SELF-GUIDED HIKE TO FOURMILE CANYON CREEK FLOOD DEPOSITS AND CHANGES TO THE LANDSCAPE

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This hike updates the Field Guide to the Geology Along the Old Kiln Trail, Boulder, Colorado, City of Boulder Open Space and Mountain Parks. The GPS locations, geologic history, and rock descriptions have not changed. The emphasis of this guide is on the dramatic changes to the landscape as a result of the September 9-16, 2013 rain storm that caused damaging floods and landslides in Boulder, along the Front Range, and northeastern Colorado. Most photographs in this guide were taken in the first few months after the flood.

September 2013 began with an unusual heatwave with temperatures in the 90's. It was a relief when the rains started. An unusual weather pattern was set up in the atmosphere that focused moisture on the Front Range, and Boulder was in the "bulls eye" of heavy precipitation. Most of the rain fell between September 11th through September 13th. Boulder recorded 9.08 inches on Wednesday September 12th, a new one-day record. When the rain finally stopped, 17.18 inches had fallen, almost the yearly total. Fourmile Canyon Creek watershed was near the area of most intense rainfall.

The Four Mile Creek trailhead parking lot is the gray square right of center. Pre-flood location of Fourmile Canyon Creek is outlined by the trees. Old drainages can be seen. Compare with post-flood photograph on next page.

After the flood, the course of the creek and the floodplain were changed dramatically. Compare this photograph with the previous one as you follow this guide. You will cross two channels eroded by the 2013 flood that can be seen as shallow depressions in the pre-flood photograph above.

Photograph of the floodplain and creek after the September 2013 flood.

DIRECTIONS TO STOPS AND LOCATIONS OF POINTS OF INTEREST ARE GIVEN IN ITALICS. The hike begins from the Four Mile Creek Trailhead off Lee Hill Drive, west of Broadway in North Boulder. Follow the trail to the "bridge to nowhere".

Fourmile Canyon Creek flows through a long narrow steep-walled canyon with several steep drainages joining it. The drainage basin is small, about 10.2 square mile compared to approximately 447 square miles for Boulder Creek. About a third of the Fourmile Canyon Creek drainage basin was burned in the 2010 Fourmile fire. Some areas along the upper reaches of the drainage basin suffered high intensity fire that destroyed the trees and made it susceptible to rapid runoff.

Bridge to “nowhere” and debris collected by the bridge in the September 11-13, 2013 flood.

Pre-flood estimates for a Fourmile Canyon Creek 100-year flood are about 3,300-3,500 cfs (cubic feet per second). The 2013 flood may have exceeded this flow. To put this in perspective, the maximum volume of water flowing down Boulder Creek in Boulder reached about 5000 cfs. An estimated flow for Fourmile Canyon Creek is close to 4000 cfs in the September 2013 storm. More sustained rainfall over this drainage basin and the burn scar from the 2010 Fourmile fire may have contributed to the dramatic deposition and erosion across this entire floodplain.

EROSION OF NEW CHANNELS

Follow the trail west from the bridge and you will cross two “new” channels carved by the 2013 flood. Look carefully at the walls of the channels.

The walls of the new channels show evidence of earlier, larger floods. Look for some very large boulders under a dark soil. It takes hundreds to thousands of years to form dark, organic-rich soil. Starting with clean sand after a flood, organic matter very gradually accumulates to form soil, Between the two channels, boulders from the older flood deposits are sticking out at the ground surface. The 2013 flood reworked the boulders and sand from the older flood deposits. Some of the sediment was carried by the flood from the burn area.

Newly carved channel by the September 2013 flood. Large rounded boulders from an older flood are exposed.

Close-up of older flood deposits with large rounded boulders and a well-developed soil above them.

The channel upstream along Lee Hill and Wagon Wheel Gap roads is extremely narrow in places. Many bridges to homes along the creek were severely damaged or completely destroyed. These bridges may have created temporary dams that caught rocks, trees, and other debris, and for a brief time held back the flow. When the pressure of the water and debris became too great, temporary dams collapsed and surges of water moved downstream. Across the floodplain, there is evidence for pulses of flood water. At first, floodwater carried mostly sand. Larger cobbles and boulders were transported where the current was fastest.

Bridge destroyed at “choke point” along Lee Hill Drive. Note the vegetation on the bridge deck indicating how high the flow was here (photograph taken September 15, 2013 by James V. Holmes).

The height of the flow along Lee Hill Drive can be estimated near a “choke point” where the canyon narrows and the remains of a damaged bridge has debris caught on the deck. This photograph shows that flood water was flowing over the top of the bridge. Just downstream, flood water flowed across Lee Hill Drive where it carried and deposited sand and gravel on the north side of the road. On the south side of the road flood water covered and buried the trailhead parking lot with sand.

WHERE DID ALL THE SAND AND BOULDERS COME FROM?

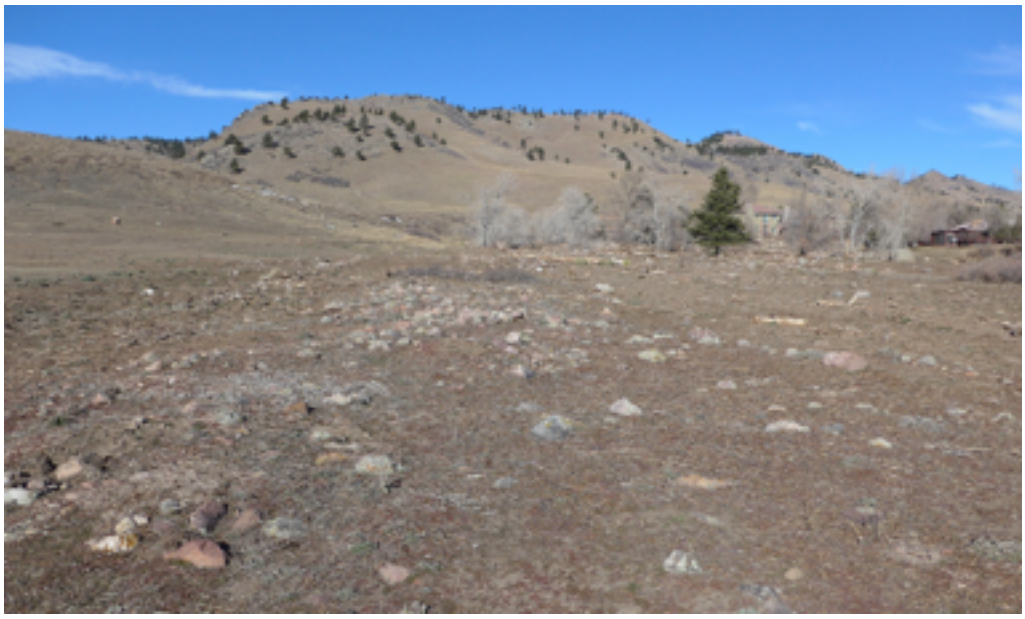
Many places along the trail and the tree trunks where the pre-flood channel is located have been buried by sand and rock debris. Some of the sand has come from the area burned in the 2010 Fourmile Fire and reworking of older deposits in the drainage basin and on the floodplain.

A large amount of the sediment and debris was contributed from hill slopes that had been undercut, and from landslides (photograph below).

Erosion of Wagon Wheel Gap road

Two landslides contribute sand and rock debris to the floodwaters (Photographs by Jamie V. Holmes).

After crossing the two "new" channels carved by the 2013 flood, continue along the



trail.

Boulders from an older flood deposit are exposed on the north side of the trail south of the creek. This area had flood water carrying logs and wood flowing over it in 2013. Note how far this is from the pre-flood channel.

Follow the hiking/biking Foothills Trail to the first trail junction with the Old Kiln Trail. Take the trail that goes north (right), toward Lee Hill Drive. Walk along the trail until you come to the mud and debris across the trail.

You are walking across the debris field from a large landslide that started high up near the top of Dakota Ridge and flowed down across the trail. Farther along the Old Kiln Trail there are better views of where this slide started. What is interesting to observe here is the rock debris surrounded by mud. This slide contained a lot of water and was quite fluid as it moved. When it reached this section of the trail, most of the larger rocks stopped moving and the mud kept flowing downslope until it reached a low berm where it stopped.

Scattered rocks from the debris flow from Dakota Ridge.

Footprints in mud that drained from the slide.

FLOOD OF JULY 7, 2011

About a third of the drainage basin of Fourmile Canyon Creek was burned in the Fourmile Fire in 2010. On July 7th 2011, a big thunderstorm produced a small flood that came down Fourmile Canyon Creek and overflowed the channel (photo). It is interesting that there was not sufficient flow to carry and deposit sand and move large rock debris.

Height of flood water during 2011 flood. Note that sand and boulders were not carried downstream by the flood water.

Continue along the trail. Note the sand deposited over the trail as you approach the exposure of Smoky Hills Shale on your left. This is another indication of how high the flood water rose. Follow the trail around the corner parallel to Lee Hill Drive.

No deposition of sand in the 2011 flood.

Sand and rock deposited during the 2013 flood.

The area on the right image has been modified by a new rock-lined channel excavated in 2014 to prevent flooding of homes close to Lee Hill Drive.

DEPOSITION AND EROSION BY THE 2013 FLOOD

The tremendous power of the flood water can be seen along the trail where a collection of boulders has been deposited on the pre-flood grassy slope.

Note how boulders have been moved onto the grass in the foreground and on top of the sand in the background.

Old limestone kiln before the flood.

Depth of erosion caused by the 2013 flood.

Photograph taken from Lee Hill Drive looking south. Huge amounts of sand were deposited by early surges of flood water. Later surges excavated these deposits and moved larger boulders and debris.

Continue walking over the flood deposits. The Old Kiln Trail continues uphill. By the split rail fence, the trail forks. Follow the Old Kiln Trail along an old road uphill to see the head of the big landslide that came down the south side of the canyon above Lee Hill Drive (see entire landslide in photograph on page 6).

Walk to the south end of the split rail fence where the layers of white rock (Fort Hays Limestone) are exposed. On the slope below, notice the scar of the big landslide that you walked across on the trail below. Head scars and debris trains of other landslides are apparent.

Head of landslide starting near top of Dakota Ridge (Photograph by Barbara Dobbs).

Landslide scar above Fort Hays Limestone
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Landslide scar below Fort Hays Limestone

You can return to the trailhead parking lot by following the trail on the right or retrace your steps along the trail back to the trailhead.

NOTES AND REFERENCES:

There is confusion in the names and location of Fourmile Creek and Fourmile Canyon Creek. I did not recognize the difference when I wrote the Field Guide to the Geology along the Old Kiln Trail (on the City of Boulder Open Space website). Throughout the guide, I called the small drainage that crosses open space Four Mile Creek since it is accessed from the Four Mile (or Fourmile) Trailhead off Lee Hill Drive. The more accurate designation for this drainage is Fourmile Canyon Creek. Another nearby drainage is Fourmile Creek, located southwest of Fourmile Canyon Creek. Fourmile Creek empties into Boulder Canyon at Orodell. It also had extensive damage during the September 2013 flood.

The 2010 Fourmile or Four Mile fire burned the upper reaches of both Fourmile Creek and Fourmile Canyon Creek.

“A Thousand-Year Rain: the Historic Flood of 2013 in Boulder and Larimer Counties” published by The Piedmont Publishing Group is a book of photographs and first person accounts showing the human impact of the flood. It also has an excellent summary of the meteorological causes of this historic flooding along the Front Range.

Another excellent resource is the Preliminary Assessment from CIRES Western Water Assessment at the University of Colorado, NOAA ESRL Physical Science Division, and the

CSU Colorado Climate Center at http://wwa.colorado.edu/resources/front-range-floods/assessment.pdf.

BASIN stands for Boulder Area Sustainability Information Network. This is an excellent public resource on environmental information with a focus on water in Boulder County at bcn.boulder.co.us/basin/. This website is a wonderful resource for information on the historic floods in Boulder County.

YouTube videos capture the flooding as it happened. Here are two that show the Fourmile Canyon Creek and its tributaries that produced the flood covered in this guide.

http://youtu.be/Ks1tBOGHMDo Excellent video of the flood as it is occurring and still images from Google Street showing the contrast between before and after pictures.

http://www.youtube.com/watch?v=tHtX8n_r4vA&sns=em Short video taken during the flood near the original bridge across Fourmile Canyon Creek from the trail leading from the Four Mile Trailhead off Lee Hill Drive.