

Table DR1. Timing data for 27 debris flows and 2 rock slides.

Landslide Number	Landslide Description	Headscarp Location (Latitude, Longitude)	Time of occurrence	Source of information	Comments
1	Rock slide in Golden Gate Canyon	N 39.769207 W 105.266741	Wednesday, September 11, 4:45 pm	Dennis Staley, U.S. Geological Survey (USGS), Golden; Sharon Blender, Golden Gate Canyon resident	Large rock slide deposit on road was hit by a motorist, crystalline rocks at headscarp
2	Debris flow from Porphyry Mountain that impacts a house on Main St. in Jamestown, killing the resident	N 40.122725 W 105.387816	Wednesday night, September 11, ~11:00 pm to early Thursday morning, September 12, ~5 am	Tara Schoedinger, Mayor of Jamestown	Crystalline rocks at headscarp
3	Debris flow near the junction of Linden Drive and South Cedar Brook Road in Pine Brook Hills that trapped a car carrying four passengers, resulting in two fatalities. Has the same headscarp source areas as number 12 listed below	At least 6 headscarps: N 40.041647 W 105.308932 N 40.042205 W 105.308258 N 40.042483 W 105.308693 N 40.042601 W 105.308302 N 40.042047 W 105.307723 N 40.042478 W 105.305976	Wednesday, September 11, ~11:30 pm to Thursday, September 12, 12:56 am	Greg Anderson, Logistics Captain, Boulder Mountain Fire Protection District (BMFPD) Sadie Gurman and Yesenia Robles, Denver Post reporters, Denver Post story entitled "Boulder flood victims were teen couple returning home with friends" from September 13 issue.	Start of the given time range is from Denver Post story. End of time range is when BMFPD was called for a rescue of two people missing from the car. BMFPD emergency responder was on scene and rescued the other two occupants of the car. Crystalline rocks at headscarp. Number 7 in BMFPD report to USGS.

4	Debris flow that impacts a house at 1579 Linden Drive in Pine Brook Hills destroying a bedroom and bathroom	N 40.047055 W 105.305011	Wednesday September 11, 11:40 pm	Greg Anderson, Logistics Captain, BMFPD	Time is when resident reported the debris flow to BMFPD, sedimentary rocks at headscarp, number 1 in BMFPD report to USGS.
5	Debris flow behind 500 Wagonwheel Gap Rd, Boulder County	Cannot locate in imagery, see address in 2 nd column for location	Thursday September 12, 12:00 am	Greg Anderson, Logistics Captain, BMFPD	Time is when resident reported the debris flow to BMFPD, rocks at headscarp not known, number 2 in BMFPD report to USGS.
6	Two debris flows mobilized from small slides that hit a house at 3rd St. and Forest Ave. in Boulder	Two headscarps: N 40.032611 W 105.295513 N 40.032518 W 105.295467	Thursday, September 12, ~12:00 am	Thomas Heinrich, homeowner	Material deposited in house, sedimentary rocks at headscarp
7	Debris flow, 142 Canyon Park, Boulder (Lower Boulder Canyon)	N 40.013401 W 105.305164	Thursday September 12, 12:00 am	Jeffrey Writer (jeffrey.writer@colorado.edu) Neighbor	Writer helped rescue resident from damaged house
8	Debris flow from hillslope north of 1178 Wagonwheel Gap Rd., Boulder County	Three headscarps: N 40.063399 W 105.3200221 N 40.063252 W 105.319968 N 40.063079 W 105.319750	Thursday September 12, 12:00 am to 7:00 am	Greg Anderson, Logistics Captain, BMFPD	Time range was reported by resident of 1178 Wagonwheel Gap Rd., crystalline rocks at headscarp, number 9 in BMFPD report to the USGS.
9	Debris flow that traps BMFPD personnel at 1579 Linden Drive in Pine Brook Hills	N 40.047889 W 105.305988	Thursday September 12, 12:20 am	Greg Anderson, Logistics Captain, BMFPD	Time is when BMFPD personnel became trapped, sedimentary rocks at headscarp, number 3 in BMFPD report to the USGS.

10	Shallow slides and debris flows, 18 Beaver Way, Pine Brook Hills	<p>Four headscarps: N 40.044389 W 105.306333</p> <p>N 40.044502 W 105.305214</p> <p>N 40.044780 W 105.304480</p> <p>N 40.045194 W 105.303922</p>	Thursday September 12, 12:30 to 1:00 am	Owner of house, Shawn Roberts, Apparatus Maintenance Director, BMFPD	Shawn Roberts was not at home, but his girlfriend was home.
11	Debris flow that impacts house at 1105 North Cedarbrook Rd. in Pine Brook Hills. House was moved off its foundation trapping a resident in the basement.	<p>Three headscarps: N 40.059682 W 105.306896</p> <p>N 40.059751 W 105.306432</p> <p>N 40.059971 W 105.306034</p>	Thursday September 12, 12:32 am	Greg Anderson, Logistics Captain, BMFPD	Time is when the debris flow was reported to BMFPD, sedimentary rocks at headscarp, number 4 in BMFPD report to the USGS.
12	Debris flow that impacts and destroys a garage and two automobiles at 66 Beaver Way in Pine Brook Hills	<p>At least 6 headscarps: N 40.041647 W 105.308932</p> <p>N 40.042205 W 105.308258</p> <p>N 40.042483 W 105.308693</p> <p>N 40.042601 W 105.308302</p> <p>N 40.042047 W 105.307723</p> <p>N 40.042478 W 105.305976</p>	Thursday September 12, 12:33 am	<p>Greg Anderson, Logistics Captain, BMFPD</p> <p>Homeowner whose garage was destroyed. Homeowner not in town at the time. Information was relayed from tenants.</p>	Time is when the debris flow was reported to BMFPD, crystalline rocks at headscarp, number 5 in BMFPD report to the USGS.
13	Debris flow on hillside above driveway of 112 Bow Mountain	Can't see in imagery, see address in 2 nd column for	Thursday September 12, 12:45 am	Greg Anderson, Logistics Captain, BMFPD	Time is when the debris flow forced a BMFPD crew to evacuate a lookout

	Rd.	location			position, crystalline rocks at headscarp, number 6 in BMFPD report to the USGS.
14	Debris flow upslope from 809 Lee Hill Drive that forces residents to evacuate.	Two possible headscarps: N 40.061508 W 105.298434 N40.062019 W 105.297682	Thursday September 12, 3:15 am	Greg Anderson, Logistics Captain, BMFPD	Time is when the debris flow was reported to BMFPD, sedimentary rocks at headscarp, number 8 in BMFPD report to the USGS.
15	Ralston Reservoir rock slide	N 39.830050 W 105.242687	Thursday September 12, 9:00 am to Friday September 13, 7:30 am	Darren Brinker, dam safety manager in the Engineering Group of Denver Water.	Time range is the gap between reservoir inspections by caretakers at Ralston Reservoir.
16	Debris flow deposits on road at approximately 1800 Lee Hill Drive, Boulder County	Two headscarps: N 40.067463 W 105.306894 N 40.067560 W 105.307037	Thursday September 12, 12:15 pm	Greg Anderson, Logistics Captain, BMFPD	Time is when deposits on road were noted by BMFPD emergency responders, sedimentary rocks at headscarp, number 12 in BMFPD report to the USGS.
17	Debris flow that mobilized from translational landslide on a dip slope of Lyons Formation on the east-facing flank of Ralston Buttes	N 39.841936 W 105.263305	Initial failure was between 1 and 2 pm on Thursday, September 12. Secondary failure to the north of the original failure occurred on Friday, September 13. Stream adjacent to Richard Zirbel's residence was flowing	Bill Gee, owner of property immediately north of the landslide; Richard Zirbel, owner of downstream property	Debris flow occurred adjacent to property owned by Bill Gee, damaged Jefferson County Open Space gate and fence, and passed by the residence of Richard Zirbel

			with muddy debris on Thursday at 4 pm and continued flowing into Friday the 13 th .		
18	A large landslide/debris flow along Four Mile Canyon Creek, just upstream from 157 Pinto Drive, Boulder County	N 40.059331 W 105.320153	Thursday September 12, 5:00 pm to Friday September 13, 9:00 am	Greg Anderson, Logistics Captain, BMFPD	Time range is the window in which this landslide/debris flow occurred, associated with flooding of Four Mile Canyon Creek, crystalline rocks at headscarp, number 14 in BMFPD report to the USGS.
19	Debris flow blocked the road near 600 West Coach Road, Boulder County	N 40.068213 W 105.334876	Thursday September 12, 5:00 pm to Friday September 13, 9:00 am	Greg Anderson, Logistics Captain, BMFPD	Time range is the window in which this landslide/debris flow occurred, crystalline rocks at headscarp, number 18 in BMFPD report to the USGS.
20	Debris flow that splits building into two pieces at 100 Arapahoe Ave in Boulder	N 40.005548 W 105.302011	Thursday September 12, 6:00 pm to Friday, September 13, 8 am	John Aguilar, Boulder Daily Camera reporter, author of Daily Camera story entitled "In the mouth of Boulder Canyon: The aftermath of a 100-year flood" from September 13.	
21	Second debris flow above 809 Lee Hill Drive (first was described in number 15 listed above)	Two possible headscarps: N 40.061508 W 105.298434 N40.062019 W 105.297682	Thursday September 12, 6:00 pm to Friday, September 13, 9:30 am	Greg Anderson, Logistics Captain, BMFPD	Time is the gap when residents were away from the property. They returned September 13 at 9:30 am and saw that the second debris flow had occurred. Sedimentary rocks at headscarp, number

					20 in BMFPD report to the USGS.
22	Debris flow mobilized from large landslide on the east side of Twin Sisters Peak	N 40.287460 W 105.510998	Thursday September 12, 6:00 pm to Friday September 13, 8:00 am	Wendell Green, Donna Ellis, Tim Rausch property owners on the east and northeast sides of Twin Sisters Peak. Green's residence is just north of, and adjacent to, the debris flow path.	Time range is the gap between observations by Green on September 12 and Rausch on September 13. Green documented major flooding in the debris flow drainage during daylight hours on September 12 (prior to the occurrence of the debris flow).
23	Debris flow from hillslope northwest of 1178 Wagonwheel Gap Rd., Boulder County	Two headscarps: N 40.064705 W 105.321345 N 40.064293 W 105.320716	Thursday September 12, 6:30 pm	Greg Anderson, Logistics Captain, BMFPD	Time reported by resident of 1178 Wagonwheel Gap Rd., crystalline rocks at headscarp, number 16 in BMFPD report to the USGS.
24	Debris flow deposits on road at approximately 1900 Lee Hill Drive, Boulder County. Located north of debris flows listed in number 17 above.	Three headscarps: N40.070465 W105.308434 N 40.070001 W 105.308023 N 40.069946 W 105. 307853	Thursday September 12, 7 pm to Friday September 13, 1 pm	Greg Anderson, Logistics Captain, BMFPD	Time is when deposits on road were noted by BMFPD emergency responders, sedimentary rocks at headscarp, number 12 in BMFPD report to the USGS.
25	Debris flow that initiated from a landslide above treeline on east side of Mount Meeker	N 40.246666 W 105.586551	Thursday September 12, 7:00 pm to Friday September 13, 7:30 am	John Davis, caretaker at Saint Malo church adjacent to Cabin creek where the debris flow occurred.	Time range is the gap between visits to the church by Davis.

26	Debris flow that mobilized from large landslide on west side of Twin Sisters Peak	N 40.293548 W 105.528893	Thursday, September 12, 10:20 pm	Yun Xiang Tseng (known as Chen), owner of the Aspen Lodge Resort and Spa	Debris flow deposits filled the parking lot behind the Aspen Lodge. Chen stated that a smaller debris flow from the same source affected the Wind River Ranch directly north of the Aspen Lodge earlier in the day on September 12.
27	Debris flow that began as a landslide in a fill prism underlying the Union Pacific railroad north of the mouth of Coal Creek Canyon	N 39.907352 W 105.285012	Friday September 13, 12:00 am to 10:00 am	Phil Egan, Director of Track Maintenance, Union Pacific Railroad, Denver	Time range is the window in which this landslide/debris flow occurred. Our inference is that the landslide was probably triggered by flooding in a creek that drained through a culvert in the fill prism. The travel distance of the resulting debris flow was the longest in the Front Range during the September event.
28	Landslide/debris flow occurred on hillslope above driveway at 112 Bow Mountain Rd. This followed the previous debris flow at the site (number 13 listed above)	Can't see in imagery, see address in 2 nd column for location	Friday September 13, 5:00 am	Greg Anderson, Logistics Captain, BMFPD	Crystalline rocks at headscarp, number 19 in BMFPD report to the USGS.
29	Debris flow that nearly hit the Fall River Entrance station to Rocky Mountain	N 40.409559 W 105.588925	First noticed on morning of Friday September 13	Danny Basch and Paul McLaughlin, National Park Service (paul_mclaughlin@nps.gov)	

	National Park, (called the Bighorn slide)				
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Table DR2. Data from sediment collected at debris-flow headscarps and deposits. Divisions between clay and silt, and silt and sand, were 0.004 mm and 0.062 mm, respectively (from the Wentworth scale).

Sample Name	Latitude Longitude	%Clay	%Silt	%Sand/ Gravel	Comments
JAC1-110113	N 40.289403 W 105.493459	2.54	10.24	87.22	East-facing debris-flow deposit, sample depth was 0-10 cm, Proterozoic biotite schist and gneiss, east side of Twin Sisters Peak
JAC1-110213	N 39.786930 W 105.336474	0.14	10.97	88.89	South-facing debris-flow headscarp, sample depth was 40-50 cm, colluvium on Proterozoic schist, Golden Gate Canyon
JAC1-111013	N 39.946687 W 105.348210	1.80	44.34	53.86	East-facing debris-flow headscarp, sample depth was 50-60 cm, Proterozoic monzogranite, old burn area near Gross Reservoir on west side of Flagstaff Mountain
JAC1-111513	N 40.213618 W 105.455919	3.69	19.22	77.09	North-facing debris-flow headscarp, sample depth was 110 cm, colluvium on Proterozoic granite of Longs Peak, North St. Vrain drainage
JAC1-112513	N 39.842031 W 105.263336	6.01	15.73	78.26	East-facing debris-flow headscarp, sample depth 80-90 cm, colluvium on Lyons Formation on east side of Ralston Buttes
JAC2-111013	N 40.006040 W 105.295818	3.15	21.68	75.17	East-facing debris-flow headscarp, sample depth was 100-110 cm, colluvium on Pennsylvanian Fountain Formation, east side of Flagstaff Mountain
JAC2-111513		2.33	24.74	72.93	South-facing debris-flow headscarp, sample depth was 30 cm, colluvium on

	N 40.215622 W 105.452005				Proterozoic schist, North St. Vrain drainage
JAC2-112513	N 39.829745 W 105.257779	11.84	22.45	65.71	West-facing debris-flow headscarp, sample depth was 20-35 cm, colluvium on Jurassic Morrison Formation, west side of hogback near Ralston Reservoir
JAC3-111513	N 40.213661 W 105.451779	1.61	16.85	81.54	South-facing debris-flow deposit, sample depth was 0-10 cm, colluvium on Proterozoic schist, North St. Vrain drainage
JAC3-112513	N 39.829745 W 105.257779	13.56	29.57	56.87	West-facing debris-flow headscarp, sample depth was 70-80 cm, colluvium and weathered bedrock, Jurassic Morrison Formation, west side of hogback near Ralston Reservoir
JAC4-112513	N 39.829745 W 105.257779	23.70	28.10	48.20	West-facing debris-flow headscarp, sample depth was 130-145 cm, weathered bedrock, Jurassic Morrison Formation, west side of Cretaceous Dakota Group hogback near Ralston Reservoir
JAC5-112513	N 39.831567 W 105.266906	3.57	17.18	79.25	West-facing debris-flow headscarp, sample depth 65-75 cm, colluvium on Fountain Formation, west side of Fountain Formation hogback near Ralston Reservoir
JWK-111113	N 40.246745 W 105.586701	2.63	9.60	87.77	East-facing debris-flow headscarp, sample depth was 50 cm, colluvium on Proterozoic granite of Longs Peak, east-facing flank of Mount Meeker
JWK1-110713	N 40.064661	0.35	10.41	89.24	Southeast-facing debris-flow headscarp, sample depth was 70 cm, colluvium on Boulder Creek Granodiorite, southeast-facing slope in Fourmile wildfire burn area southwest of Sunshine Canyon

	W 105.386295				Dr.
JWK1-112013	N 40.097777 W 105.362331	0.40	8.38	91.22	South-facing debris-flow headscarp, sample depth was 30 cm, colluvium on Boulder Creek Granodiorite, north side of Lefthand Canyon.
JWK2-110713	N 40.124684 W 105.390620	1.67	7.33	91.00	South-facing debris-flow headscarp, sample depth was 30-40 cm, colluvium on Paleocene and Eocene syenite, south-facing slope of Porphyry Mountain north of Jamestown
JWK3-110713	N 40.125701 W 105.389071	2.46	15.26	82.28	South-facing debris-flow headscarp, sample depth was 30-40 cm, colluvium on Paleocene and Eocene syenite, south-facing slope of Porphyry Mountain north of Jamestown
JWK4-110713	N 40.122701 W 105.387842	1.32	6.25	92.43	South-facing debris-flow headscarp, sample depth was 30-40 cm, colluvium on Paleocene and Eocene syenite, south-facing slope of Porphyry Mountain north of Jamestown. Caused fatality in Jamestown.

Figure DR1. Slope and upslope contributing area at debris-flow initiation locations (headscarps).

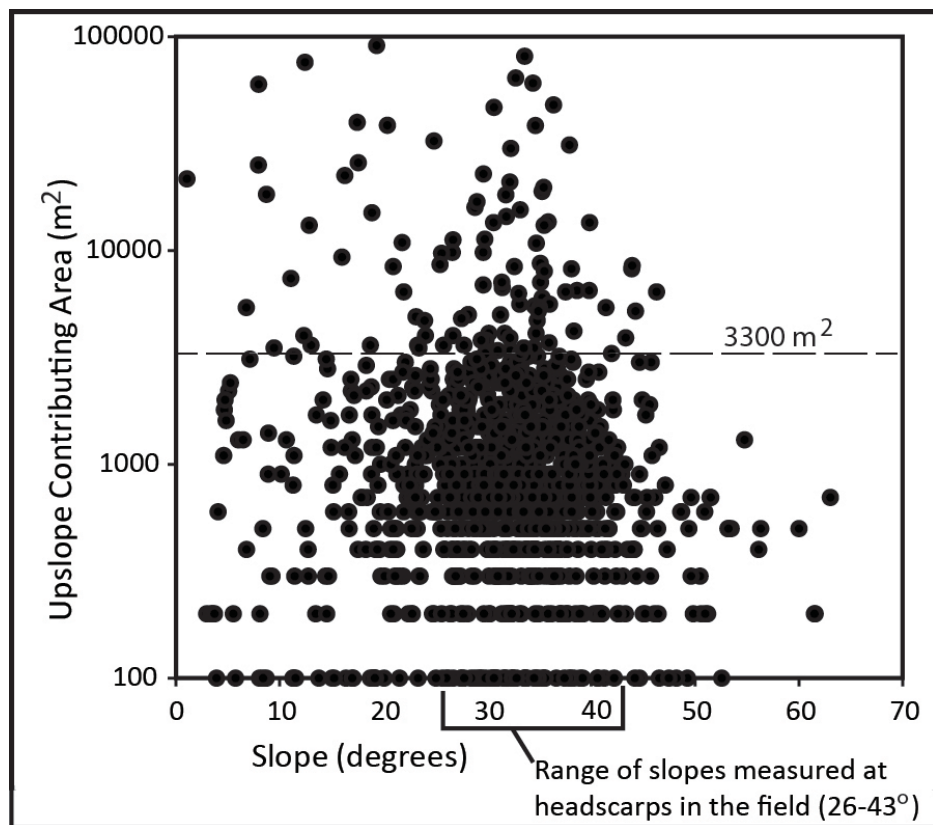


Figure DR2. Ternary diagram showing results of grain size analyses from Table DR2. Textural boundaries are from the U.S. Department of Agriculture.

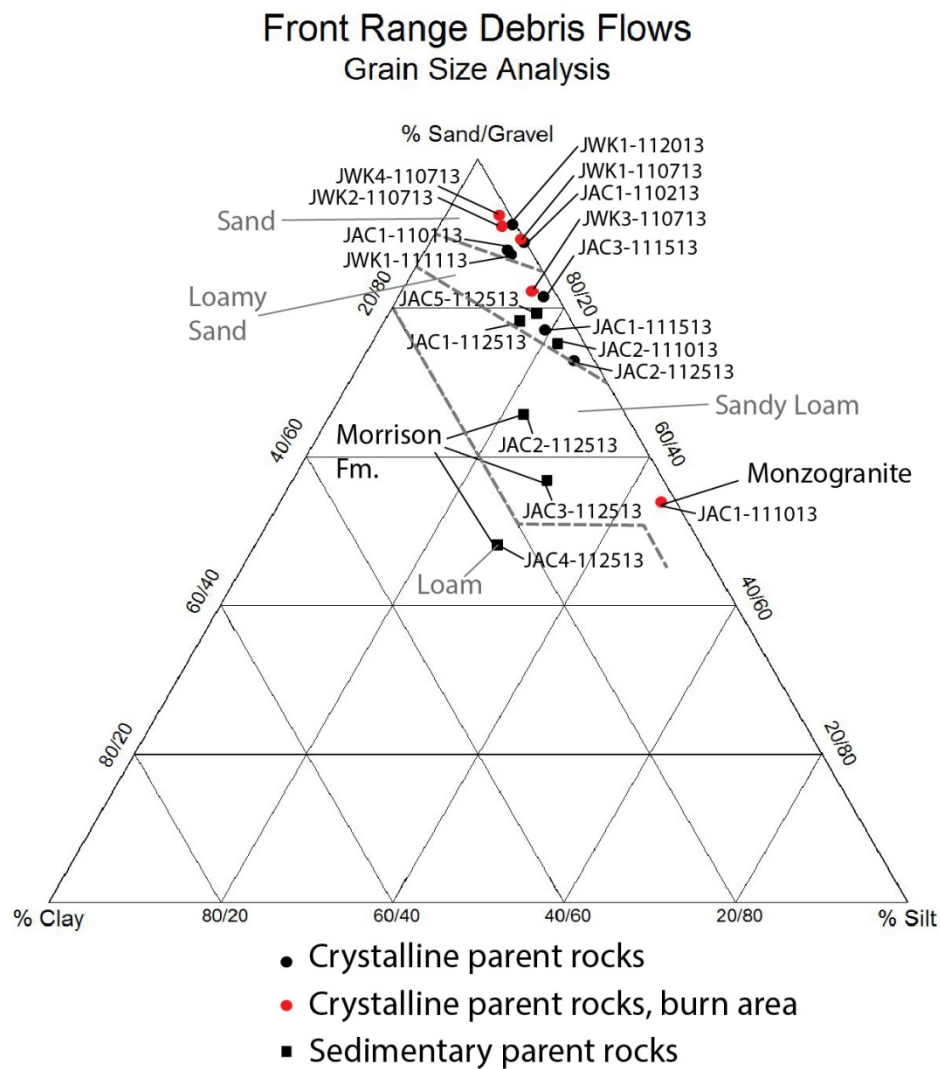


Figure DR3. Rose diagram showing a random sample of slope aspects at 100,000 10-m Digital Elevation Model cells in the study area. Values on circles are percent of total.

