

Landslide, Mud and Debris Flow

Lucas Valley has experienced shallow, rainfall-triggered landslides emanating from just below the summit of Big Rock Ridge which have produced damaging mud and debris flows.

- Jan. 2006 a shallow landslide filled the area west of Mt. Tenaya Ct., clogging storm drains with mud and debris, with the overflow covering Idylberry Rd. with several inches of mud from Mt. Tenaya Dr. to the east side of Mt. Lassen Dr. Homes were damaged on Mt. Tenaya Ct., the south side of Idylberry Rd. and Mt. Darwin Ct.
- Feb. 2019 a shallow landslide overwhelmed the debris rack at Mt. Dana Ct. sending mud and debris into the storm drains, blocking the drainage leading to Miller Creek along the west side of Mt. Palomar Ct. where homes were flooded and vehicles damaged.

Shallow landslides are located within the soil mantle or weathered bedrock to a depth of < 3 meters (9.84 ft.). The scars from these landslides are easily visible on Big Rock Ridge. LVHA residences adjoining the hills, along drainage channels, and many others downslope in the community face the risk of damage from landslide and the resulting mud and debris flow.

The U.S. Geological Survey (USGS) [Landslide Hazards Program](#) provides [Landslide Preparedness](#) information.

Following the Jan. 2006 event, USGS installed monitoring instruments on Big Rock Ridge, its second monitoring site in the Bay Area. Data from this installation became available online in Nov. 2019 at [San Francisco Bay Area – Marin County \(BALT2\) Site near San Rafael, CA](#)



The USGS “BALT2” site located in Marin County consists of dataloggers monitoring the hillslope in the central part of the image. This slope is typical for many in the Marin County region that have generated mobile debris flows in the past. Evidence of two recent landslides are shown in the fore- and middle-ground. The area consists of grasslands over an approximately 1-meter-deep sandy soil layer, underlain by sandstone.



The USGS “BALT2” monitoring site showing datalogger enclosures, solar panel (far right), air temperature and relative humidity sensor (left, white), and rainfall gauge (far left, brown and white).

USGS uses aggregate data from the 4 monitoring sites in the Bay Area to provide information on landslide potential to the National Weather Service (NWS). When USGS data identifies saturated soil conditions, NWS storm and flash flood warnings will include “increased threat of mud, rock and landslides.” This warning protocol is in the experimental and developmental stage with the goal of developing landslide warning criteria with the NWS. Data available online is near real time (refreshed every 5 minutes), providing our residents with a means to monitor important local indicators of potential landslide activity, even at this early stage of development.

Data is displayed in 3 charts covering a rolling 2 week period:

Rainfall

- 15 minute rainfall intensity shows millimeters per hour in 15 min. increments. $1\text{ mm} = 0.0383701\text{ inches}$.
- Cumulative precipitation in mm over the 2 week period.

Soil Water Content and Ground Water Pressure – there are 2 of these charts for BALT2, an Upper Nest and a Lower Nest; these monitoring sites are about 50 ft. apart.

- Volumetric water content in cubic centimeters (ratio of water volume to soil volume) measured by sensors placed at varying depths – 25 cm (9.84 in.), 55 cm (21.65 in.) and 100 cm (39.37 in.). VWC of 0.20 = 20% water content. $1\text{ cm} = 0.383701\text{ inches}$.
- Pore water pressure in centimeters of water measured by sensors at depths of 113 cm (44.49 in.) or 118 cm (46.46 in.). Pore water pressure should be 0 or a negative number until soil is saturated. A positive number may indicate failed or imminent failure of steep slope soil.

Air Temperature, Relative Humidity, and Battery Voltage

- Battery Voltage (only useful for equipment monitoring).
- Air temperature in degrees Celsius. $\text{Degrees Fahrenheit} = (\text{degrees Celsius} \times 1.8) + 32$.
- Relative Humidity (%) *The ratio between the amount of water vapor in the air and the maximum amount of water vapor the air can hold at that temperature.*

What to watch?

USGS data from the Big Rock monitoring site provides useful indicators, particularly overnight and when weather obscures visual monitoring. **This data does not identify a landslide in progress, or where one may occur, and remains experimental**, though it is our best available indicator of local soil conditions.

- Rain Intensity – *A torrential rain is defined as an accumulation ≥ 0.3 (3 tenths) inch per hour (7.62 mm/hr).*
- Cumulative Precipitation – an accumulation ≥ 6 inches may be of moderate concern if rainfall occurs steadily over 2 weeks, while such an accumulation over a couple of days is a serious concern – monitor in conjunction with Soil Water Content.
- Volumetric Water Content – VWC > 0.2 (20%) to 0.35 indicates soil saturation.
- Pore Water Pressure – a positive number (> 0) may indicate that a landslide or debris flow is imminent or underway.

Visual monitoring for potential indicators of mud and debris flow

- Miller Creek – high flow or overflow above the normal bank levels; high turbidity (soil content) – moderate = muddy with submerged rocks still visible 1 to 2 ft. below the surface; heavy = no visibility below the surface
- Drainage channels and culverts – flow level, turbidity, any debris obstruction
- Debris racks – obstructed by debris; debris and mud accumulation diverting flow to drainage channel
- Storm drains – clogged or overflowing, evidence of soil or debris accumulation

USGS [Landslide Preparedness](#) identifies additional landslide warning signs, and guidance on what to do before, during and after a landslide.

See the Flood Control Resources document at [LVHA.org](#) for information on flood control resources.

What to do

When a strong rainstorm is forecast, prepare by removing leaves and debris in street gutters that may wash into and block storm drains

- During heavy rain conditions, monitor storm drains and remove debris blocking the flow of water into the drains
- Report blocked or overflowing drains to Marin Co. Public Works

Observe conditions in Miller Creek, drainage channels, culverts and debris racks from a safe distance

- Keep children away from flowing water (6 inches of swift flow can sweep an adult away)
- Report major obstructions such as downed trees, collapsed banks or heavy erosion, large debris or soil accumulations in debris racks, and blocked drain pipes emptying into Miller Creek

Monitor the hills along Big Rock Ridge for evidence of landslide activity (binoculars recommended), report new activity to Marin County Public Works and LVHA Business Manager; call 911 to report landslide activity directly threatening or impacting residences

- Shallow landslides move rapidly – do not hike up a ravine or drainage channel to investigate the source of a mudflow or debris accumulation, and stay above slumping areas on the hillsides

Contact Numbers

Marin Co. Public Works

- General # 415-499-6528
- Roads, drains: 6am to 5pm Mon. thru Fri. at 415-473-7388 and 415-473-7513 nights, weekends and holidays

LVHA Business Manager 415-472-3202