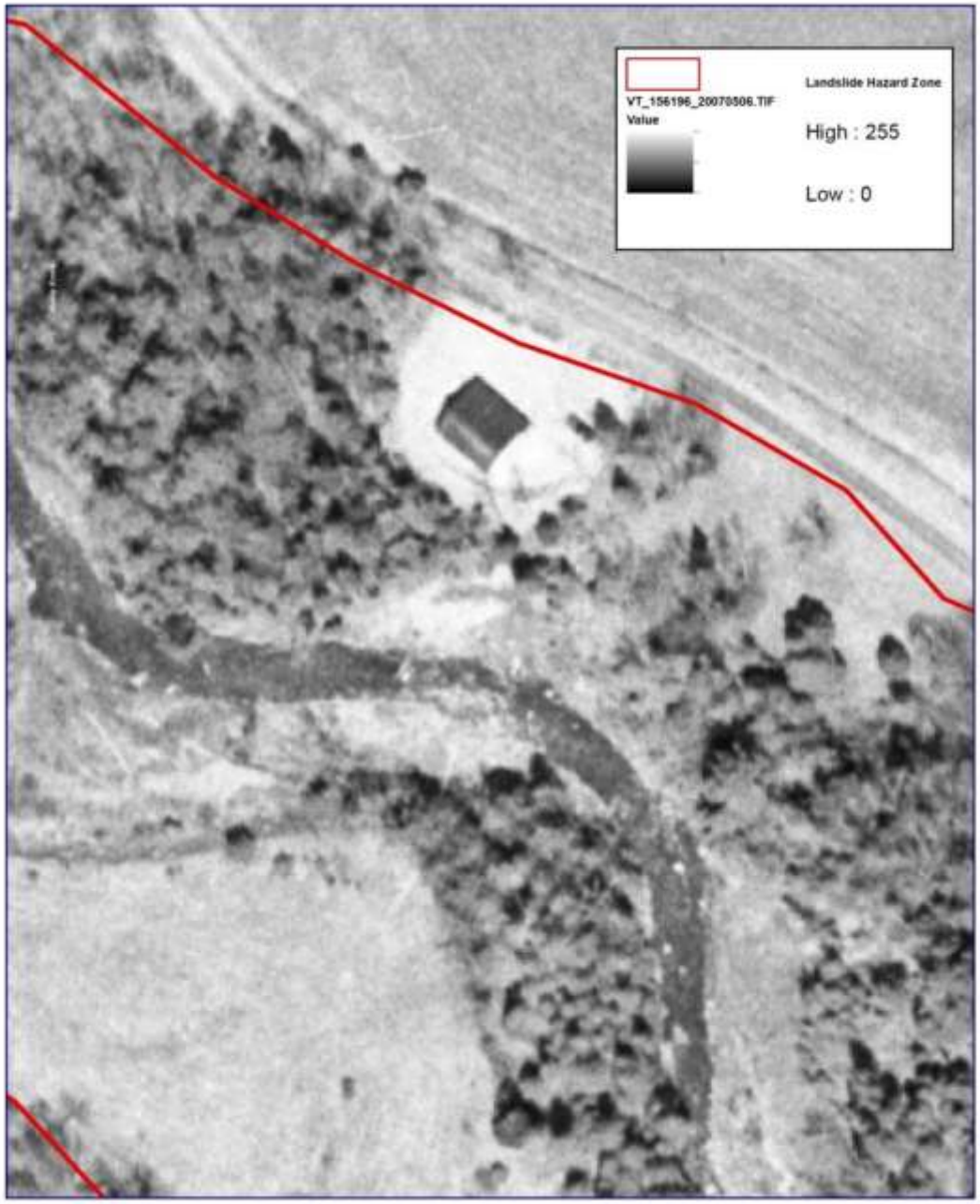
Site GB-1025, June 25, 2015.



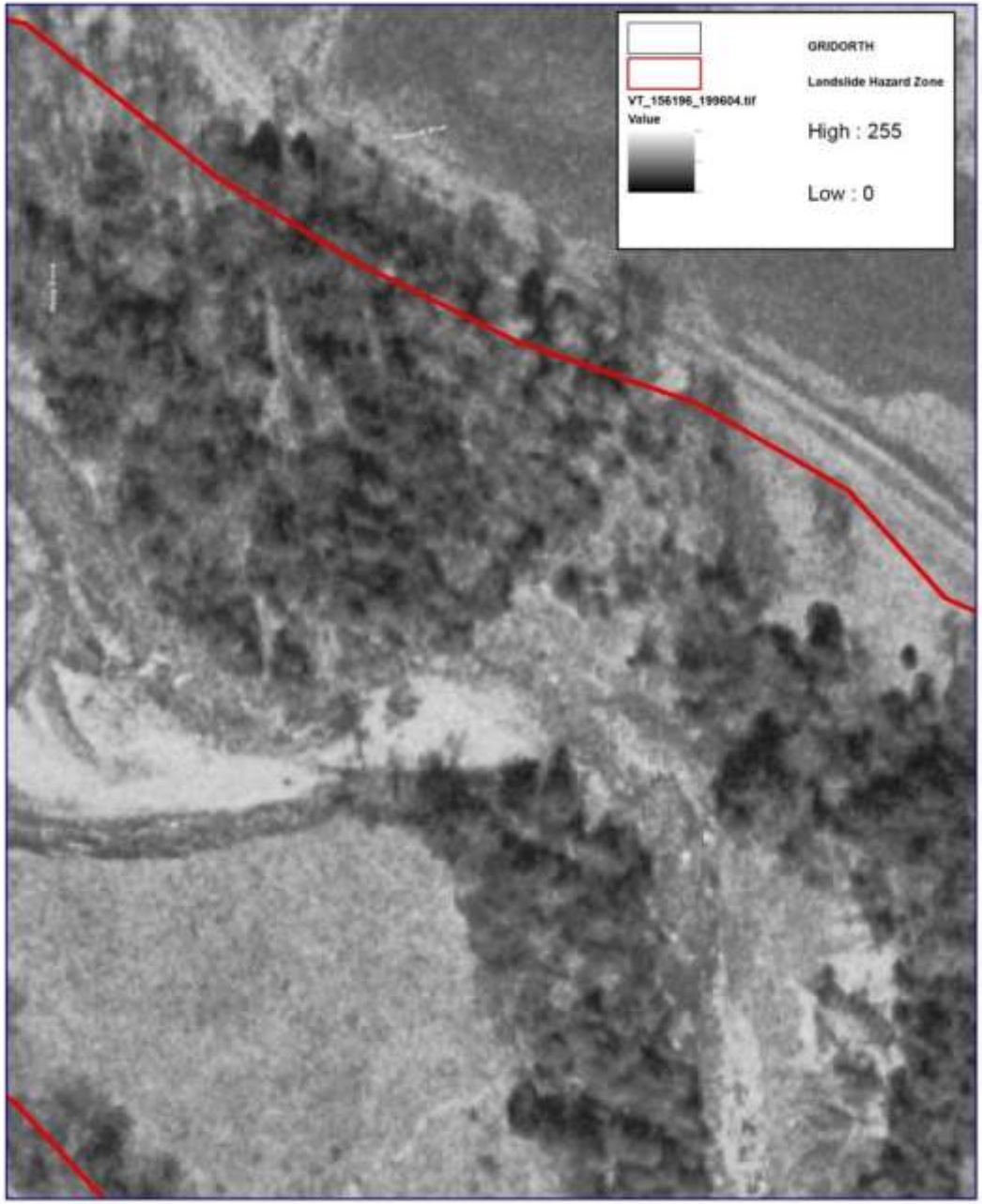
Imagery courtesy of Jarlath O'Neil-Dunne of the University of Vermont Spatial Analysis Lab.

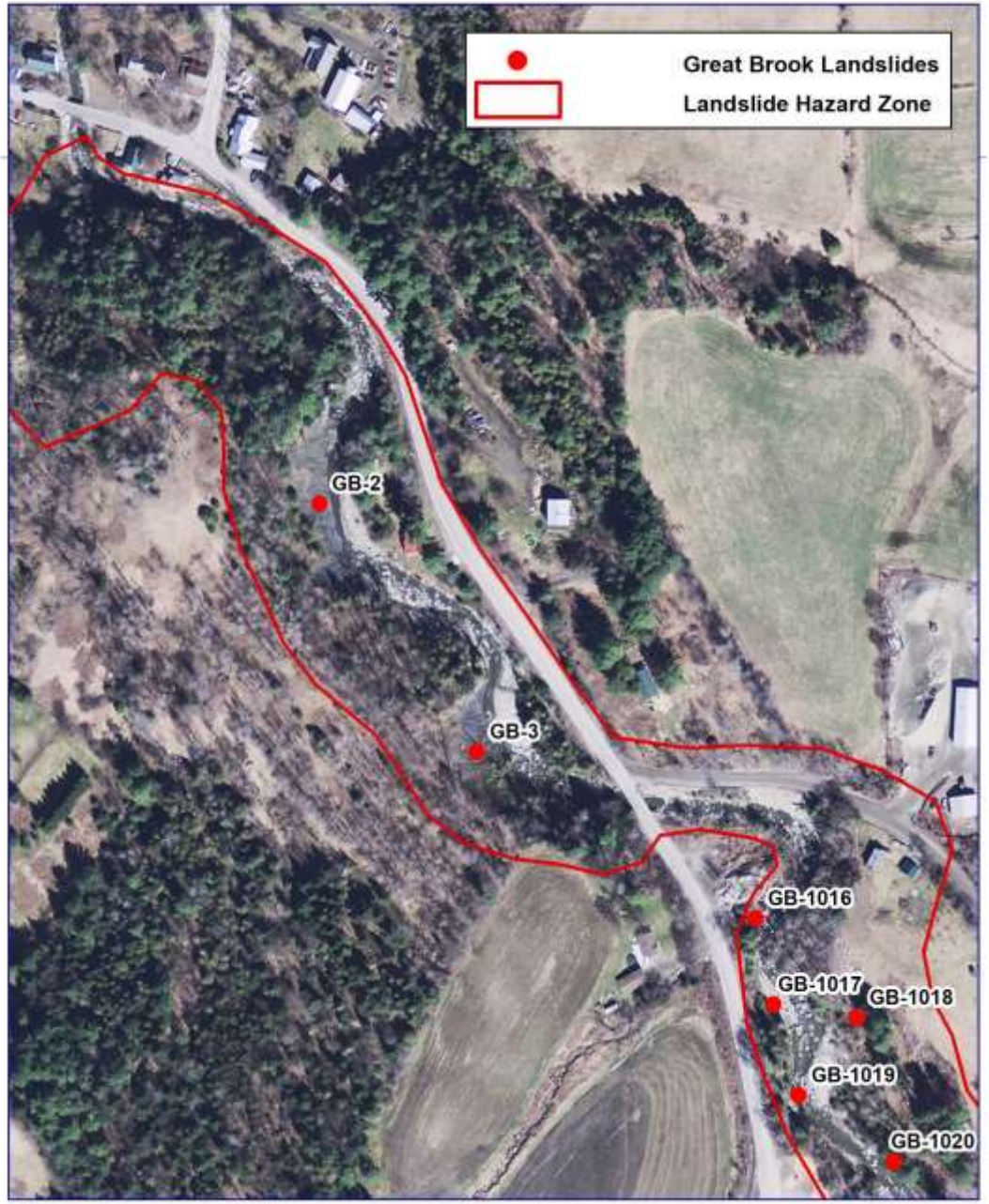
Site GB-1025, Spring, 2014. No trees left between house and top of landslide.

Site GB-1025, Spring, 2007. House built sometime around 2005.



Site GB-1025, Spring, 1996. No house present.




Great Brook Landslides
Landslide Hazard Zone
GB-2
GB-3
GB-1016
GB-1017
GB-1018
GB-1019
GB-1020
Base maps from U.S. Geological Survey
Coordinate System: Vermont State Plane
meters, NAD 83. This map is not a survey
and is for planning purposes only.
George Springston, 2/18/2016
0
50
100
150
200
250
Meters
N

Changes at Site GB-3, Photo 1 of 10
Site GB-3, 5/18/2011, prior to the May flood. George Springston.

Changes at Site GB-3, Photo 2 of 10
Site GB-3, 5/27/2011, Day After May, 2011 Flood. George Springston.

Changes at Site GB-3, Photo 3 of 10
Site GB-3, 9/14/2011, two weeks after Irene. George Springston.

Changes at Site GB-3, Photo 4 of 10
Site GB-3, 4/26/2012, Post-Irene. George Springston.

Changes at Site GB-3,
Photo 5 of 10
Site GB-3, 7/02/2013, Post-Irene. George Springston.

Changes at Site GB-3, Photo 6 of 10
Site GB-3, 7/11/2013. George Springston.

Changes at Site GB-3,
Photo 7 of 10
Site GB-3, 4/24/2014. Photo by George Springston.

Changes at Site GB-3, Photo 8 of 10

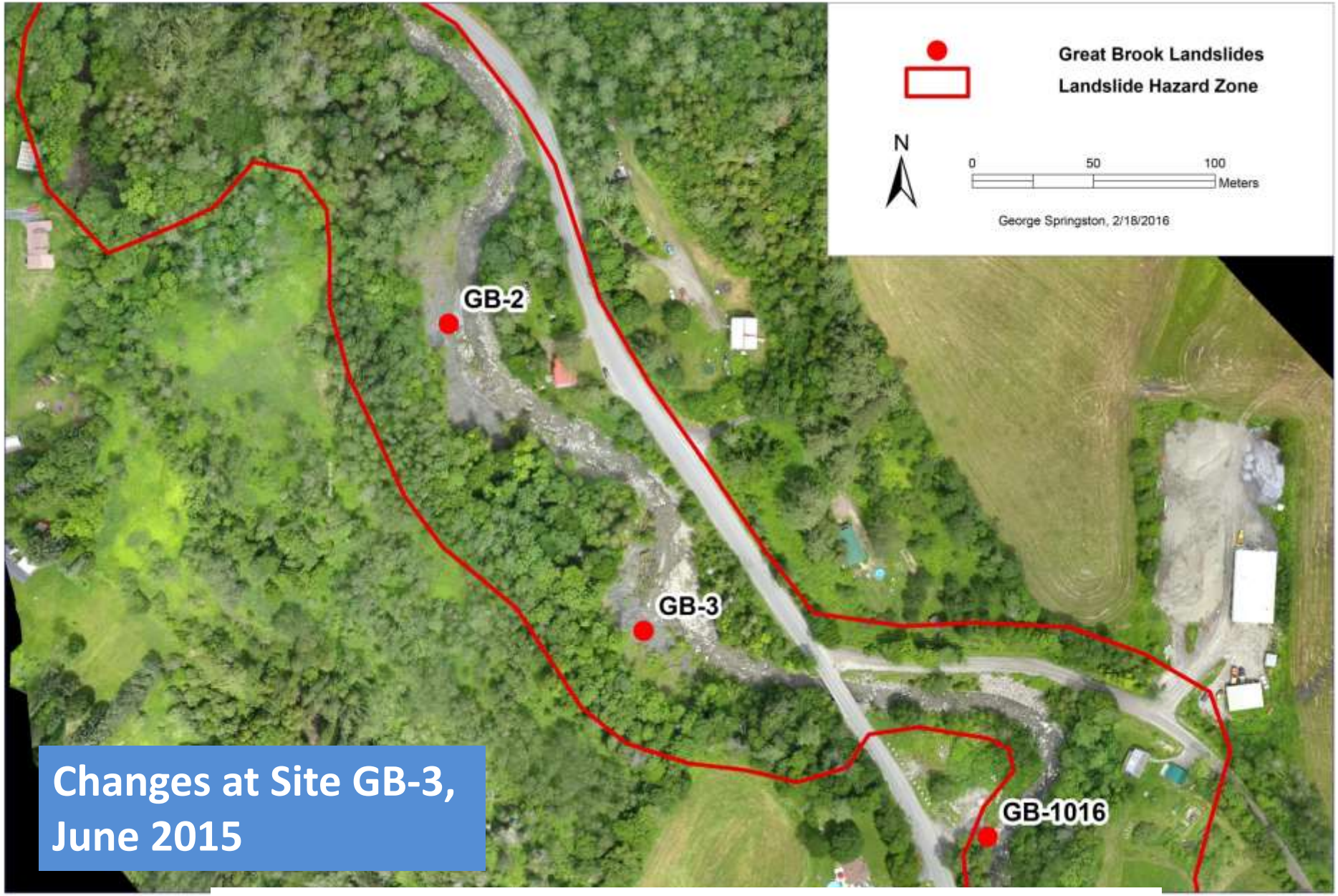
Site GB-3, 5/16/2015. Photo by George Springston.

Changes at Site GB-3, Photo 9 of 10

Site GB-3, 9/25/2015. Photo by George Springston.

Changes at Site GB-3, Photo 10 of 10

Site GB-3, 2/6/2016. Photo by George Springston.

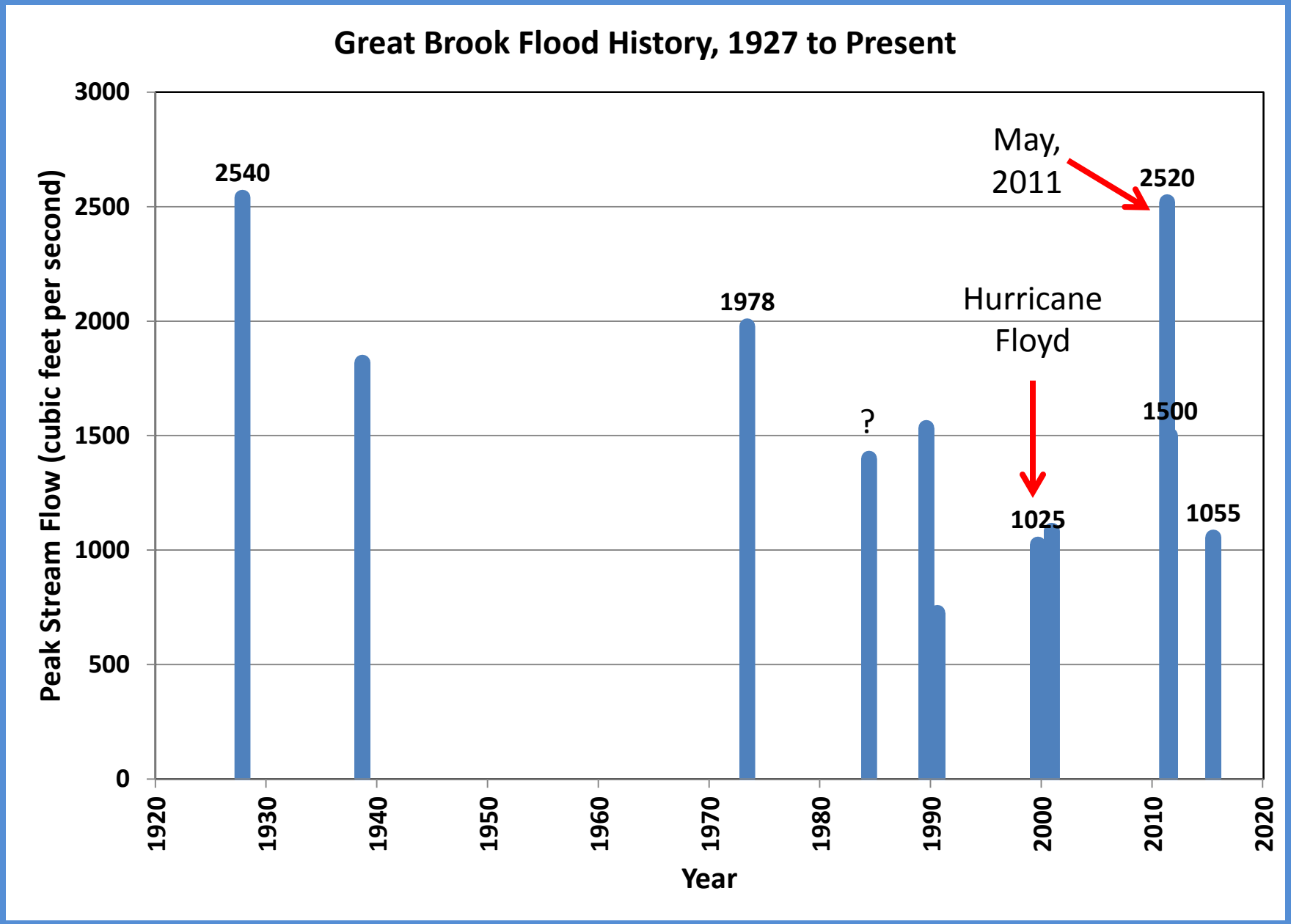


Changes at Site GB-3, June 2015

http://www.uvm.edu/~ebuford/ol3/greatbrook_swipe.html

Changes at Site GB-3, June 2015, pre-flood
N
0
10
Meters
George Springston, 2/18/2016

Changes at Site GB-3, July 2015, post-flood
N
0
10
Meters
George Springston, 2/18/2016



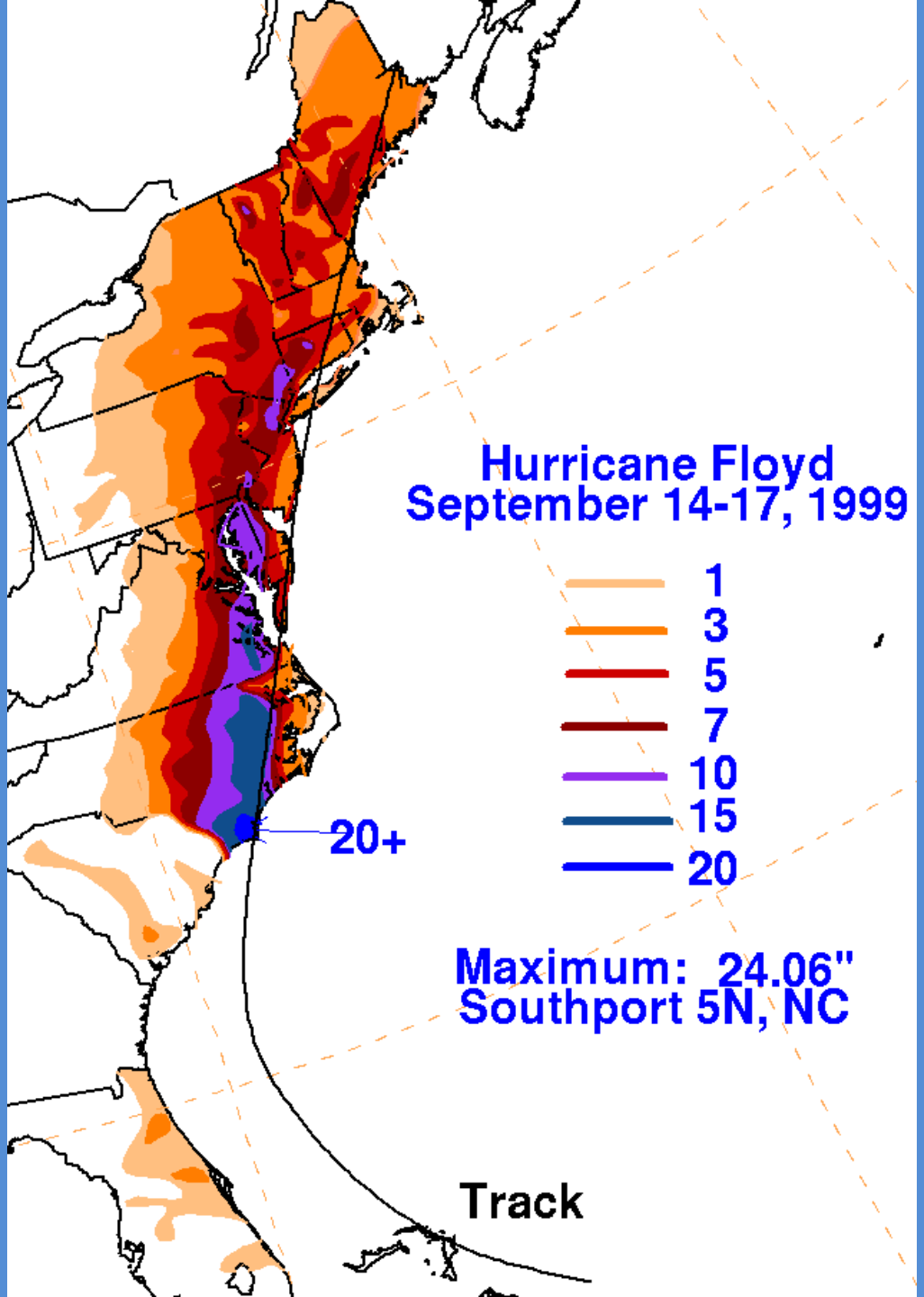
Peak runoff values are estimates except for those from 1999 and 2000, which are derived from stream gaging. See Springston (2015) and Milone and MacBroom (2016) for further details.

Rainfall Associated with Flooding Since 1973

- June 1973 4.1” rain
- June 1984 ?
- Aug. 1989 6.7”
- Aug. 1990 3.9”
- Sep. 1999 5.3”
- Dec. 2000 3.3”
- May 2011 5.2”
- Aug. 2011 5.1”
- July 2015 3-4”

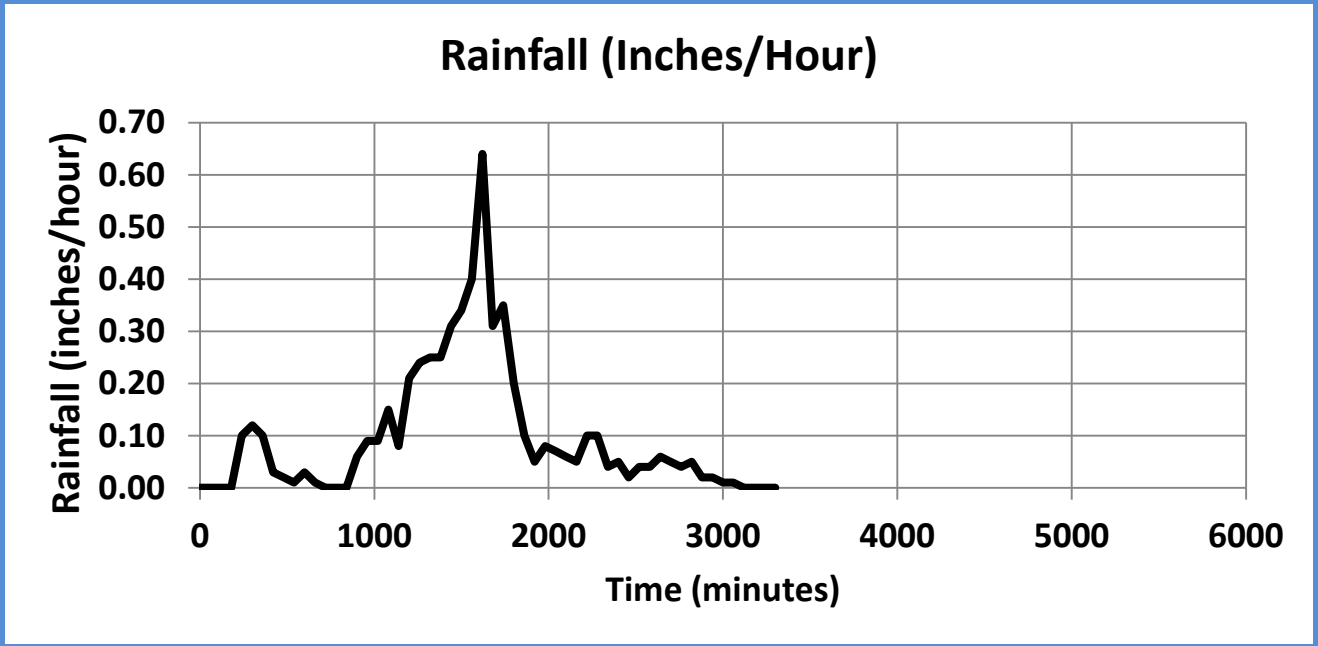
1989 Flood. Photo courtesy of Ed LeTourneau.

Hurricane Floyd reached Vermont on 9/15--17, 1999. Soils were dry and streams were low due to a prolonged drought.

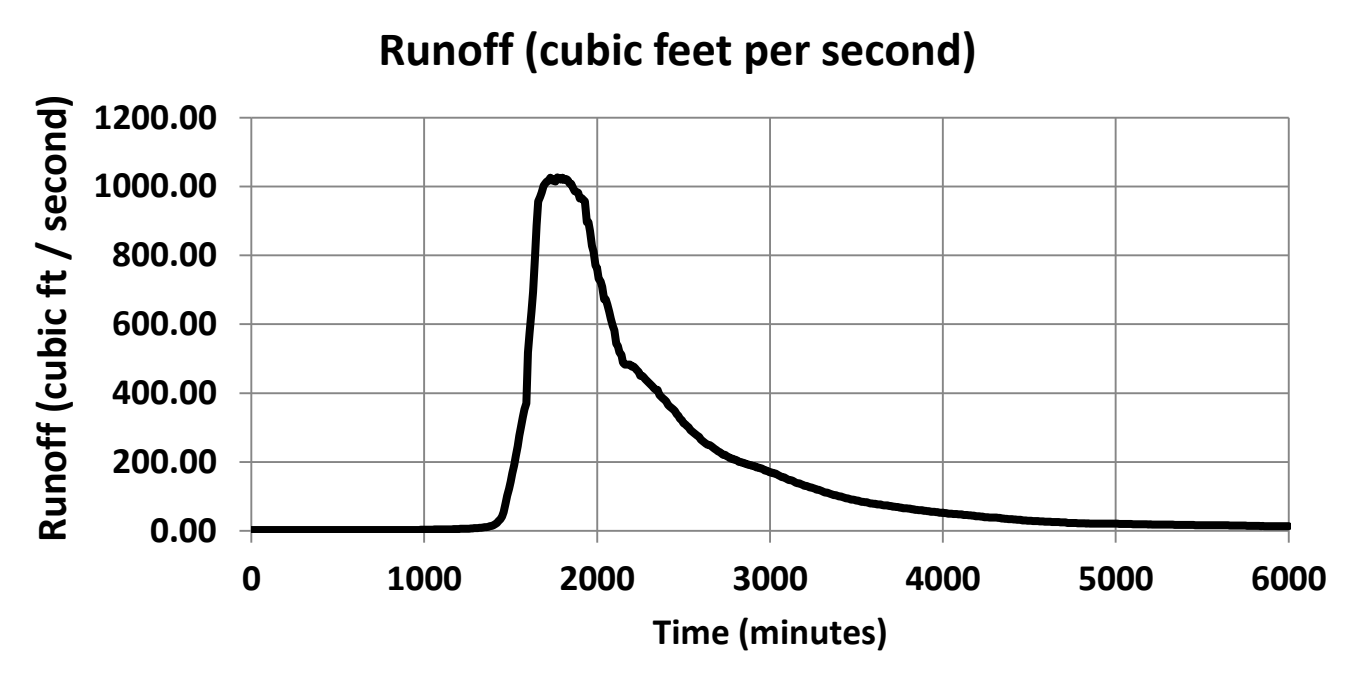


From: http://www.hpc.ncep.noaa.gov/tropical/rain/ Accessed 1/30/2012

Rainfall and runoff (stream flow) from Hurricane Floyd in Great Brook, Plainfield, Vermont, 9/15--17, 1999



Time from peak rainfall to peak runoff is about 150 minutes (2.5 hours). This is consistent with watershed size, slope of stream, etc.



Summary

- Study identified 47 active landslides, 3 inactive ones, 7 streambank erosion sites, and 15 sites with gullying.
- Landslides occur repeatedly in similar locations on steep slopes near the streams.
- Most landslides are in the lower reaches, which lack bedrock grade control in the channel.
- Additional rejuvenated landslides can be expected to occur after any future large floods.
- Two houses have been destroyed due to fluvial erosion since 1984. Several others are currently at risk.
- Many of the problems are related to constrictions at bridges, channelization of the stream, removal of boulders from channel, armoring of banks with rip-rap, berming, and floodplain encroachment.

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Further Information

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UVM Spatial Analysis Lab page devoted to Great Brook imagery: http://letters-sal.blogspot.com/2015/07/on-july-19th-series-of-storms-moved.html

1989 Flood

Ed LeTourneau