

Colorado Flood Threat Bulletin – 2025 Final Report

DECEMBER 10, 2025

PREPARED BY:



990 S Broadway

Suite 400, Denver, CO 08209



215 S. Wadsworth Blvd, Suite 510

Lakewood, CO 80226

PREPARED FOR:



COLORADO

Colorado Water
Conservation Board

Department of Natural Resources

**C/O Kevin Houck
1313 Sherman St., Room 721
Denver, CO 80203
Phone: 303-866-3441
Fax: 303-866-4474**

Contributors

Alyssa Hendricks Dietrich, CCM
Senior Meteorologist
Project Manager
ahdietrich@dewberry.com

Cara Williams
Hydrologist
cwilliams@dewberry.com

Stevenray Janke
Meteorologist
sjanke@dewberry.com

Dana McGlone
Subconsultant
HydroMet Consulting, LLC
hydrometconsulting@gmail.com

Dmitry Smirnov, PhD
Subconsultant
HydroMet Consulting, LLC

Julie Gaddy, CCM
Subconsultant
HydroMet Consulting, LLC

Kyle James
Subconsultant
HydroMet Consulting, LLC

CONTENTS

1) INTRODUCTION.....	4
2) CHARACTERIZATION OF FORECAST PERIOD WEATHER.....	14
3) VERIFICATION METRICS.....	23
4) USER ENGAGEMENT	31
5) CONCLUSIONS	36
6) REFERENCES	37
APPENDIX A – FORECAST VERIFICATION WORKSHEET	39
APPENDIX B – BURN AREA VERIFICATION WORKSHEET	48
APPENDIX C – DATA SOURCES.....	53
APPENDIX D - COLORADO CLIMATE	55
APPENDIX E – FLOOD THREATS ISSUED.....	58
APPENDIX F – QPE BIAS ASSESSMENT	60
APPENDIX G – OUTREACH SURVEY.....	64

ACRONYMS

CDOT.....	Colorado Department of Transportation
CoCoRaHS.....	Community Collaborative Rain, Hail, and Snow Network
CO-NM REPS.....	Colorado-New Mexico Regional Extreme Precipitation Study
COOP.....	Cooperative Observer Program
CWCB.....	Colorado Water Conservation Board
FAR.....	False Alarm Rate
FBF.....	Fire Burn Forecast
FEMA.....	Federal Emergency Management Agency
FFG.....	Flash Flood Guidance
FTB.....	Flood Threat Bulletin
FTO.....	Flood Threat Outlook
GARR.....	Gauge Adjusted Radar Rainfall
HMC.....	HydroMet Consulting, LLC
IEM.....	Iowa Environmental Mesonet
LSR.....	Local Storm Reports
MRMS.....	Multi-Radar Multi-Sensor
NAM.....	North American Monsoon
NDMC.....	National Drought Mitigation Center
NOAA.....	National Oceanic and Atmospheric Administration
NRCS.....	Natural Resources Conservation Services
NSSL.....	National Severe Storms Laboratory
NWS.....	National Weather Service
PM Update.....	Update to FTB product during the afternoon hours
POD.....	Probability of Detection
PWS.....	Personal Weather Station(s)
QPE.....	Quantitative Precipitation Estimate
SNOTEL.....	Snow Telemetry
SPM.....	State Precipitation Map
SQL.....	Standard Query Language
SWE.....	Snow Water Equivalence
USGS.....	United States Geological Survey

2025 Colorado Flood Threat Bulletin

Final Report

1) INTRODUCTION

The 2025 forecast season (May 1st to September 30th) was the fourth year of a five-year contract awarded to Dewberry and HydroMet Consulting, LLC (HMC) to produce the Colorado Flood Threat Bulletin (hereafter, Program) on behalf of the Colorado Water Conservation Board (CWCB). Since work began on the Program in 2006, it has maintained the double objective of 1) producing and effectively disseminating reliable heavy rainfall and flood forecasts, and 2) incorporating the frontier of hydro-meteorological research into operations for more accurate heavy rainfall forecasts. To build confidence in the forecast accuracy, a transparent and robust verification process was added in 2014. Numerous Program upgrades have been made since the Program's inception (see previous season's final reports, Dewberry and HMC, 2022, Dewberry and HMC, 2023 & Dewberry and HMC, 2024). For the Program's 2025 season, the five main products delivered by the Program remained unchanged:

1. the daily Flood Threat Bulletin (FTB) that both describes and visualizes the flood threat across the state of Colorado;
2. the bi-weekly (Monday/Thursday) 15-day Flood Threat Outlook (FTO) that highlights the upcoming possible flood threat from rapid snowmelt (spring) and local heavy rainfall, or conversely, the development of drought conditions;
3. the daily State Precipitation Map (SPM) that recaps the past 24- to 72-hours of hydrometeorological conditions and includes flood reports;
4. the Fire Burn Forecast (FBF) that is a standalone forecast system that assigns a daily flood threat to the most impactful wildfire burn areas, includes the previous day's precipitation totals over these designated burns areas, and records burn-specific flood/debris flow reports;
5. the monthly Streamflow Tracker that shows recent and Water Year to-date adjusted (i.e., naturalized) streamflow conditions across most of the largest river basins within Colorado.

For the 2025 operational season, Dewberry continued to operate as the Program's Project Manager with subconsultant HMC in charge of forecast operations (together, hereafter referred to as Team). Dewberry meteorologists Alyssa Hendricks Dietrich and Stevenray Janke, and hydrologist Cara Williams produced the SPM and identified flood events for archiving within FBF. The Programs' forecasts (FTB/FTO/FBF), supplemental in-season FBF analyses and Streamflow Tracker tables were developed by HMC meteorologists Dana McGlone, Dmitry Smirnov and Julie Gaddy. Archived forecasts continue to be available through the Program's website www.coloradofloodthreat.com. Alyssa Hendricks Dietrich served as the Project Manager for Dewberry, and Mat Mampara served as Principle-in-Charge.

This Final Report was created to provide verification metrics for the daily flood forecasts, summarize the hydro-meteorological weather conditions over the 2025 forecast season, evaluate Program viewership, and summarize outreach activities.

Daily Flood Threat Bulletin (FTB)

FTB daily issuance occurs by 11:00 AM within the forecast season. Often, FTB forecasts are issued earlier to provide increased lead time to end-users, which is especially important on days when there is an elevated flood threat. The FTB highlights the daily threat level of flooding across the state, describes the nature of the threat, and notes the time in which the threat of flooding would be the greatest in a zone-specific manner (14 climate-defined Forecast Zones, see Figure 4). The beginning of each FTB discussion also highlights any threats issued for the FBF and provides a direct link to that forecast page for more information. Additional information provided by the FTB includes the probability and maximum intensity of thunderstorm rainfall rates, expected storm totals and a characterization of the threat of severe weather (tornadoes, high winds, hail, etc.). Table 1 summarizes the six-tier category system that is used to characterize the daily flood threat. The first five tiers indicate the day's flood threat: None, Low, Moderate, High, and High Impact. The last tier, National Weather Service (NWS) Warning, specifies if there are any active NWS Flood Warnings (riverine flood threat) at the time of the FTB post. During situations with a particularly threatening and/or rapidly evolving flood threat, the FTB and associated map can be updated during the afternoon hours (PM Update). This will occur when there is (1) initially "no threat", but at least an upgrade to Low threat is warranted, or (2) when a threat needs to be upgraded to a High threat, regardless of the initial threat issued in the morning. Updates to social media posts are also provided to notify end-users about the evolving flood threat. It is essential to note that the FTB was originally designed, and is still intended to be, a *forecast* product analogous to an NWS Flash Flood Watch, in contrast to shorter-lead *nowcast*-type NWS products such as Flash Flood Warnings or Areal Flood Advisories. In short, the FTB is not meant to be a substitute for the latter.

Table 1: Description of the six-tier category threat system.

Threat	EXPECTED PROBABILITY OF FLOODING WITHIN A GIVEN COUNTY
NONE	Less than 10%
LOW	10-30%
MODERATE	30-60%
HIGH	Greater than 60%
HIGH IMPACT	Greater than 60% along with a particularly severe threat to life & property
NWS WARNING	Active NWS (riverine) Flood Warning(s)

The threat of daily flooding is conveyed to the end-user using graphics and text. The graphical component of the product includes a map of the state of Colorado with county boundaries and a color-coded flood threat to succinctly illustrate the probability of flooding (Figure 1). Scroll over features on the maps will pop up relevant maximum rain rates and potential hazards by threat level for each of the threat areas drawn (not shown). All FTB forecasts issued for the season are available at the bottom of the product's page using a calendar search, and past forecasts (prior to 2023) are available through Dewberry.

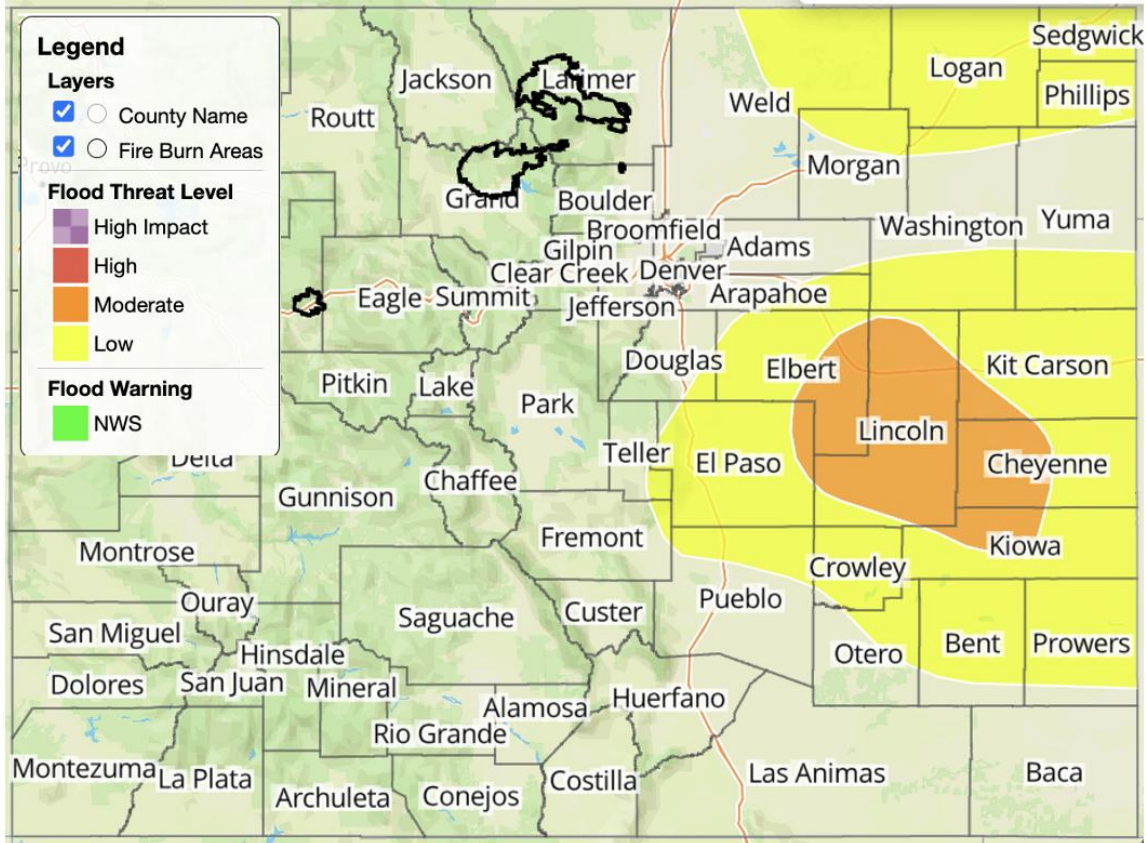


Figure 1: Example of the FTB map from August 9, 2025. The Low and Moderate threats are highlighted in yellow and orange, respectively.

Flood Threat Outlook (FTO)

The FTO is a bi-weekly product issued on Mondays and Thursdays by 3PM to address the expected flood threat across the state over the next 15 days. This product addresses both the snowmelt (May/June) and precipitation-driven flood threat, and it provides a precipitation forecast map, by event, for the entire state when meaningful precipitation is expected. Each event’s precipitation map is available via a drop-down menu as a visual aid to the forecast discussion. The FTO continues to be structured in an event-based manner, where rainfall is partitioned by its meteorological forcing features and presented in a timeline at the top of the product’s page.

An example of a threat “timeline” is shown below in Figure 2 from May 26th. This FTO includes a snowmelt riverine flood threat forecast. Also, on the first Thursday of each month, an additional climate-related analysis describing the previous month’s precipitation is provided within the FTO. The focus is on the precipitation anomaly and in the past have included graphics such as Snow Water Equivalent (SWE) percent of normal, changing drought conditions, and reservoir storage. Similar to FTB, past forecasts are available at the bottom of the page by use of a calendar, and past forecasts (prior to 2023) are available through Dewberry.



Figure 2: Example of an FTO “timeline” from May 26, 2025, illustrating the flood threat and a snowmelt outlook.

State Precipitation Map (SPM)

The State Precipitation Map (SPM) includes gridded Quantitative Precipitation Estimates (QPE) of 24-, 48- and 72-hour accumulations, as well as maximum 1-, 3- and 6-hour precipitation over the past 24-hour period at 250-meter resolution. The gridded QPE product begins with Multi-Radar, Multi-Sensor (MRMS) Pass II available from National Severe Storms Laboratory and is gauge-adjusted with 24-hour accumulations from the Community Collaborative Rain Hail and Snow (CoCoRaHS) network.

Making sure the Program has the highest quality gridded QPE and gauge-based precipitation observations are essential for post-storm assessment, tracking flood events, and assessing antecedent soil conditions that can influence the FTB forecast. It should be noted that the objective of the SPM is to provide a near real-time (i.e., very short lag time) look at precipitation accumulation across the state. This comes at the cost of introducing a possible gridded QPE bias, despite correcting with CoCoRaHS gauge data, that is difficult to fully resolve by the SPM's noon issuance deadline (see Appendix E). To account for this complication, the gridded QPE shown in the SPM was NOT used in the verification procedures outlined in Appendix A.

In addition to gridded QPE, automated data pipelines pull and store daily flood and heavy rainfall reports from the NWS using Iowa Environmental Mesonet (IEM). The Team also manually identifies flood reports, for example those from Colorado Department of Transportation (CDOT), CoCoRaHS Significant Weather Reports, and social media, which are also stored in the Team's database and presented in the SPM. To further grow the database for heavy rain reports, the Team screens 24-hour CoCoRaHS gauge accumulation that exceeded that 10-year Average Recurrence Interval (ARI) using the CO-NM REPs. This helps provide greater context on heavy rainfall days as NWS heavy rain reports are infrequent and irregular, but is limited by the 24-hour duration, though accumulations are likely less than 24-hours. All reports can then be displayed on the web map as shown by the blue and green dots in Figure 3, which helps add a spatial component to the precipitation summaries.

Lastly, meteorologists and hydrologists provided text-based summaries of recent hydrometeorological conditions including qualifying extreme rainfall totals with their relevant ARI and tracking severe weather and large wildfire activity. Discussions are also supplemented with gauge data from CoCoRaHS, Cooperative Observer Program (COOP), Mile High Flood District's ALERT, and Snow Telemetry (SNOTEL) networks, which are not always supplied from the data pipelines. The Program continues to allow anyone to report flooding through the "Report a Flood" tab located at the top of the website, however it is rarely used by end-users.

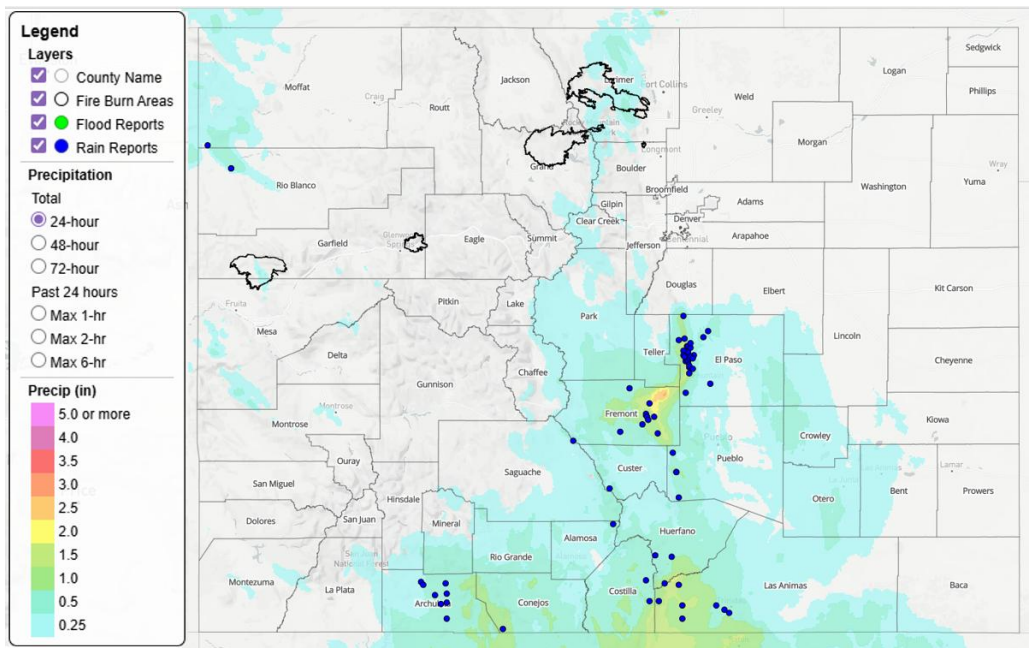


Figure 3: Example of SPM from May 6th, 2025, showing the previous day's precipitation, flood reports (green, none pictured) and heavy rainfall reports (blue).

Fire Burn Forecast (FBF)

There is concern for extremely dangerous runoff, mud flows, and debris slides over recent wildfire burn areas located over steep terrain, especially those near population centers and highly traveled roads. Since roughly 1980, Colorado has experienced an increasing trend in wildfires exceeding 10,000 acres (HMC and Dewberry, 2022). During the 2020 wildfire season alone, Colorado experienced three of its largest fires on record with a total of seven fires exceeding 10,000 acres in size. While burn areas continue to recover each season, they still produce enhanced flooding hazards, frequently with much lower rain intensity, during heavy rainfall events. Due to the stark difference between runoff sensitivity over burn areas compared to nearby unscarred areas, the FBF product was created in 2021. The FBF is a standalone wildfire forecast system meant to complement the overall goals of the Program and remove burn areas from the daily FTB discussions (as was done from 2017 to 2020). The main objective of the product is to create a concise, easily accessible tool that (i) helps assess and prepare for the flood threat specifically focusing on the most vulnerable burn areas, and (ii) archives recent conditions for an enhanced perspective of multi-day rainfall events. Similar to the FTB, the FBF provides an early outlook for threat awareness, and it is not to be used for real-time flood warning and monitoring.

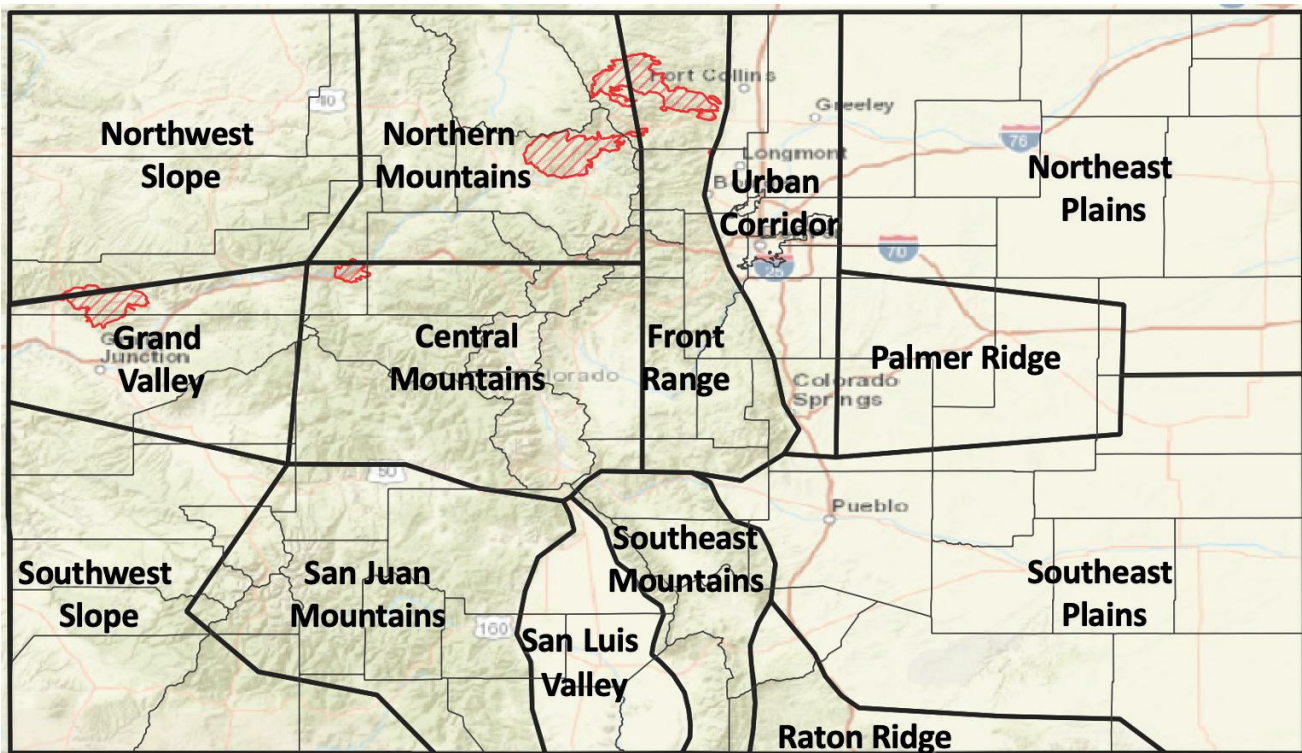


Figure 4: Forecast zones and wildfire burn areas (red hatch) that were featured on the daily FTB and FBF maps for 2025.

Source for burn areas: National Interagency Fire Center

This forecast season, the Team and CWCB Program Manager initially identified and monitored six potentially dangerous burn areas in the FBF (Figure 4): Alexander Mountain (year of fire: 2024), Cameron Peak (2020), East Troublesome (2020), Grizzly Creek (2020), Pine Gulch (2020), and Stone Canyon (2024). Because of the robust and worsening drought over western Colorado, after another very early season melt out and hot, dry weather, the fire season began in July. By August, there were four new significant burn areas: Turner Gulch (Mesa County, July 12), Elk Fire (Rio Blanco County, August 2), Lee Fire (Rio Blanco County, August 2), and Stoner Mesa Fire (Montezuma County, August 26). With more than 230K combined acres burned this year, ~138K acres from the Lee fire alone, this was the worst wildfire season since 2020 when ~625K total acres burned. This season, the FBF table was not updated to include any of these new burn areas due to the more rural nature of the fires. However, several debris flow events were noted over the Lee/Elk Fire burn area (Lee/Elk Complex) with one debris flow event over Turner Gulch burn area. More information about these fires and the “Post-Season Fire Burn Forecast Threshold Assessment” that is completed each season can be found below.

Ideally, every recent wildfire burn area would be the subject of a dedicated flood threat, but in practice limited resources imply the need to focus on the most impactful burn areas for the daily FBF: those which are relatively large in scale (corresponds to a higher runoff threat) and those that are near high population density and/or major roads. Similar to the FTB and FTO maps, the burn areas are interactive on every Program produced map, and clicking on a burn area shows the fire’s name, year of occurrence, and the number of acres burned.

An example of data displayed in the daily FBF is shown in Figure 5. The product contains both the daily forecast as well as rainfall statistics over each burn area from the prior day. The “Fire Burn Forecast” threat level (Figure 5, left) uses the same five-tiered threat system as the FTB (None, Low, Moderate, High and High Impact) with the threat level representing the likelihood for excessive runoff, flash flooding, mud flows, and/or debris slides over the given burn area within the next 24 hour forecast period. Burn area rainfall thresholds are set at the beginning of each season and are adjusted prior to the start of the monsoon season, as necessary. There were no adjustments this season due to the lack of rainfall events over the burn areas prior to the late monsoon. If the FTB threat overlaps a burn area, the burn area will have at least a 1 tier higher threat issued to show extra sensitivity over the burn area to flood events.

The “Fire Burn Info” (Figure 5, right) shows three measures of antecedent rainfall for the prior 24 hours to assess the current soil conditions over the given burn area. The measures are: (1) maximum 3-hour and (2) average 24-hour rainfall over any portion of the burn area, and (3) the percentage of the burn area that received precipitation. The QPE estimates in 2025 are derived from the SPM that uses MRMS with a CoCoRaHS gauge adjustment. If there is an over or underestimation by this gridded QPE, values are manually adjusted to gauge measurements in the area. The last column shows an evaluation of whether flooding was reported in the past 24 hours, which is determined from news reports, social media reports, storm reports and internal Program contacts. The Team still maintains specific contacts for burn area known to have flooding issues, such as Cameron Peak and East Troublesome. To get an idea of forecast performance, the Team completed a high-level verification for burn area threats once again this season. More information and methodology can be found in Appendix B of this report.

Fire Burn Forecast 8-26-2025		Fire Burn Info 8-25-2025			
Fire Name	Today’s Threat	Max 3hr (in)	Avg 24 hr (in)	Burn Area Coverage	Flooding Reported
Alexander Mountain	Moderate	0.2	0.1	> 90 %	NO
Cameron Peak	Low	0.6	0.3	> 90 %	NO
East Troublesome	None	0.6	0.1	55 %	NO
Grizzly Creek	None	0.3	0.2	> 90 %	NO
Pine Gulch	None	0.9	0.3	> 90 %	NO
Stone Canyon	Moderate	0.2	0.2	> 90 %	NO

Figure 5: An example of data shown in the daily FBF post from August 26, 2025.

Streamflow Tracker

To expand the Program’s reach to a more diverse group of end-users, a streamflow table that tracks naturalized flow across 14 sites representative of Colorado’s largest river basins continued to be provided this season after implementation in 2022. Historically, these sites produce large flows (combined average yearly flow close to 10 million acre-feet), have long periods of record, and represent key sites at their headwaters. The table is updated mid-month during the forecast season, and it uses “adjusted” observed streamflow from National Resources Conservation Services (NRCS), which estimates the volume of streamflow that would occur without the influences of major upstream reservoirs or diversions. In addition to tracking monthly flow and Water Year to-date flows at each site, the table tracks the average and percentile values relative to normal. While average flow can be a useful metric, it does not do well at capturing the extremes of high and low flows at a site. For this reason, the percentile of normal flow was added which better captures the potentially non-Gaussian distribution of flow relative to the site’s history. This metric can be especially helpful when the site has a long period of record.

Figure 6 below illustrates the tracker table from May 2025. Blue shades indicate values above normal whereas orange shades indicate values below normal. This season there were only above normal values in April, which corresponded to the earlier melt southern and western Colorado. In August, the White River near Meeker had its lowest flow on record with all other reporting rivers below the 10th percentile. Missing data continues to present a challenge for the product as sites are updated with a varying degree of latency or are sometimes backfilled only once a year. For example, monthly statistics available by mid-month at each site ranged from 93% (April) to 50% (June). The Team reached out to Northern Water to see if the Cache la Poudre could be available during the season (real-time vs. backfilled once a year), but they did not think this was possible due to the complicated nature of the diversion system.

COLORADO STREAMFLOW TRACKER [MAY 2025]								
Location	Latest Month Data (May)				Water Year To-Date Data (Oct-May)			
	Value	Normal	% of Average	Percentile	Value	Normal	% of Average	Percentile
SOUTH PLATTE RIVER basin								
South Platte		49.8				123.5		
Cache la Poudre at Canyon Mouth		69.5				113.1		
ARKANSAS RIVER basin								
Pueblo Reservoir Inflow		67.9				262.7		
RIO GRANDE basin								
Rio Grande River at Del Norte	107.1	156.2	69%	19	281.8	308.3	91%	43
NORTH PLATTE RIVER basin								
North Platte near Northgate		64.4				155.3		
COLORADO RIVER basin (NORTH)								
Little Snake River near Lily	68.3	154.3	44%	10	137.3	271.6	51%	10
Yampa River near Maybell	217.3	379.3	57%	8	455.3	675.1	67%	14
White River near Meeker	49.5	94.2	53%	6	205.2	250.6	82%	11
COLORADO RIVER basin (CENTRAL)								
Colorado River near Cameo	420.2	663.2	63%	12	1173.3	1469.2	80%	20
Gunnison River near Grand Junction	194.7	528.2	37%	7	828.4	1177.2	70%	18
COLORADO RIVER basin (SOUTH)								
Dolores River at Dolores	41.5	102.4	41%	5	83.0	176.6	47%	8
Animas River near Durango	73.8	137.9	54%	9	186.1	284.2	65%	13
Vallecito Reservoir Inflow	39.9	65.8	61%	9	100.6	129.5	78%	23
San Juan River near Carracas	59.5	129.2	46%	3	153.1	298.7	51%	5
TOTAL		2662.4				5695.7		

All Units are x1000 acre-feet; Updated: June 20, 2025; Next Scheduled Update: July 17, 2025

HydroMet Consulting LLC

Figure 6: An example of the Streamflow Tracker from May 2025. The middle column shows monthly data, while the right column shows Water Year to-date data.

Performance Metrics

Table 2 shows the final year-to-date number of all products provided and the percent provided on time. Out of 503 total products delivered, the Team delivered 500 on time or ahead of time. **All 153 FTB products were delivered on time.** Of the three late products, one was FBF and the other two were FTOs, and all late products were posted within 15 minutes of their deadline. Below, Table 2 shows September performance, since there was no monthly Progress Report prepared, and all other necessary information for the September Progress Report is contained within this Final Report. Other monthly Progress Reports were prepared for May through August and sent to the CWCB Project Manager no later than 3 weeks after the end of the month.

Table 2: On-Time performance metrics for all issued products in 2025 (SPM, FTB, FTO and FBF).

		Products to Date	Products on Time	Products Late	Percent on Time			Products to Date	Products on Time	Products Late	Percent on Time
September	SPM	30	30	0	100%	YTD	SPM	153	153	0	100%
	FTB	30	30	0	100%		FTB	153	153	0	100%
	FTO	8	8	0	100%		FTO	44	42	2	95%
	FBF	30	30	0	100%		FBF	153	152	0	99%
	TOTAL	98	98	0	100%		TOTAL	503	500	3	99%

In-Season Analysis of Flash Flood Events

In an effort to supply rainfall related data after a noteworthy flash flood or debris flow event, the Team produces in-season, event-based analyses at the request of the Program Manager. The near real-time reanalysis work can be helpful for end-users, particularly emergency management teams. The analyses provided typically contain information about the timing of rainfall, intensity and magnitude of rainfall, and corresponding peak flows on nearby rivers and creeks. This is intended to aid responders with insight about the event and help raise awareness for future heavy rainfall scenarios. The analyses are disseminated through social media, which allows the Program to engage more end-users, boosts Program viewership, and conveys that the Program is not just about providing forecasts for heavy rainfall.

There was no specific post-storm analysis requested by the Program Manager this season. However, the Team sent the Program Manager a few emails contextualizing a couple of noteworthy events. The first was on August 20th where a 0.1% AEP storm occurred near Monument. Personal weather stations (PWS) in the area recorded 2.7-2.9 inches in 60-minutes, while the next nearby non-PWS observation was only 0.82 inches (CoCoRaHS). The Team has been trying to harness PWS data to capture events that occur between conventional network gauges, and this serves as one, of many, excellent examples. Alongside this, the Team has also been comparing the NOAA Atlas 14 values to the NM REPS study, which often can be quite different from one another. These differences are especially noteworthy in areas with rapid change in elevation (i.e. Palmer Ridge). Another event recap email was sent to the Program Manager following the SW Colorado flood event in October. This email contained images of historical San Juan River at Pagosa Springs flows and Precipitable Water anomalies in comparison to climatology during the event. The amount of available moisture paired together with strong dynamics for the October event is what made it truly historical.

Post-Season Fire Burn Forecast Threshold Assessment

As an effort to keep track of the recovery over each burn area and adjust rainfall intensity thresholds prior to the start of the season, the Team produces a yearly Technical Memo during the off season addressing the FBF thresholds (HMC, 2022, HMC, 2023, & HMC, 2024). The procedure for the Post-Season Fire Burn Forecast Threshold Assessment uses the same general methodology for post-wildfire burn debris flow forecasting from the latest peer-reviewed literature (e.g., Hoch et al., 2021). The methodology follows that burn areas have high initial sensitivity (≤ 1 year after the burn occurred) and over a 3-5 year period after, this threshold begins to recover to the “normal” value of the surrounding terrain.

For each burn area, a two-part analysis is completed. The first part of the analysis is to inform of the long-term net precipitation deficit/surplus over the burn, which serves as a proxy for the vegetative recovery process. For this analysis, a time series of net warm season precipitation accumulation (from the year of the burn) is compared to climatology. An example of this is shown in Figure 7 for East Troublesome. Cumulative anomaly, percent of normal and maximum 24-hour totals over the period are also collected along with PRISM climatology for perspective (top left). The second part of the analysis (not shown) informs on the number of hours during the warm season (since the year *after* the burn occurred) where greater than 0.25 inches of rain was estimated using Multi-Radar Multi-Sensor (MRMS) data. This also helps inform on the vegetation’s recovery, but this analysis includes a spatial component.

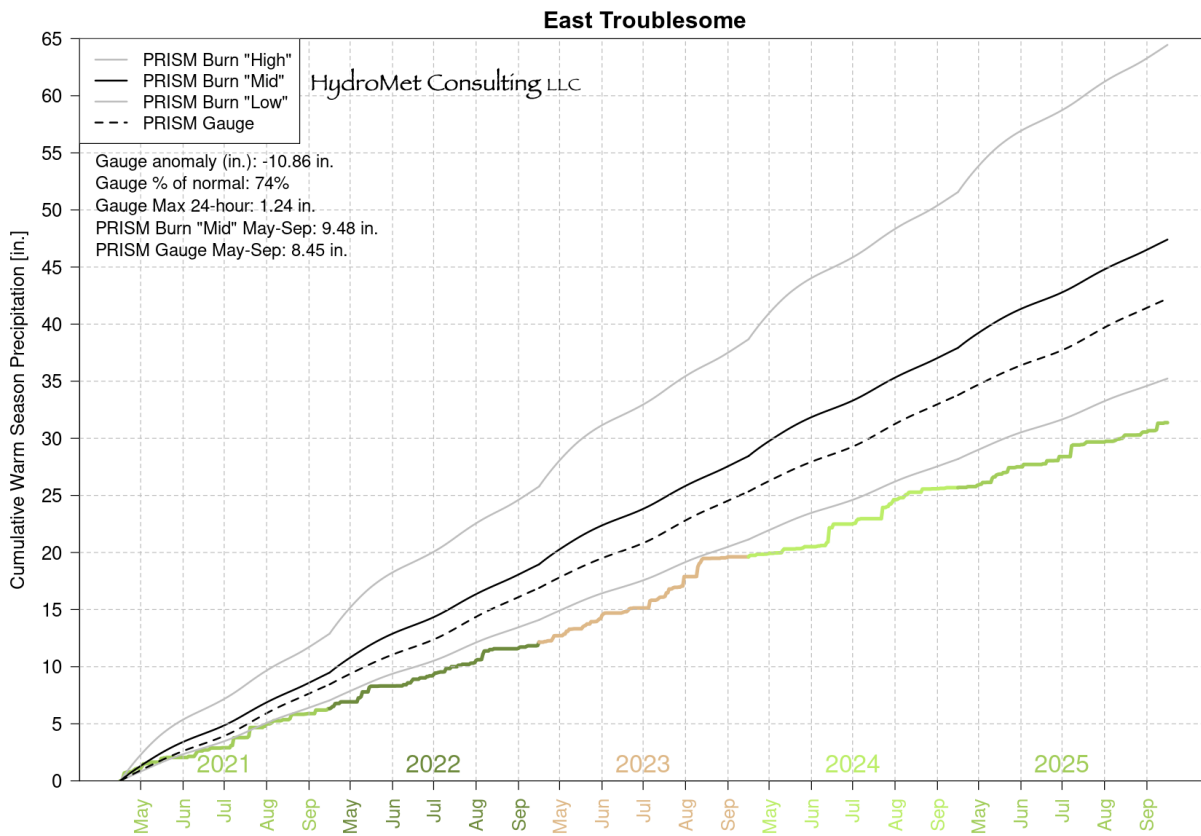


Figure 7: Example of a cumulative warm-season rainfall graphic (2021 green, 2022 dark green, 2023 tan, 2024 light green and 2025 green) over the East Troublesome burn area as compared to normal and PRISM climatology (black line).

Assessments and recommendations are then presented in the preseason to the CWCB Program Manager. Adjustments to thresholds are finalized with input also received from Emergency Managers and Colorado State Forest Service prior to the start of the next season. As expected, the rainfall intensity thresholds utilized in the FBF product either stay the same or increase each season. Table 3 shows the 2025 forecast thresholds for each of the burn areas. While the thresholds listed are in inches per hour (to match the Team’s internal guidance as well as gridded rainfall estimates), the assumption is that most rainfall accumulation occurs in a 15 to 45-minute period. For the thresholds given below, the bottom four burn areas (green) match the Program’s 1.0 inch per hour threshold over mountainous terrain. However, unlike FTB, there is no areal coverage of rainfall rates that need to be met to issue a FBF threat. Additionally, if one of these four burn areas is included in the FTB threat map, the FBF forecast threat level is raised one category (e.g., Low up to Moderate). Forecast thresholds may be adjusted prior to the onset of the monsoon, but only with CWCB Program Manager approval and after being tested by a variety of intense rainfall events. No thresholds were changed mid-season in 2025, and no new burn areas were added.

Table 3: Fire burn area thresholds used for 2025 forecast operations. Green shading indicates that the threshold matches the Flood Threat Bulletin (though extra sensitivity may still be employed, at the forecaster’s discretion).

Burn Area Name	Year of Fire	Acres Burned	Forecast threshold (inches/hour)
Alexander Mountain	2024	9,969	0.25
Stone Canyon	2024	1,309	0.25
Cameron Peak	2020	208,912	1.00 (0.75 inches with antecedent rainfall)
East Troublesome	2020	193,811	1.00
Grizzly Creek	2020	32,431	1.00
Pine Gulch	2020	138,803	1.00

2) CHARACTERIZATION OF FORECAST PERIOD WEATHER

Overview

The 2025 operational season saw numerous significant weather events. To start the season, snowpack levels in May were once again below the median following an early melt out in April, which helped mitigate the early FTB season riverine flood threat. Most of southern Colorado found itself in some level of drought entering the FTB season, with up to D3-Extreme drought conditions over portions of the Grand Valley, Southwest Slope, and San Juan Mountains (Figure 8).

A surface low during the first week of May brought widespread steady rainfall and drought relief from the San Juan Mountains and Southwest Plains to the Urban Corridor. Several 2-day precipitation accumulations exceeded 3 inches with the event, and over 150 heavy rain reports were recorded. Rainfall from the event was mostly long-duration and lower intensity which mitigated the flood threat. Apart from the first week, the rest of May experienced mostly average precipitation, and flood reports were minor.

The rest of the season was more active from a flood report perspective, but no month stood apart from the others as June, July, and August each tallied about 40 flood reports (Figure 12). Outside of the northwestern regions, most of the state saw above normal precipitation for the month of June, including record wet conditions for pockets of the Northeast Plains (Figure 9). A pair of surface lows caused rainfall that washed out a road and caused debris flows on the 5th, as well as 8 flood reports across the Urban Corridor on June 17th.

The North American Monsoon (NAM) started off mostly dormant in July. Outside of early season rainfall, little precipitation fell across western regions, leading to record dry conditions for some in July. On the other hand, the eastern half of the state mostly saw above normal precipitation for July, with isolated areas of the Northeast and Southeast Plains experiencing record wet conditions (Figure 9). On the 16th, a cold front brought heavy rainfall and flooding to Greeley, Arvada, and Manitou Springs – prompting the City Hall and a nearby RV park in Manitou Springs to be evacuated following a rapid rise in Fountain Creek. July closed with a 3-day stretch of 17 flood reports (9 major, 8 minor) thanks to a surface low and associated cold front which brought flooding from the Raton Ridge to the Northeast Plains.

By early August, portions of the western regions had gone weeks without rain, leading to D3-Extreme Drought for much of the area and extreme fire conditions. The Lee Fire developed during this time near Meeker and saw explosive growth, quickly climbing into Colorado's top largest wildfires; by the time of containment, the Lee Fire was the 4th largest in state history. As the Lee Fire raged out west through the month, the eastern half of the state continued seeing isolated record wet conditions (Figure 9). Severe storms brought large hail, including up to 3.8 inches in diameter near Karval on the 9th, and a storm in Monument dropped 2.73 inches of precipitation in one hour on the 19th. The NAM ramped up during the tail end of August, finally bringing much needed days of rainfall to the western regions. The increase in precipitation was welcomed by firefighters, but the scorched ground left behind by the still ongoing Lee Fire, which at this point had ballooned to over 130,000 acres, caused extreme debris flow risk. Unfortunately, debris flows occurred 6 days in a row around the Lee and nearby Elk burn areas from the 23rd to the 28th. The 24th alone saw 5 debris flows around the burn areas, one of which trapped a semi-truck that tried to drive through the debris.

The flood threat decreased, as is typical, in September, but the Lee Fire burn scar continued to pose problems throughout the month, with even small amounts of heavy rain triggering frequent Flash Flood Warnings and more debris flows. Near normal precipitation was in store for western regions of the state while eastern portions once again saw wetter than normal conditions (Figure 9). The persistent above normal precipitation led to a drought-free eastern half of the state to close out the season. The uptick in moisture towards the end of the season wasn't enough to heal the drought across western regions as widespread D3-Extreme drought conditions dominated (Figure 8).

Although the FTB season ended in September, there are sometimes unique heavy rainfall events that occur outside this time range. In these cases, special bulletin FTB and SPM products can be issued, which was the case in October of 2025. Beginning October 10th, remnants of Tropical Cyclones Raymond and Priscila produced back-to-back rainfall events and historic flooding over portions of the Southwest Slope and San Juan Mountains. Days of heavy rainfall overstressed several creeks and rivers in the region, including Vallecito Creek which experienced record flow

on the 11th. The flooded creek breached levees in the town of Vallecito, causing water damage in around 100 homes and prompting hundreds more to evacuate.

In Pagosa Springs, the San Juan River also reached major flood stage which flooded businesses and infrastructure and prompted more evacuations. A comparison of daily average flow (1935-2025) on the San Juan River at Pagosa Springs can be seen in Figure 10, showing the massive spike in October that exceeds all previous daily averages and dwarfed the 2025 snowmelt peak. US-160 between Pagosa Springs and South Fork saw significant amounts of water and debris on the road from the flooded Rio Grande River, which caused a large stretch of the road to close. Over the course of the 2 events, 5-day rainfall totals from the 10th-14th reached 5-7 inches in areas that average around 2 inches for the entire month. The soaking rainfall brought significant drought relief to the Southwest Slope and San Juans Mountains as seen in the improvement between September 30th and October 14th (Figure 8).

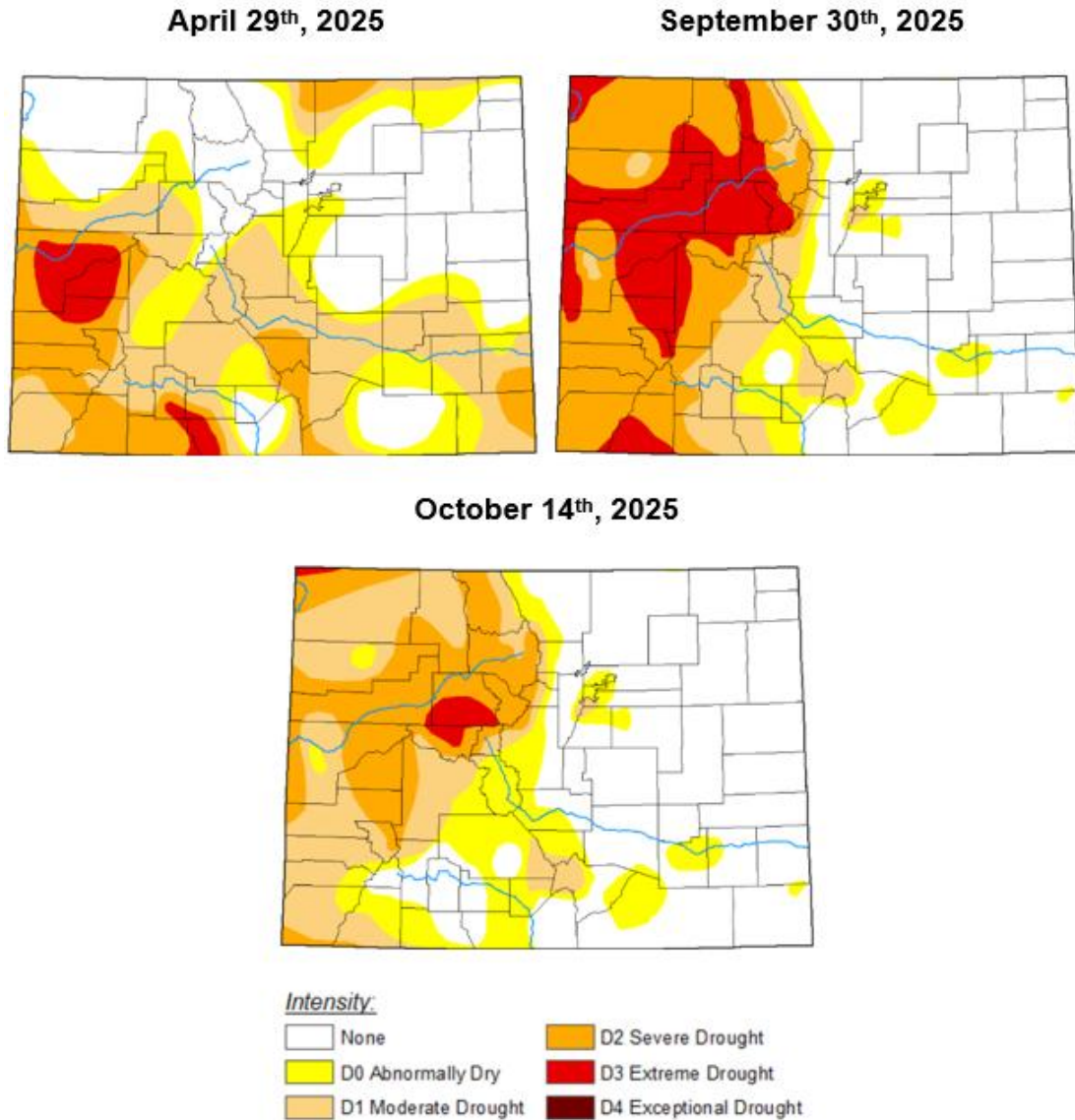


Figure 8: US Drought Monitor update valid on April 29th, 2025 (top left), September 30th, 2025 (top right), and October 14th, 2025 (bottom) showing the drought conditions at roughly the start and end of the 2025 season, as well as conditions after the October 10-14th flood event. Source: The U.S. Drought Monitor is jointly produced by the National Drought Mitigation Center (NDMC) and the University of Nebraska-Lincoln, the United States Department of Agriculture, and the National Oceanic and Atmospheric Administration. Maps courtesy of NDMC.

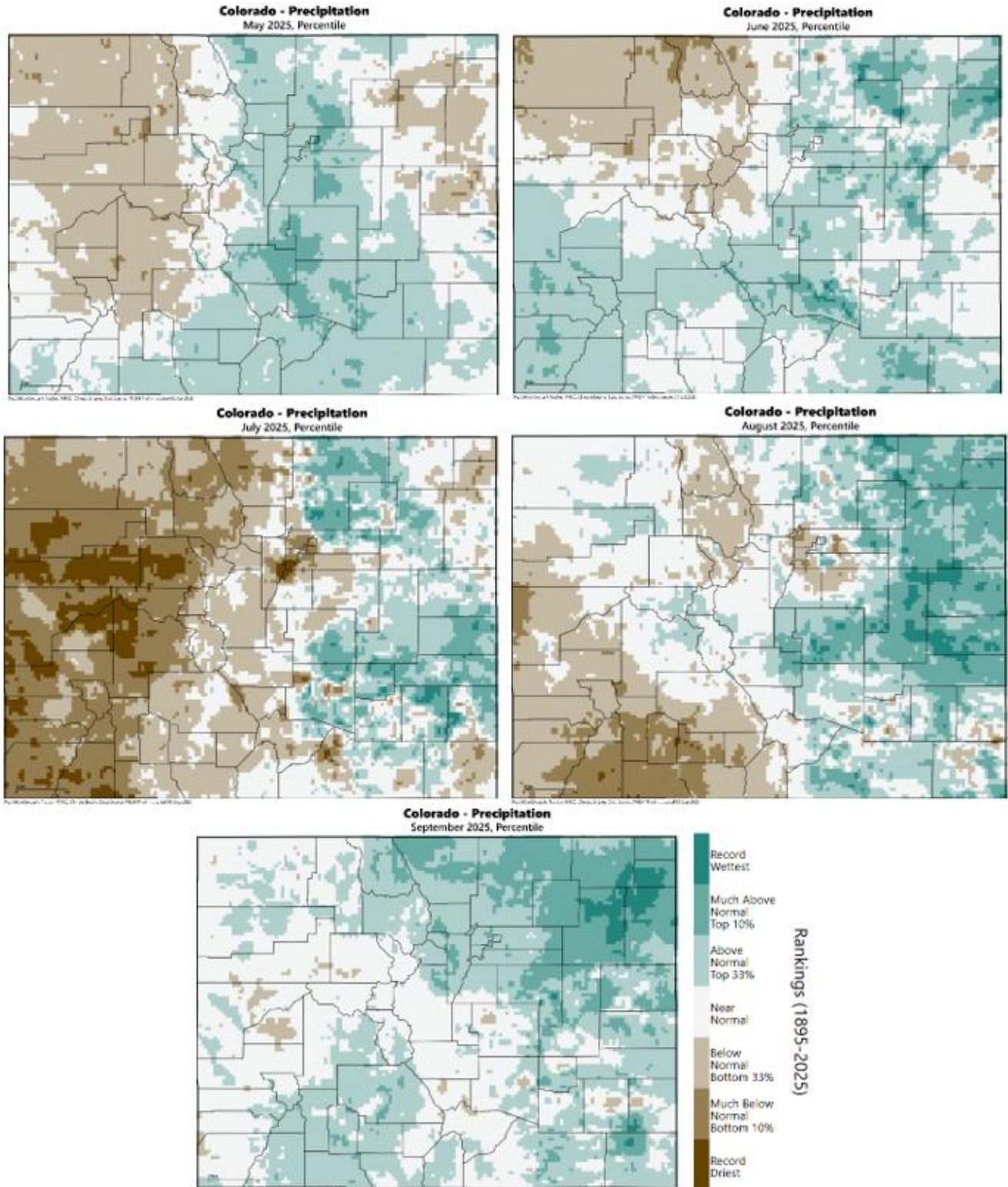


Figure 9: Monthly precipitation anomalies (PRISM) ranked by percentile May-September 2025. Source: WestWide Drought Tracker.

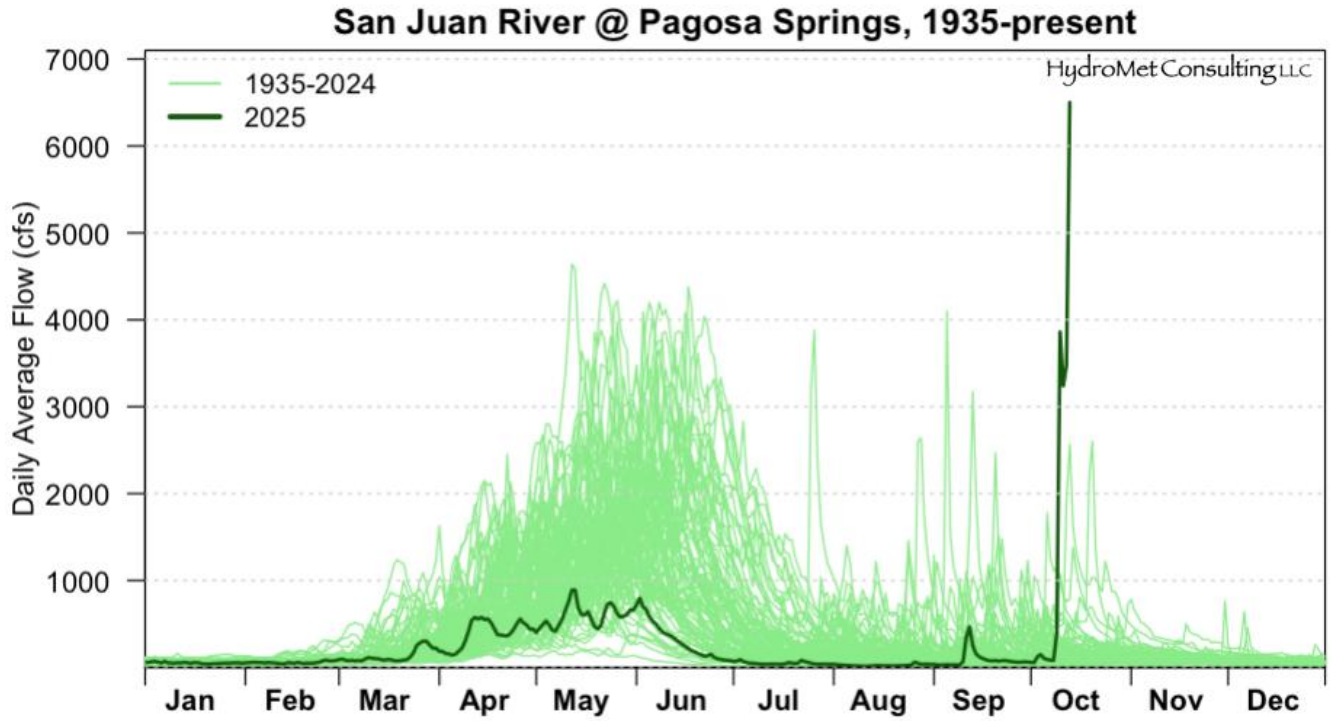


Figure 10. Daily average flow of the San Juan River at Pagosa Springs, including 1935-2024 traces (light green) and 2025 (dark green).

Major Events

A list of five significant events reported this season is shown in chronological order in Table 4, plus the extraordinary post-season October rainfall. These events were selected for having both widespread impacts and various locations across the entire state, providing a snapshot of headlines throughout the season.

Table 4: Six impactful flood and rain events over the 2025 season, in chronological order.

FLOOD EVENT	DATE (S)	INTENSITY	IMPACTS
AZ/NM Low Brings Widespread Rainfall for Southeast Colorado	May 5-7, 2025	3-4 inches in Cañon City and Colorado Springs over 3-day period	Over 150 heavy rain reports over 3-days, water emergency in Manitou Springs “as water flowing into town was too turbid for treatment facilities to keep up with”
Severe Thunderstorms, Flooding from Shortwave Trough in Northeast Colorado	June 17, 2025	Up to 1.5 inches in 1-hour; 0.4 inches in 5-minutes at Limon Municipal Airport	Flooding along Urban Corridor and Palmer Divide, large (2+ inch) hail, Teller County tornado
Manitou Springs, Urban Corridor Heavy Rainfall	July 16, 2025	Isolated 2+inches in 1-hour, 1.87 inches in Manitou Springs, 2.39 in Colorado City	City Hall, RV Park, and other businesses evacuated in Manitou Springs from flash flooding on Fountain Creek; Flooding on Highway 34 in Greeley; Flooding on I-25 between Pueblo and Colorado City
Widespread Rainfall from Monsoon Moisture for Eastern Colorado	July 29-August 26, 2025	Multiple days of 1+ inch rainfall from short duration (1-3 hour), monsoonal thunderstorms. August 19 wet microburst in Northern El Paso County rate of 3 inches/hour	30+ flood reports over month of August along Urban Corridor, Southeast Mountains, Palmer and Raton Ridges, Northeast and Southeast Plains
Western Slope Debris Flows	August 24-25, 2025	As little as 0.22 inches in 2-hours, highlighting sensitivity of recent burn areas	Multiple debris flows on still burning Lee, Elk, and Turner Gulch fires
Southwest Flooding from Tropical Remnants	October 9-14, 2025	5+ inches over wide swatch of Southwest Slope and San Juan Mountains during 5-day period	Levee breach and evacuations in Vallecito, San Juan River crests at major flood stage in Pagosa Springs, travel impacts from debris flows and flooding across Southwest Colorado

Seasonal Stats

There was a total of 59 Flood Days over the 2025 forecast season, which is below the average of 67 Flood Days. Figure 11 shows the daily number of rain gauge reports over one inch for each day of the season, separated by east and west gauge locations, as defined by the 5,250-foot elevation contour (see Figure 14). Also overlaid is the estimated areal extent of precipitation that exceeded one inch, measured by Stage IV gridded precipitation. There were 57 (19) days in total where at least one station measured at least one (two) inch over eastern Colorado and 73 (23) days over western Colorado. These numbers are slightly up compared to last season. Typically, when there is a large areal extent and several gauges either east and west (or both) over 1 inch, one can interpret this as large-scale rainfall event. An example of this is on May 6th, where the Front Range and immediate adjacent eastern plains of Colorado saw heavy rainfall. The graphic below can also distinguish events that are more rural in nature. That is when the Flood Day area is a higher end value, but the gauge count is low, such as August 9th. This was a flood event confined to the eastern plains with much of the Flood Day area over the Palmer Ridge. One limitation for Flood Day identification is that rainfall intensity may have not occurred within an hour, so widespread events could be representative of a stratiform rainfall event which tend to not cause flooding issues such as May 6th. Finally, it's worth pointing out that the NAM this season was late and didn't cause many flooding issues until August, which is atypical. There were several Flood Days at the end of the month, which is somewhat unusual, especially with the beginning of August also being quieter.

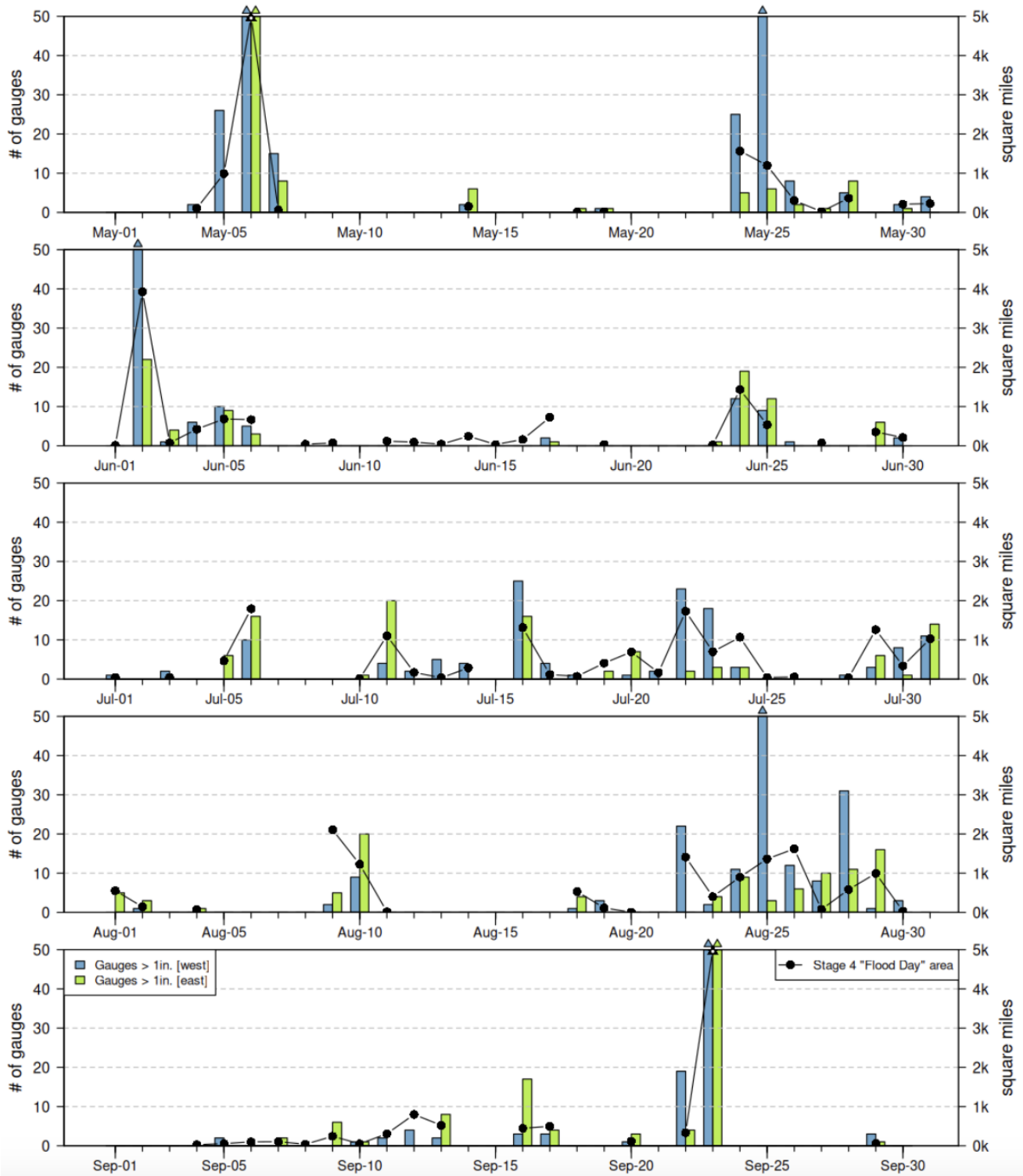


Figure 11: Daily summaries of number of gauges exceeding 1 inch of precipitation over “western” (blue) and “eastern” (green) areas. See Figure 14 for demarcation of these areas. A blue or green triangle indicates more than 50 gauges measuring 1 inch. See Appendix A for more detailed daily gauge statistics. Also shown is the estimated areal coverage of precipitation, in square miles, exceeding 1 inch based on NOAA Stage IV gridded precipitation product (line with black dots). Upward point triangles indicate an area in excess of 5,000 square miles. The total area of Colorado is 104,000 square miles.

There were a total of 162 individual flood reports this season. Flood reports came from various sources including NWS Local Storm Reports, CoCoRaHS observation remarks and significant weather reports that indicate flooding, social media reports of flooding with an identifiable location, and CDOT road conditions. August was the most active month for flood reports, with a total of 60 individual flood reports (Figure 12). Flood reports spanned across 13 of the 14 forecast zones, with the San Luis Valley remaining flood report-free this season (Figure 13). The majority were reported along the populated Urban Corridor from Fort Collins to Colorado Springs.

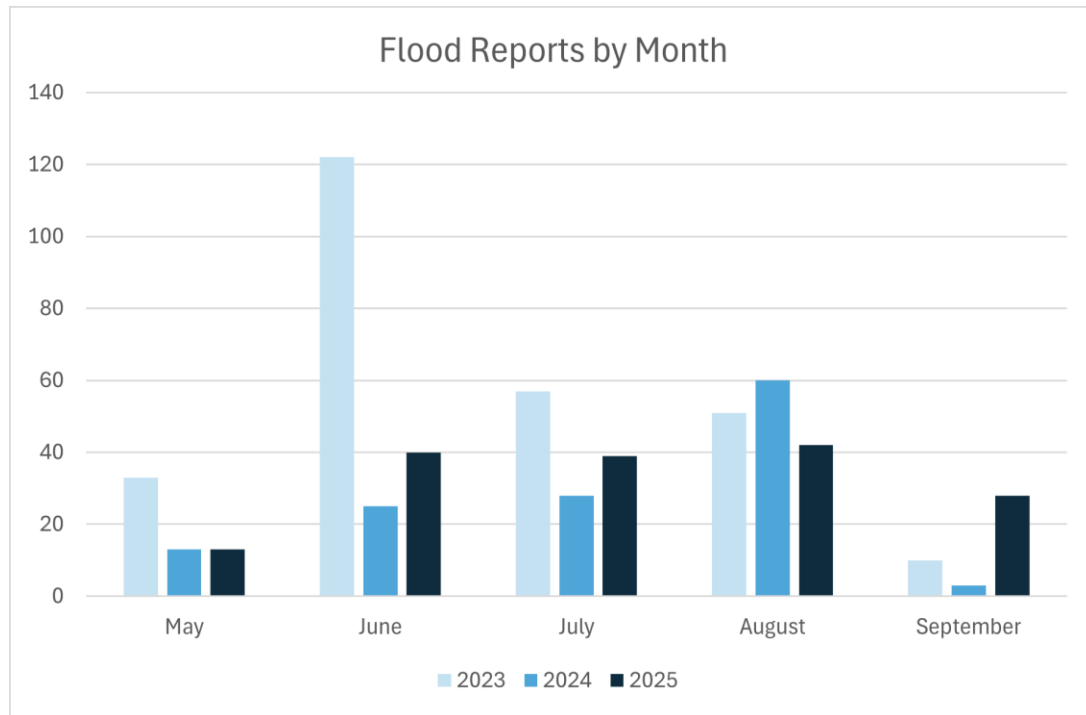


Figure 12: Number of flood reports per season for 2023-2025. This figure is updated annually to compare flood reports by month between successive seasons.

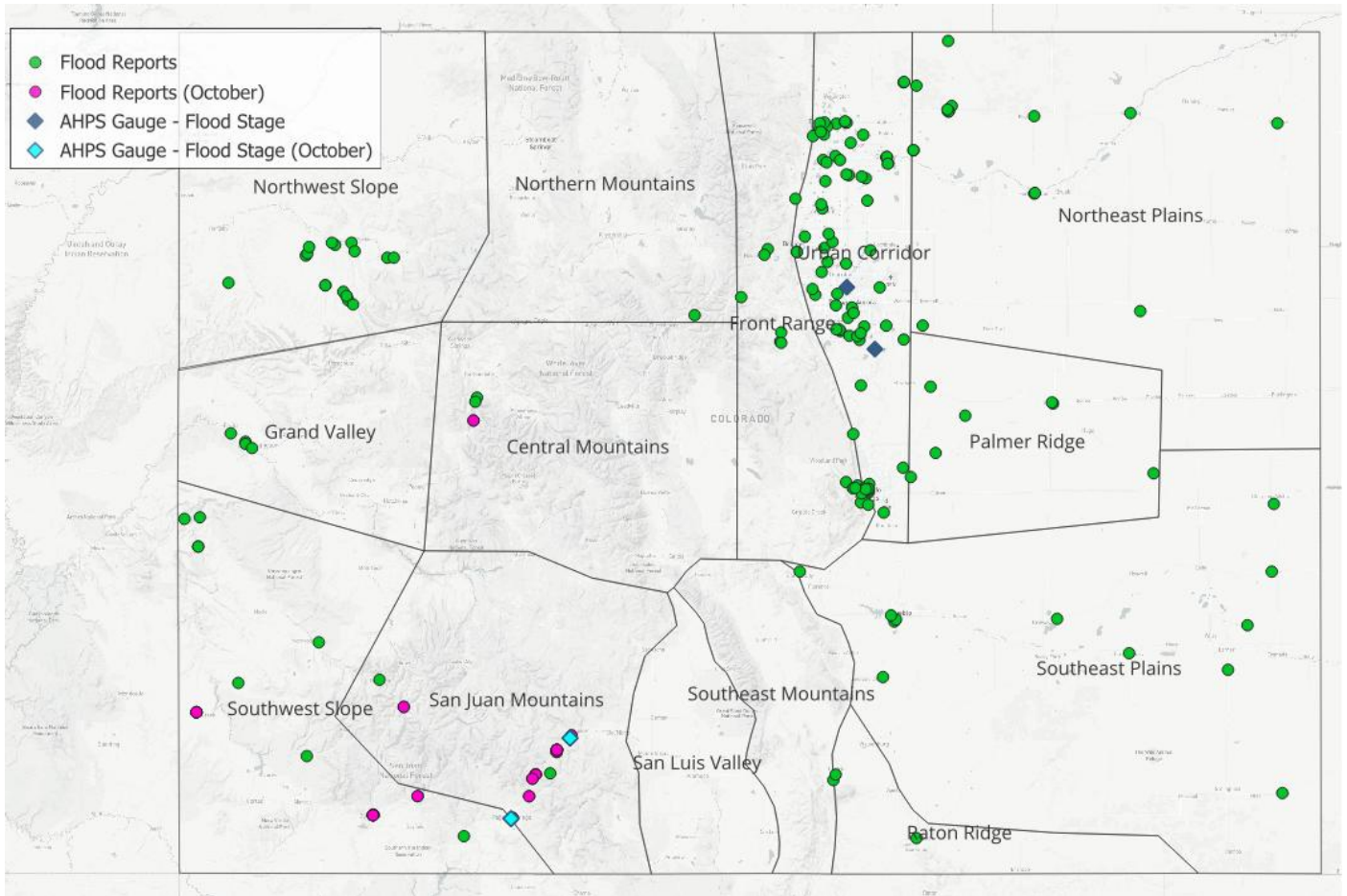


Figure 13: Map of all flood reports, including riverine, within the state from May 1 – September 30, 2025. The map also includes reports from the October 9-13, 2025 flood event.

VERIFICATION METRICS

Data Sources

Daily FTB forecasts were verified on several factors, most notably the ability to: (i) identify days when flood threats were realized, (ii) specify the approximate location of the potential flooding without grossly overestimating the flood threat area, and (iii) minimize False Alarm forecasts where flooding was forecast but not observed. The use of multiple radar-estimated products (including a daily QPE product bias estimate) has also helped create a more thorough analysis. The Team continually places substantial effort on verification to increase forecast utility and, in turn, help improve future forecasts. The data sources and methodology used to verify the 2024 forecasts can be found in Appendix C.

FTB Verification Methodology

To determine if a flood threat was realized on a given day, a “Flood Day” identification system was developed to describe whether flooding and/or rainfall intensity capable of causing flooding was observed. A Flood Day is defined as a binary-type variable: it is either “Yes” when flooding and/or qualifying rainfall intensity is observed, or “No” otherwise. Note that, in practice, the latter condition relating to rainfall intensity is essential as flooding often goes undocumented or occurs in poorly gauged areas. Adding a measure based on rainfall intensity ensures a more comprehensive and consistent treatment of the issue. Given the large variance in the rainfall-runoff relationship across Colorado (see Appendix D), it would be difficult to describe a Flood Day with just a single intensity threshold. Thus, to provide some ability to cover relatively flatter eastern areas (higher threshold for flooding) compared with steeper central and western areas (lower threshold), a Flood Day is hereby preliminarily defined when at least one of following three criteria is met in or in close proximity to the issued flood threat area (e.g., Figure 15):

1. Gridded or observation-based 1-hour and 2-hour rainfall exceeds (see Figure 14):
 - a. 1.00 in. west of the 5,250-foot elevation contour over the eastern plains
 - b. 1.50 in. east of the 5,250-foot elevation contour over the eastern plains
2. Gridded or observation-based 24-hour rainfall exceeds (see Figure 14):
 - a. 2.75 in. west of the 5,250-foot elevation contour over the eastern plains
 - b. 5.00 in. east of the 5,250-foot elevation contour over the eastern plains
3. A qualifying NWS Local Storm Report (LSR) report is received. For more information, see Appendix C, data source “LSR” under “Storm Report”.
4. If a Flood Day was based solely on the QPE data, additional conditions were checked. First, the areal coverage of qualifying rainfall must have exceeded ~50 square miles for each storm center. This helps to eliminate days with localized (i.e. a single grid point), marginal rainfall that is unlikely to cause flooding. Second, QPE bias plots were subjectively interpreted to ensure values were reasonable. See Appendix F for more information.

In verification reports from 2016 to 2021, the issuance of an NWS Flash Flood Warning would produce a Flood Day classification. However, due to varying topographic influences and uneven distribution of rainfall across the state (Appendix D), Flash Flood Warning issuance protocol across Colorado NWS offices varies significantly. Thus, NWS Flash Flood Warnings alone no longer cause a Flood Day classification. They could, however, contribute to a Flood Day if other factors are supportive. Note that this does NOT include Warnings issued over fire burn areas which have much lower rainfall intensity thresholds.

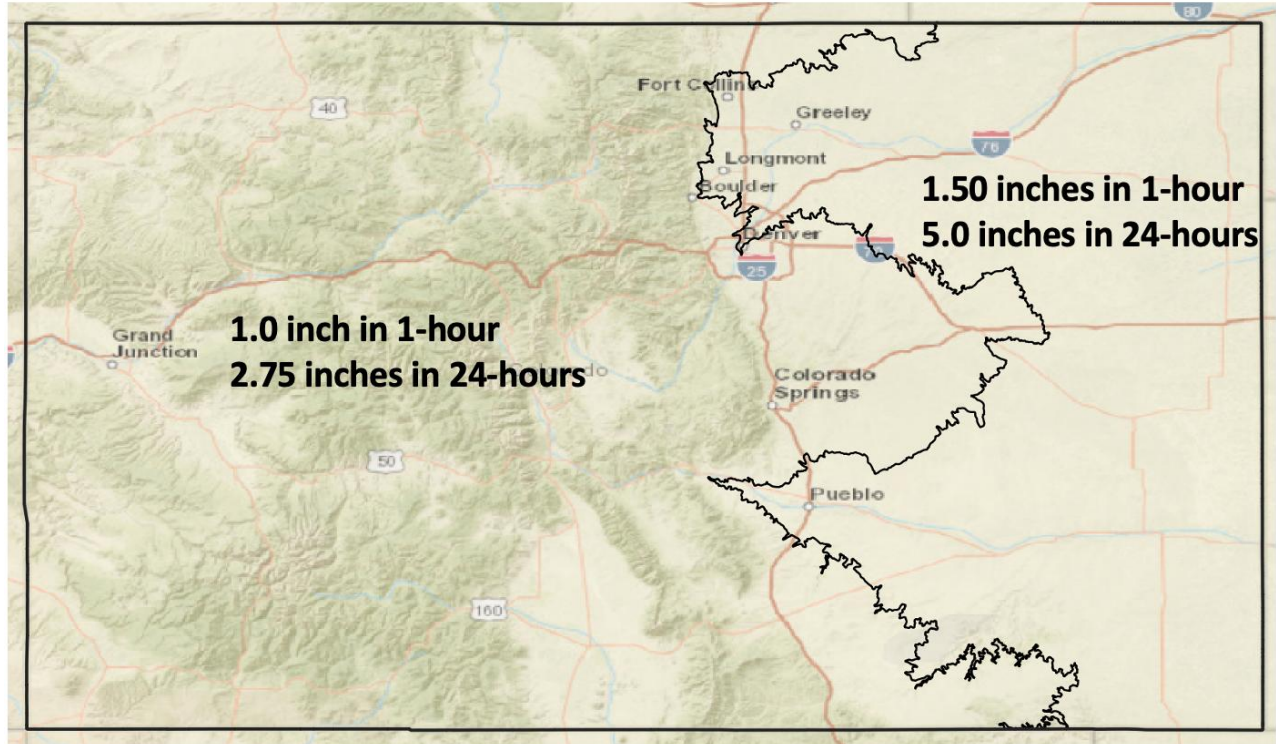


Figure 14: Colorado map with thick black line showing the 5,250-foot elevation contour line east of the Continental Divide, which acted as the demarcation in rainfall-runoff sensitivity. To the east, 1.50 inches in 1-hour is used to denote a "Flood Day"; to the west, 1 inch in 1-hour is used.

After an initial objective, preliminary Flood Day classification using the protocol above, a manual quality control procedure was completed to account for the overriding conditions shown in Table 5. As discussed previously, a significant addition to the manual procedure was the incorporation of a QPE bias assessment (BIAS in Table 5), which incorporates numerous factors and makes the previous years' HAIL and AREA conditions obsolete. Additionally, unlike in past years where the factors below generally resulted in a *removal* of an objectively defined Flood Day, the BIAS procedure is no longer one-way: it can either assign a Flood Day in a situation where QPE *underestimated* rain gauge data OR remove a Flood Day assignment if QPE *overestimated* rain gauges. This also explains why the number of instances where BIAS was applied was much higher than the HAIL and AREA methods in previous years. Simply stated, there are many days when the highest rain rates occur between rain gauges, and BIAS deciphers which of those instances are suggestive of a Flood Day. Nonetheless, the predominant bias in QPE is to overestimate rainfall, and of the 23 BIAS adjustments, 22 were to remove the Flood Day classification. Lastly, since 1-hour and 2-hour gridded QPE and sub-hourly rainfall gauges are reliably available and, as of 2024, the Program has 24-hour thresholds for flooding set this season (2.75 inches west and 5 inches east), the Low Intensity (LI) flag used in past reports for long duration events has become obsolete and been removed as an overriding condition. New to last season was a Location Miss (LOC MISS) flag. This occurs when a flood threat was issued, but it did not sufficiently overlap the area that experienced heavy rainfall or underwent a flash flood event (LSR). There were no instances of a LOC MISS this season, which is an improvement from past seasons.

Table 5: Conditions warranting a change in the objective Flood Day classification

Condition	Label	Outcome	# Occurrences
Snowfall results in a qualifying 24-hour precipitation total, but minimal runoff does not support flooding.	SNOW	Flood Day = 0	0
There is no rainfall over an area, but antecedent conditions and/or snowmelt cause riverine flooding.	RIVERINE	Flood Day = 0	1
QPE alone was required to identify a Flood Day, as no gauge observations were available. QPE was determined to be either too wet requiring a preliminary Flood Day classification to be removed, or too dry requiring a Flood Day to be assigned (see Appendix F).	BIAS	Flood Day = 0	23
A Flood Day occurred, but the threat issued did not overlap the area that experienced the flood event.	LOC MISS	Flood Day = 0	0

Verification Map for August 9, 2025

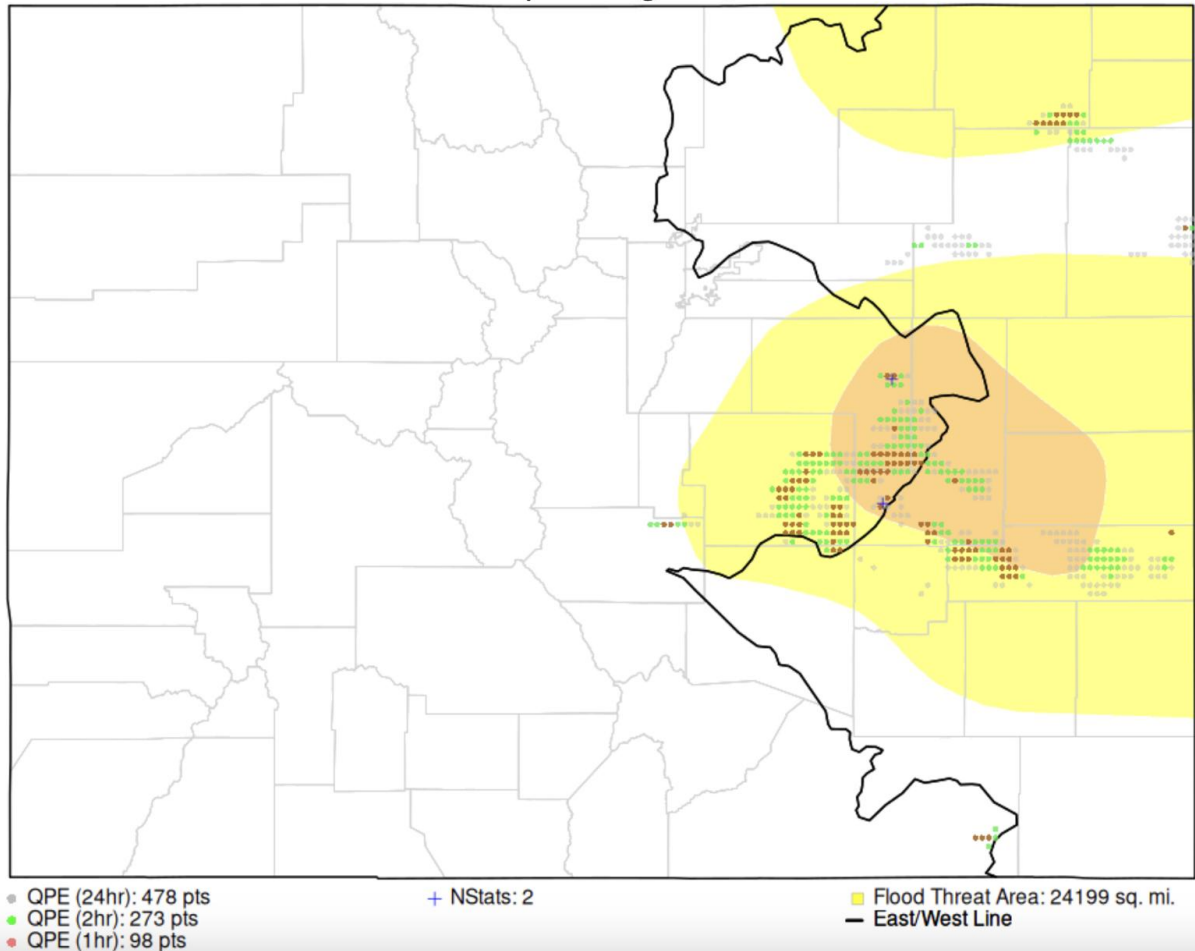


Figure 15: Example of daily verification map from August 9, 2025, showing qualifying 1-hour (red), 2-hour (green), and 24-hour (gray) MRMS grid points, qualifying rain gauges (blue crosses) and Moderate/Low threat areas (orange and yellow color fill, respectively).

FTB Results

Appendix A contains the Verification Worksheet that was used to assess forecast performance. To be consistent with previous seasons, the analysis herein is based on the initial flood threat map only and does NOT include any afternoon updates (PM Update) to the flood threat. Although, PM Update will be discussed in more detail below. As there is no single number that can comprehensively measure forecast accuracy, Table 7 shows the seven metrics that are used in this report, all based on the contingency table approach shown in Table 6. There are two possible outcomes when a Flood Day forecast is issued: (i) a Flood Day is observed [case (a) in Table 6], a “Hit”, or (ii) a Flood Day is not observed [case (c) in Table 6], a “False Alarm”. There are two additional scenarios that complete the set of all outcomes. First, if a “Flood Day” is not forecast, but is observed, this results in a “Miss” [case (b) in Table 6]. Second, if a non-Flood Day is forecast and a non-Flood Day is observed, this also results in a “Hit”, although more specifically a “Dry Hit”, which is often referred to as a correct negative [case (d) in Table 6]. Conventionally, real-time forecast operations generally strive to preferentially minimize the Miss Ratio, which, given the uncertainties with heavy rainfall forecasting, necessarily results in a higher False Alarm Ratio. CWCB has also supported this methodology. As shown in Table 7, target percentages for each metric have been established based on values accepted as reasonable within the forecasting community.

Table 6: Contingency table showing the four possible outcomes of forecasting and observing a Flood Day.

		Flood Day Forecasted	
		Yes	No
Flood Day Observed	Yes	(a) Hit	(b) Miss
	No	(c) False Alarm	(d) Hit (Dry)

Table 7: Description of metrics used for validating forecast accuracy.

Metric	Abbreviation	Calculations (see Table 6)	Summary	Goal
Accuracy or “Hit” Ratio	Hit %	$\frac{a + d}{a + b + c + d}$	Measures probability that all Flood Days and non-Flood Days are accurately forecast. Perfect forecast value is 100%.	>75%
Threat Score	TS	$\frac{a}{a + b + c}$	Measures probability that Flood Days (Hit) and non-Flood Days are accurately forecast. Perfect forecast value is 100%.	>60%
False Alarm Ratio	FAR	$\frac{c}{c + a}$	Measures probability that a Flood Day (Hit) is forecast but a non-Flood Day is observed. Perfect forecast value is 0%.	<20%
Probability of Detection	POD	$\frac{a}{a + b}$	Measures probability of accurately forecasting Flood Days. Perfect forecast value is 100%.	>75%
Miss Ratio	Miss %	$\frac{b}{a + b}$	Measure probability that a non-Flood Day is forecast but a Flood Day is observed. Perfect forecast value: 0%. Note the sum of the Miss % and POD equals 1.	<15%
Bias	Bias	$\frac{a + c}{a + b}$	A ratio of total number of Flood Days forecast compared to those observed. Perfect forecast value is 1.0.	N/A

Table 8 shows the individual monthly and season-aggregated forecast verification. **Forecast verification performance exceeded three targets established in Table 7 for the season.** The overall **Hit Ratio (Hit %)** of **83%** indicates that forecast performance remains high and is above the >75% targeted goal. More importantly, the **Probability of Detection (POD)** was **78%**, which is slightly lower than the last couple of seasons but above the targeted 75% goal. This metric specifically singles out Hits vs. Dry Hits, which indicate the accuracy of the flood threat forecasts issued.

Table 8. Summary of forecast performance by month and in total. Red font indicates performance did not meet the program targets.

Forecast / Observed	May	Jun	Jul	Aug	Sep	Total
(a) Flood / Flood	5	8	14	14	4	45
(b) No Flood / Flood	1	3	4	1	4	13
(c) Flood / No Flood	2	4	3	1	3	13
(d) No Flood / No Flood	23	15	10	15	19	82
Total Days	31	30	31	31	30	153
Hit %	90%	77%	77%	94%	77%	83%
POD	83%	73%	78%	93%	50%	78%
FAR	29%	33%	18%	7%	43%	22%
Miss %	17%	27%	22%	7%	50%	22%

Despite the encouraging Hit Ratio and POD, the **False Alarm Ratio (FAR)** was **22%**, which was just above the Program goal of <20%. A lower FAR helps increase confidence in the forecasts that are issued by the Program. Moreover, the **22% Miss % was much higher than last season and fell short of the Program goal of <15%**. The Program prefers to err on the side of caution in issuance of flood threats, which often and necessarily results in a higher FAR, but lower Miss %. This is in stark contrast to the performance of the NWS analogous Flash Flood Watch product, which tends to have a very low FAR at the expense of a significant Miss %. There are several takeaways of the higher FAR and Miss % this season. First of all, there will be some random variations in these metrics, due to more or less challenging forecast situations. But that likely does not explain this year's relative underperformance. It is important to note that HMC forecasts rely on HMC's fully objective Bias Corrected QPF (BCQPF) product. The BCQPF guidance is currently being used by the Mile High Flood District (Denver metro), Maricopa County Flood Control District (Phoenix metro) and undergoing testing for the Tarrant Regional Water District (Fort Worth metro). Compared to these use cases, however, the FTB still has a much more significant component for human forecaster input. This year, the higher FAR and Miss % suggest forecasters tended to lean rather heavily on the conservative side in issuing threats, not doing so without sufficient forecaster confidence. Stated differently, in a majority of the Misses, BCQPF guidance supported at least a Low threat, but was overruled by the human forecaster (not shown). Heavy rainfall forecasting is undoubtedly challenging and has previously been somewhat of an art and science combination. But improved modeling and post-processing have recently re-prioritized guidance as the best first guess, instead of being secondary to the forecaster's intuition. Thus, all indications suggest that the only way to address the issues seen this year is to employ more automated guidance for the FTB next season, as HMC is already doing in other products.

Looking into the month-to-month performance (Table 8), July and August were the most active, which aligns with climatology. However, late August was more active than early August, which is slightly later than normal. May saw 6 Flood Days, while September saw 8 Flood Days. It is unusual for September to have more Flood Days than May. The Hit % was above the targeted 75% for all months, and the total season POD was above the targeted 75%. However, POD fell short of Program metrics in June and September. The Miss % was higher than Program metrics for all months except August, which led to a season Miss % of 22%. This is the highest Miss % since 2020. Interestingly the FAR, which is usually reverse of the Miss % was also 22% for the season. This was a slightly better metric than Miss % because both July and August met Program metrics. However, the FAR during the other months was quite a bit higher than the targeted FAR of <20%. After there was some statistical improvement from July to August, September saw a drop in forecast performance. These metrics were less skewed than usual because there were 8 Flood Days whereas the last few years have seen ~4 Flood Days in September.

Unlike the past couple of seasons, there were no days a Flood Threat was issued, and a Flood Day was observed, but the threat area did not overlap with the qualifying rainfall intensity. This would have qualified as a Location Miss in Appendix A. So, there has been some improvement in this metric from the last couple of seasons

The overall Bias this season was 1.0 (perfectly unbiased), but as previously stated, it is best if this value is slightly >1, which suggests a slight preference towards False Alarms, minimizing Misses. With a dip in metrics this season, the Team will re-prioritize some already planned upgrades to internal guidance in the off-season. This will include major new automation upgrades to HMC's BCQPF guidance, which should make the forecasts more objective than subjective. Changes to the forecast protocol should improve metrics for the 2026 forecast season.

Table 9: Summary of yearly forecast performance since 2012. Note that the verification procedure was significantly enhanced in 2014, which makes it difficult to compare pre-2014 statistics to 2014-present. shows yearly performance summaries for the Program from 2012 to present. **The total number of Flood Days was 58 this season. This is slightly below the 2014 to 2024 average of 65 Flood Days, but more than last year's 55 Flood Days. Compared to last season, performance dropped across all metrics. As far as hitting the forecast metrics presented in Table 7, only the Hit %, TS, and POD were met this season. The Miss % and FAR were above target goals with the Miss % highest since 2020.** The overall Bias this season was 1.0 (perfectly unbiased), but as previously stated, it is best if this value is slightly >1, which suggests a slight preference towards False Alarms, minimizing Misses. With a dip in metrics this season, the Team will re-prioritize some already planned upgrades to internal guidance in the off-season. This will include major new automation upgrades to HMC's BCQPF guidance, which should make the forecasts more objective than subjective. Changes to the forecast protocol should improve metrics for the 2026 forecast season.

Table 9: Summary of yearly forecast performance since 2012. Note that the verification procedure was significantly enhanced in 2014, which makes it difficult to compare pre-2014 statistics to 2014-present.

Year	Hit %	TS	FAR	POD	Miss %	Threats Issued	Flood Days	Bias
2012	86%	N/A	18%	84%	16%	65	64	1.02
2013	84%	N/A	13%	85%	15%	83	85	0.98
2014*	76%	N/A	18%	73%	27%	75	84	0.89
2015	77%	N/A	25%	78%	22%	85	88	0.97
2016	84%	N/A	21%	88%	12%	93	91	1.02
2017	86%	N/A	15%	86%	14%	76	74	1.03
2018	87%	N/A	21%	82%	18%	52	50	1.04
2019	86%	65%	13%	72%	28%	48	54	0.83
2020	89%	67%	13%	74%	26%	41	34	1.21
2021	88%	73%	20%	90%	10%	65	58	1.12
2022	87%	71%	25%	92%	8%	64	52	1.25
2023	90%	80%	9%	86%	14%	72	73	0.95
2024	91%	78%	14%	89%	11%	57	55	1.04
2025	83%	63%	22%	78%	22%	58	59	1.00

Due to the nature of heavy rainfall in Colorado, there is often a steady decrease in the number of threats as the threat level increases. Table 10, along with the Bias, FAR and Miss % metrics previously discussed, indicates that forecasts were *underconfident* this season. Some of the 24 Moderate threat “Hits” should have been elevated to a High or High Impact threat. The Team will review the criteria to issue a High threat in the off-season to make this Moderate to High ratio more in balance with one another.

Table 10 shows the forecast performance as a function of threat level. Note that the threat level in the table represents the highest threat issued for a given day. A robust forecast system should show higher Hit % as the threat level increases due to more confidence that heavy rainfall and/or flooding will be realized. This continues to be the case again for 2025 with a **57% Hit % for Low threats, 96% for Moderate threats and 100% for High threats.**

Due to the nature of heavy rainfall in Colorado, there is often a steady decrease in the number of threats as the threat level increases. Table 10, along with the Bias, FAR and Miss % metrics previously discussed, indicates that forecasts were *underconfident* this season. Some of the 24 Moderate threat “Hits” should have been elevated to a High or High Impact threat. The Team will review the criteria to issue a High threat in the off-season to make this Moderate to High ratio more in balance with one another.

Table 10: Accuracy as a function of threat level, which corresponds to the (potential) impact. Note: threat levels categorization was reduced to the highest non-burn area threat level.

Threat Level	Observed Flood Day	Observed Non-Flood Day	Total Days
Low	16 (57%)	12 (43%)	28
Moderate	24 (96%)	1 (4%)	25
High	5 (100%)	0	5
High Impact	0	0	0
Total	45 (78%)	13 (22%)	58

PM Updates

Occasionally, there are forecast uncertainties that make the morning flood threat assessment challenging. For example, cloud cover may be present causing uncertainty in afternoon instability, which would directly impact the chance for stronger thunderstorm development and resulting heavy rainfall. Or a forecast can change from what is predicted. For example, if dew points trend several degrees higher than the original forecast, rainfall rates are likely going to be higher than initially forecast. There may also be some uncertainty in the impact from rainfall. Often confidence for a flood event increases over the course of the day as ingredients come together. So, what is initially forecast as a Low or Moderate flood threat may become a High flood threat by the early afternoon. All these scenarios are reasons why a PM Update may be issued by the Team. Though it is ideal to provide FTB forecasts with maximum lead time, the PM Updates are often still able to provide at least 1-2+ hours of lead time.

For the 2024 and 2025 seasons, to be in line with the Project’s scope, the Team tried to limit the issuance of a PM Updates to only two scenarios. The first scenario is when there was originally No threat, but a Low threat emerged. The first scenario is when there was No threat and at least a Low threat was needed. The second was when an upgrade to a High threat was necessary. By limiting the number of PM Updates issued, the Team’s goal was to better grab the attention of the end-user when it was most needed. This can give the PM Updates more value when they are issued. The PM Update includes an update to the flood threat map, more accurate maximum rainfall intensities, and the specific locations that are most likely to see flood impacts. When possible, the Team also tries to mention the possibility of a PM Update and where forecast uncertainty lies in the morning discussion. This will allow the end-user to tune back in by early afternoon (before rainfall begins) for any updates to the forecast. In addition to a short discussion explaining the PM Update issuance at the top of the day’s FTB discussion, new social media posts are also disseminated to the Program’s accounts. This is the most effective way to quickly get information to end-users because the social media platforms best deal with “real-time” information.

For this season, there was only one PM update issued on May 23rd. Unfortunately, the Low threat PM Update issued ended up being a False Alarm. In the morning post, a dryline was forecast to set up over the eastern plains. By early afternoon, surface moisture had steadily increased with dew points in the 50s°F, and storm motion was anticipated to be slower. With storms developing in a moist and unstable environment, heavier rainfall rates were expected than forecast in the morning. Severe weather in the form of large hail (up to 3 inches in diameter!) and tornadoes ended up limiting the heavy rainfall threat for the day. Often when severe weather is present, especially large hail, the heavy rainfall potential decreases. While this instance was a False Alarm, PM updates continue to be an integral part of the Programs’ goals to provide the best available flood forecast.

3) USER ENGAGEMENT

An online presence through the Program’s website and social media accounts continues to be of importance for increasing the Program’s audience and reputation. Even a perfect forecast can have little to no value if it is not properly disseminated, which is why the Program continues to participate in forecast communication through a diverse set of mediums. Like prior seasons, the Team provided end-users with four outlets to receive forecast updates and other flood threat information. Most significant is the Program website (Table 11), which has been the main form of communication since the Program began and underwent a complete redesign of the website in 2023. Beginning in 2017, the Team began providing an email alert option that sent the Flood Threat Bulletin’s headline to end-user’s inbox each morning with a link to the full post. The Team also continues to utilize the X social media platform to provide forecast updates, interesting hydrometeorological observations, and other informational messages. In 2018, a Facebook page was created to reach a separate demographic from X. All four forms of communication continue to be utilized with mixed results in growth compared to 2024.

Table 11. Website and social media accounts used by the Flood Threat Bulletin.

PLATFORM	ACCOUNT	ENGAGEMENT
Email and Website	coloradofloodthreat@gmail.com www.coloradofloodthreat.com	287 Subscribers (+1)
X (formerly Twitter)	@COFloodUpdates	1,674 followers (-61)
Facebook	@COFloodUpdates	798 followers (+93)

Due to the always changing popularity of the various social media outlets and platform layout updates, it is recommended that the Program always monitor the effectiveness of its online presence and the popularity of the content that is shared by the Program. It is also important to note that, to some extent, all the communication methods described herein compete with one another (i.e., if an end-user uses X to view Program content, they may not use another method). Thus, providing end-users with options, but without excessive bombardment, is the best strategy. Table 12 summarizes the most important social media and website usage metrics over the 2016- present period.

Table 12. Social media and website usage, 2016- present.

SOCIAL MEDIA METRIC	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Email Subscribers (end of season)	--	19	35	128	131	142	165	278	286	287
Median Daily Site Views (No Threat)	24	18	22.5	51	27	46	42.5	38.5	23.5	38
Median Daily Site Views (Low Threat)	32	22	44	66.5	44	48	70	53	41	53
Median Daily Site Views (Mod Threat)	41.5	34	58	98	56	86	98.5	69.5	68	88
Median Daily Site Views (High/High Impact Threat)	90.5	42	117	106	212	191.5	185	73	87	250
X Followers	901	1,036	1,183	1,331	1,404	1,528	1,591	1,720	1,735	1,674
Avg. Daily X Impressions	1,874	1,973	2,059	1,597	1,590	3,299	1,782	2,171	1,026	824
Facebook Followers	--	--	155	272	323	421	585	638	705	798
Avg. Daily Facebook Reaches	--	--	--	--	440	456	953	386	493	--
Avg. Daily Facebook Page Visits	--	--	--	--	--	--	--	--	7	9

Email Subscription and Website

The number of email subscribers increased by just one this season compared to the end of 2024, finishing the season with a total number of subscribers at 287. At the beginning of each season, a ‘Welcome Back’ email is sent out and any email addresses that bounce back are unsubscribed. On May 1, there were 279 active subscribers after removing inactive subscriptions, indicating the season netted 8 new subscribers to reach 287. Due to a larger than normal number of federal employees leaving their government positions in 2025, there were more bounced back emails. So, more subscribers were removed than in previous years.

Increasing the number of subscribers should continue to be a key objective for the Program, which could be achieved by a pre-season campaign and in-season outreach. It is also recommended to consider other methods on how to better advertise the email subscription option, such as a prior idea of reaching out to local Emergency Managers that do not follow the Program.

The website utilizes the latest Google Analytics (GA4) to track website usage. Figure 16 below shows daily website usage during 2025 (black) overlaid with the previous four seasons. As expected, median website viewership increases on days with elevated flood threats. The 2025 median viewership on No Threat days was 38, but 53 on Low, 88 on Moderate, and 250 on High/High Impact days. median usage on High threat days was the highest since we began monitoring usage stats. However, keep in mind that this stat may be skewed because there are so few High/High Impact threats issued in a season. Usage peaked at 1,081 on July 23rd when a High flood threat was issued for the Front Range and Urban Corridor, the highest peak in usage since 2022. A dive into the days Google Analytics trends did not suggest any bot behavior that day, as the greatest number of visitors came from Denver and user engagement was similarly high, meaning multiple pages were interacted with – bots tend to quickly visit a site and then leave. Website usage followed similar trends to previous seasons, with the largest peaks generally in July and August. Overall median website usage went up in 2025, especially from the down season in 2024.

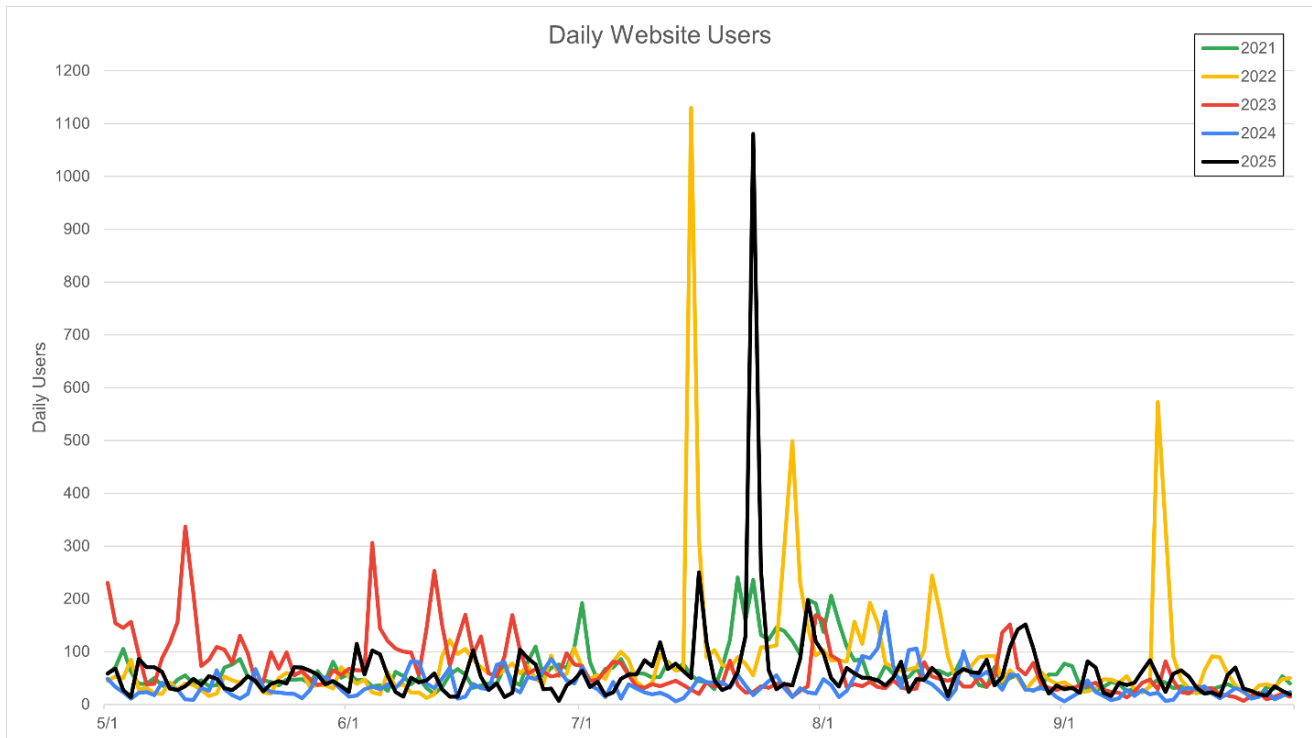


Figure 16. Daily website users for 2025 (black), as well as the last four seasons.

Social Media

During the historic floods of September 2013, the Program noted an opportunity to expand the outreach of the Flood Threat Bulletin to better inform the public of the current and forecasted flood situation. The method that was selected was the X (formerly Twitter) social media platform, with the goal being to provide updates on any impending flood related threat across Colorado in a concise, headline-style matter. The X account was an immediate success during the September floods, and it was assimilated into daily operations starting in 2014 to provide (i) meteorological information in the form of links to our forecast products (FTB and FTO), (ii) “nowcasts”, of interesting flood-related weather conditions or observations, (iii) life threatening National Weather Service Flash Flood Warnings, and (iv) heavy rain/flooding reports from the public and National Weather Service offices. Additionally, due to the wealth of hydrometeorological data that is collected in support of the daily FTB and biweekly FTO posts, the Program’s social media strategy attempts to maximize the way this data is leveraged by creating unique posts.

A hashtag is a method of organizing messages into categories that the hashtag is supposed to succinctly summarize. For example, the #COFlood hashtag is one that the Program consistently uses and has become almost completely dedicated to our products. Hashtags are searchable through X and Facebook and using these relevant and popular hashtags such as #COWx or #COFlood allows people looking for specific information to be directed to our products. The following is a list of common tags that were used in 2025: #FTB, #FTO, #SPM, #COWx, #COFlood, #COFire, and #CODrought.

The #cowx hashtag on X was also the main source of social media reports for the SPM, though with diminishing usefulness compared to previous seasons, which is suspected to be due to the general decrease in X users stemming from high-profile volatility within the company and changes to the timeline algorithm prioritizing users that pay a subscription fee. For the second year in a row, the Program sponsored a “Verified” account. The use of specific hashtags also plays a large role in expanding viewership on all social media platforms and helps grab attention on specific holidays when outdoor recreation can be increased.

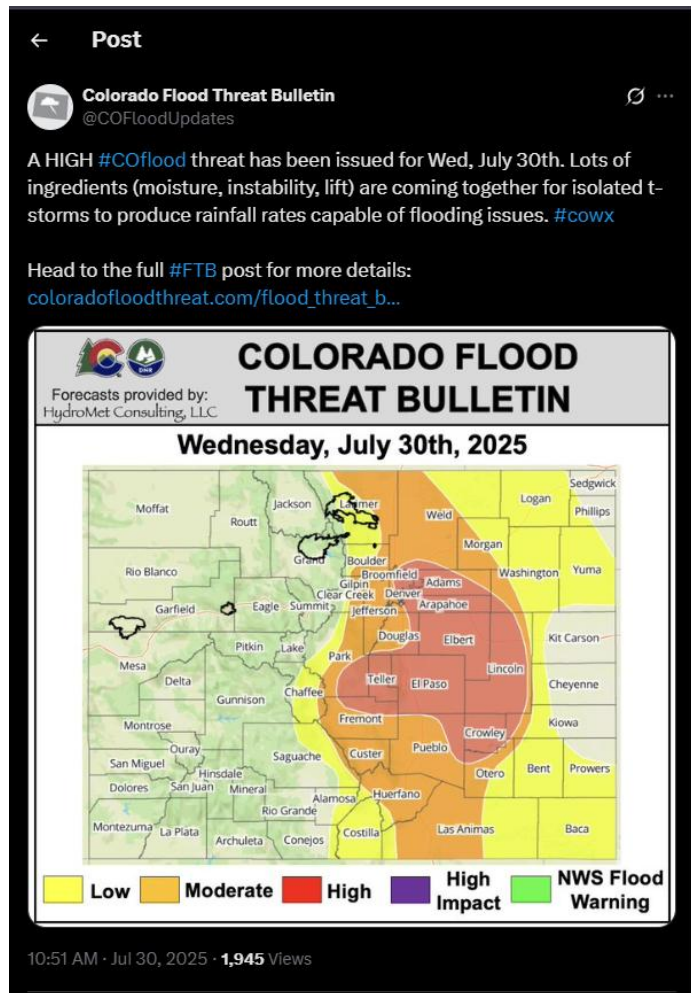


Figure 17. The highest-viewed X post issued during the 2025 season with 5793 impressions.

For the first time, the Program’s X account, @COFloodUpdates, saw a decrease in Followers to 1,674 (2024 had 1,735). This number of daily active users on the platform has decreased by nearly a quarter since 2022, according to Mashable (Binder, 2024), which likely affected the Program Viewership. However, from May 1 to October 1, the number of Followers for the account increased from 1,614 to 1,674, netting an additional 60 new followers during the FTB season. This season there were 489 Retweets, which is also down from 526 last season and from 633 in 2023. Over the 2025 season, the Program created 258 unique Tweets, 21 fewer than 2024.

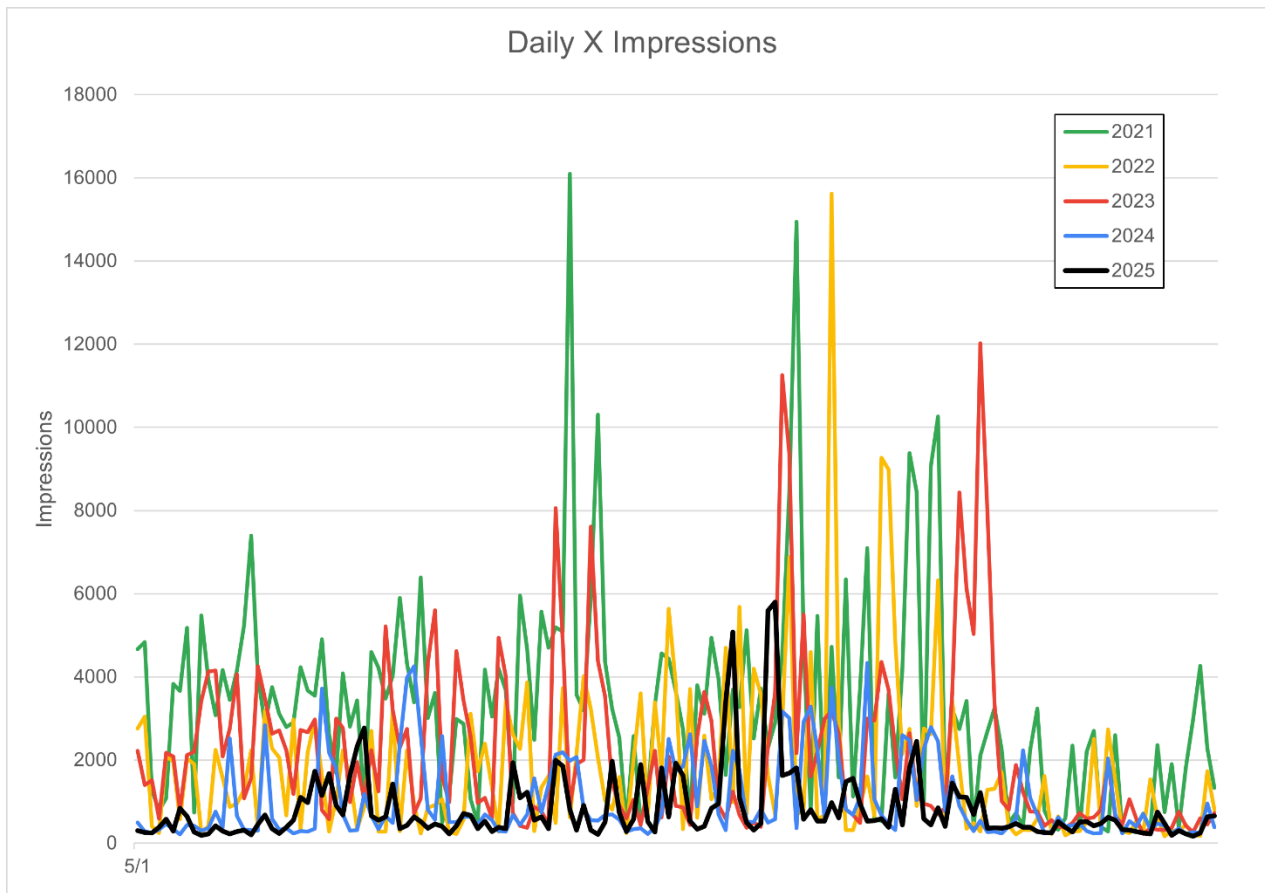


Figure 18. Daily X Impressions for 2025 (black line), as well as the last four seasons.

Since the X account has been successful at circulating the FTB forecast products, a Facebook account for the Program was created at the beginning of the 2018 season. The main push behind the idea was that the Facebook page would likely reach a different demographic of potential end-users. The @COFloodUpdates handle was reused for the Facebook page to keep uniformity across the social media accounts. All posts on Facebook were also updated simultaneously with the X account, so information exchange would be consistent. One drawback to Facebook is that posts do not show up on the News Feed chronically, so end-users must visit the page directly for up-to-date flood information. The Facebook platform can be best utilized for upcoming events laid out in the FTO and special in-season analyses, since these are not as time sensitive as ongoing forecasts.

By the end of its seventh season, the Facebook account gained several new Followers putting the total at 798. While this number continues to be quite a bit lower than the X account, the number of Followers increased from 2024 which shows the platform still has utility.

The most similar analytic to X Impressions was post “Reaches”. Reaches are defined as the number of people who had any posts from our page enter their screen, and they can also assess the effectiveness of each post. Unfortunately, Facebook discontinued providing Reaches in 2024, so “Visits” have been added to Table 12 for 2024 and 2025. In 2024 the Program saw an average of 7 visits per day, and this metric improved to 9 visits per day in 2025.

4) CONCLUSIONS

1. Eastern parts of the state saw mostly above-average precipitation for the season, with some months featuring areas of record wet conditions. In contrast, the western regions experienced more variability, including a delayed start to the monsoon season that eventually gained momentum.
 - a. There were 162 flood reports this season, a step up from last year's 129. No month stood out from the others as June, July, and August all had around 40 flood reports.
 - b. Similar to last season, Colorado experienced a later monsoon season with a peak in consecutive day activity at the end of August (8 Flood days in a row).
2. Overall, there were 59 flood threats issued (58 Flood Days), so a slightly below average season. Of these threats, 16 were Low threats, 24 Moderate and 5 High threats. The much higher number of Moderate threats indicate some rebalancing needs to be achieved between the threat levels issued during the off season. Areas over the Palmer Ridge saw up to 40 days with flood threats issued, and the San Juans and portions of western Colorado saw the lowest number of threats ever issued (<15 days; see Figure 22, Appendix E). This large variation in threats issued between western and eastern Colorado is similar to the 2023 FTB season.
3. The FBF continues to be a successful addition to the Program with increased viewership on disseminated forecasts. This is especially true when High and High Impact threats are issued. A total of six burn areas were forecast for this season, and rainfall intensity thresholds for each burn can be found in Table 3. There were three major wildfires that occurred over western Colorado later in the season; one of which was grouped together as the Lee/Elk Complex. Both Lee/Elk Complex and Turner Gulch were the only burn areas to witness major flooding issues this season. Minor debris flows were also reported over East Troublesome, but all events stayed within the banks of the creek and did not cause any road closures. More information can be found in the FBF Assessment Technical Memo.
4. The Team hit season forecast goals for Accuracy (83%), Threat Score (63%) and Probability of Detection (78%), although these metrics were lower than last season (91%, 78%, 89%, respectively). There were two metrics that missed Program goals: Miss Ratio (22%) and False Alarm Ratio (22%). The underperformance shown by the Miss Ratio and False Alarm Ratio will expedite already-planned major changes, warranting an increase in the use of HMC's objective BCQPF forecast guidance. It now appears BCQPF is consistently outperforming the conventional human forecaster approach used by the FTB up to this point. There was only one PM update issued this season, which turned out to be a False Alarm. Finally, a special off-season forecast was issued for portions of western Colorado on October 13th as a second wave of moderate, long-duration rainfall hit the region.
5. Facebook saw the greatest increase in users (+93) while X saw a decrease from previous seasons (-61); email subscriptions saw little change from 2024 (+1) although website users increased. An outreach survey was sent to email subscribers in July and there were 26 responses. Results indicated that the FTB product is the most widely used and understood, with mixed results for remaining products. There is interest from end-users on more information about the other products and individual email subscriptions for the Programs' other products (Streamflow Tracker, FTO, SPM, FBF, respectively), warranting an off-season discussion between the Team and CWCB on how to best achieve this.

5) REFERENCES

- Abatzoglou, J.T., D.J. McEvoy, and K.T. Redmond. The West Wide Drought Tracker: Drought Monitoring at Fine Spatial Scales. *Bulletin of the American Meteorological Society*, 2017, 98, 1815-1820.
- Binder, Matt. (2024, March 24). *X/Twitter use is down by nearly a quarter since Elon Musk took over, report claims*. Mashable. <https://mashable.com/article/x-twitter-daily-active-users-mobile-app-decline-report-x-disputes#:~:text=Home%20%3E%20Tech-,X%20/%20Twitter%20use%20is%20down%20by%20nearly%20a%20quarter%20since,has%20not%20provided%20contradictory%20stats>.
- Cannon, S., et al. Storm Rainfall Conditions for Floods and Debris Flows from Recently Burned Basins in Southwestern Colorado and Southern California. *Geomorphology*, 2018, 96, 250-269. 10.1016/j.geomorph.2007.03.019.
- Colorado-New Mexico Regional Extreme Precipitation Study, 2018. Funded by the Colorado Department of Natural Resources. Precipitation frequency estimates accessed on [interactive web map](#).
- Dewberry and HydroMet Consulting, LLC, 2023. Colorado Flood Threat Bulletin - 2023 Final Report, https://coloradofloodthreat.s3.us-west-1.amazonaws.com/final_reports/CWCB_FinalReport_2024.pdf, created November 2024.
- Dewberry and HydroMet Consulting, LLC, 2023. Colorado Flood Threat Bulletin - 2023 Final Report, https://coloradofloodthreat.s3.us-west-1.amazonaws.com/final_reports/CWCB_FinalReport_2023.pdf, created November 2023.
- Dewberry and HydroMet Consulting, LLC, 2022. Colorado Flood Threat Bulletin - 2022 Final Report, https://coloradofloodthreat.s3.us-west-1.amazonaws.com/final_reports/CWCB_FinalReport_2022.pdf, created December 2022.
- HydroMet Consulting, LLC. Fire Burn Forecast Threshold Assessment: 2022 Technical Memo, created December 2022. Available via CWCB Program Manager.
- HydroMet Consulting, LLC. Fire Burn Forecast Threshold Assessment: 2023 Technical Memo, created December 2023. Available via CWCB Program Manager.
- HydroMet Consulting, LLC. Fire Burn Forecast Threshold Assessment: 2024 Technical Memo, created December 2024. Available via CWCB Program Manager.
- HydroMet Consulting, LLC and Dewberry. Colorado Flood Threat Bulletin 2022 Technical Training. Video Meeting. 2022 June 30, https://www.youtube.com/channel/UCzrtMOGBvGSDJaK_wBUCexA.
- Iowa State University. Iowa Environmental Mesonet, <http://mesonet.agron.iastate.edu/lsr/#BOU,PUB,GJT,GLD/>, accessed October 2023.
- MetPortal CO-NM Regional Extreme Precipitation Study (CO-NM REPS), https://rti-metportal.shinyapps.io/conm_region/, created 2018.
- National Drought Mitigation Center (NDMC), University of Nebraska-Lincoln. U.S. Drought Monitor, <https://droughtmonitor.unl.edu/>, accessed December 2022.
- National Interagency Fire Center. Wildland Fire Open Data, <https://data-nifc.opendata.arcgis.com>, created November 2020.

Natural Resources Conservation Service (NRCS), National Water and Climate Center, U.S. Department of Agriculture, <https://www.nrcs.usda.gov/wps/portal/wcc/home/> , accessed October 2023.

NOAA Atlas 14, Precipitation-Frequency Atlas of the United States. Precipitation Frequency Data Server, www.nws.noaa.gov/oh/hdsc/, created Nov 2017.

NOAA National Centers for Environmental Information, Data Tools: Daily Weather Records, <https://www.ncdc.noaa.gov/cdo-web/datatools/records>, accessed November 2023.

NOAA Stage IV, Gridded Precipitation D. UCAR Data Server, <https://data.eol.ucar.edu/dataset/113.003>.

PRISM Climate Group, Oregon State University, <http://prism.oregonstate.edu>, created July 2017.

APPENDIX A – FORECAST VERIFICATION WORKSHEET

Table 13 shows the daily verification worksheet documenting the intensity and coverage of heavy precipitation, along with whether a Flood Threat was issued. An asterisk (*) next to the date indicates that an afternoon update was issued. To be consistent with previous seasons, the analysis herein is based on the initial flood threat map only and does NOT include any afternoon updates to the flood threat. Two asterisks (**) indicate that a threat was issued, but that it did not encompass the heavy rainfall event, so it was counted as a “Miss” (this is a new upgrade beginning in 2022). Dates where an NWS Flood or Flash Flood Watch was issued due to rainfall, not snowmelt or riverine flooding, are shaded in green. These have been filtered to exclude burn area only Flash Flood Watches. Lastly, new 24-hour flood thresholds were created for the Program this season (2.75 inches west & 5 inches east). These values are bolded when exceeded in the worksheet for Max 24hr-E and Max 24hr-W for ST4 and MRMS data.

The columns in the table are described below.

NSSL MRMS Quantitative Precipitation Estimate: Contains the sub-categories below.

Max 1hr-E (inches): Maximum 1-hour precipitation east of the 5,250 ft. elevation contour.

Max 2hr-E (inches): Maximum 2-hour precipitation east of the 5,250 ft. elevation contour.

Max 1hr-W (inches): Maximum 1-hour precipitation west of the 5,250 ft. elevation contour.

Max 2hr-W (inches): Maximum 2-hour precipitation west of the 5,250 ft. elevation contour.

Max 24hr-E (inches): Maximum 24-hour precipitation east of the 5,250 ft. elevation contour.

Max 24hr-W (inches): Maximum 24-hour precipitation west of the 5,250 ft. elevation contour.

NOAA Stage IV (ST4) Quantitative Precipitation Estimate: Contains the sub-categories below.

Max 24hr-E (inches): Maximum 24-hour precipitation east of the 5,250 ft. elevation contour.

Max 24hr-W (inches): Maximum 24-hour precipitation west of the 5,250 ft. elevation contour.

QPE: Contains the highest total number of 24-hour points exceeding Flood Day threshold between the MRMS and Stage IV data. Note that 1 point is equivalent to about 5.5 square miles of areal coverage.

Rain Gauges: Contains the sub-categories below. See Appendix C for more information about gauge networks considered in this analysis. All values shown are 24-hour totals.

NStats (number): Total number of rainfall gauges exceeding Flood Day thresholds statewide.

Max-E (inches): Maximum observed rainfall from all gauges, east of the 1600m contour.

Max-W (inches): Maximum observed rainfall from all gauges, west of the 1600m contour.

Flood Reports: Whether or not a flooding or qualifying heavy rainfall report was received that day.

Flood Day: Denotes whether or not the day qualified as a Flood Day.

Threat: Highest category of the Flood Threat.

Total Threat Area: Areal coverage (thousands of square miles) the issued Flood Threat covered that day.

Flags: An overriding factor to the objective Flood Day classification due to the following.

SNOW: Snowfall results in a qualifying Flood Day 24-hour precipitation total but did not result in flooding.

RIVERINE: Riverine flooding from antecedent rainfall/snowfall, but no concurrent Flood Day threshold precipitation was observed.

BIAS: Indicates significant discrepancy, both overestimates and underestimates, between gridded QPE and rain gauge estimates that required a manual adjustment of the Flood Day assignment (see Appendix F)

LOC MISS: Although a Flood Day occurred within the state, the threat that was issued did not overlap the location that experienced the flood event.

Flood Day Classifications: Indicates the leading source that led to the assignment of a Flood Day.

LSR: NWS Local Storm Report(s) indicating flooding.

GAUGE: Quality Controlled rainfall gauge(s) reporting a qualifying rainfall rate.

GRIDDED: Gridded QPE (MRMS or ST4) reporting a qualifying rainfall rate over a ~50 square mile area.

Outcome: Classification of Flood Threat into the following three categories. Note that a blank implies a correct forecast though no Flood Day occurred (dry case).

False Alarm (FA): A Flood Day was forecasted, but a non-Flood Day was observed,

Miss: A Flood Day was observed but not forecasted or the flood threat was not issued over the region that received heavy rainfall,

Hit: A Flood Day was observed and forecasted correctly.

Table 13: Daily FTB Verification Worksheet

NSSL MRMS Quantitative Precipitation Estimate							NOAA ST4 Quantitative Precipitation Estimate	QPE	Rain Gauges			Flood Reports									
Date	Max 1hr E	Max2hr E	Max 1hr W	Max2hr W	Max24hr E	Max24hr W	Max24hr E	Max24hr W	24hr Flood Area (Max)	NStats	Max-E	Max-W	Reports	NWS Warning or Advisory	Flood Day	Threat AM	Threat PM	Total Threat Area	Flags	FD Classification	Outcome
Units	inches	inches	inches	inches	inches	inches	inches	inches	points	number	inches	inches	number					x1000 Miles			
1-May	0.53	0.61	0.44	0.52	0.72	0.81	0	0	0	0.54	0.83	0	0								
2-May	0	0	0.02	0.02	0	0.04	0	0	0	0	0.04	0	0								
3-May	0	0	0.23	0.32	0.01	0.39	0	0	0	0	0.31	0	0								
4-May	0.23	0.23	0.49	0.56	0.27	1.36	0	0	43	0.21	1.3	19	43								
5-May	0.43	0.49	0.64	0.87	1.54	2.95	0	0	251	1.56	2.37	180	251						BIAS		
6-May	0.56	0.63	0.41	0.54	2.1	2.6	0	0	2720	2.26	2.2	3152	3152								
7-May	0.82	1.04	0.79	1.07	1.6	1.26	0	1	4	1.2	1.15	11	11	Yes		NWS Warning			RIV		
8-May	0.3	0.3	0.3	0.37	0.39	0.46	0	0	0	0.27	0.42	0	0								
9-May	0	0	0.69	1.03	0	1.03	0	1	1	0	0.82	0	1								
10-May	0	0	0.46	0.47	0	0.56	0	0	0	0	0.39	0	0								
11-May	0.37	0.38	0.55	0.59	0.38	0.76	0	0	0	0.25	0.81	0	0								
12-May	0.97	1.1	0	0.01	1.09	0.13	0	0	0	0.67	0.16	0	0								
13-May	0	0	0	0	0	0	0	0	0	0	0.03	0	0								
14-May	1.18	1.61	0.76	0.99	2.09	1.65	0	1	34	1.74	1.43	28	34								
15-May	0.09	0.14	0.24	0.32	0.14	1.17	0	0	0	0.13	0.97	0	0								
16-May	0	0	0.03	0.05	0	0.06	0	0	0	0	0.18	0	0								
17-May	0.82	0.84	0.59	0.59	0.87	0.67	0	0	0	0.76	0.54	0	0								
18-May	1.09	1.43	0.84	1	1.54	1.1	0	1	0	1.52	1.09	2	2			Low		2			FA
19-May	1.85	2.28	0.62	0.69	2.84	1	1	5	8	2.03	1.1	4	8								
20-May	0.04	0.04	0.26	0.38	0.06	0.54	0	0	0	0.03	0.38	0	0								
21-May	0.2	0.28	0.09	0.12	0.37	0.14	0	0	0	0.33	0.14	0	0								

NSSL MRMS Quantitative Precipitation Estimate							NOAA ST4 Quantitative Precipitation Estimate	QPE	Rain Gauges	Flood Reports
---	--	--	--	--	--	--	--	-----	-------------	---------------

Date	Max1hr E	Max2hr E	Max1hr W	Max2hr W	Max24hr E	Max24hr W	Max24hr E	Max24hr W	24hr Flood Area (Max)	NStats	Max-E	Max-W	Reports	NWS Warning or Advisory	Flood Day	Threat AM	Threat PM	Total Threat Area	Flags	FD Classification	Outcome
Units	inches	inches	inches	inches	inches	inches	inches	inches	points	number	inches	inches	number					x1000 Miles			
22-May	0.91	1.02	0.61	0.7	1.04	0.73	0	0	0	0.73	0.44	0	0								
23-May	1.43	1.64	0.43	0.43	1.66	0.43	0	9	9	1.41	0.29	0	9				Low		BIAS		
24-May	1.72	1.98	1.93	2.14	2.98	4.14	51	165	308	1.81	3.54	285	308		1	Low		6		GAUGE	Hit
25-May	0.82	0.91	1.66	1.94	1.74	2.82	4	13	156	1.43	2.77	218	218	Yes	1	Mod		4		GAUGE	Hit
26-May	1.86	1.94	1.76	2.42	2.01	2.85	30	62	93	1.57	1.87	55	93	Yes	1	Mod		23		GRIDDED	Hit
27-May	1.15	1.22	1.13	1.47	1.26	1.46	3	10	12	1	1.35	4	12			Low		15	BIAS		FA
28-May	1.63	1.67	1.2	2.33	2.83	3.07	20	51	107	2.13	2.07	66	107		1	Low		18		GAUGE	Hit
29-May	0.56	0.6	0.72	0.78	0.65	0.91	0	0	0	0.54	0.85	0	0								
30-May	1.26	1.32	1.27	2.11	1.43	2.64	7	20	63	1.33	1.9	38	63		1					GAUGE	Miss
31-May	1.71	2.02	1.43	1.84	2.15	1.89	15	48	60	1.58	1.57	41	60		1	Low		7		GAUGE	Hit
1-Jun	2.17	2.46	1.14	1.31	2.73	1.4	11	29	32	1.86	1.13	2	32	Yes		Low		3	BIAS		FA
2-Jun	1.78	2.16	1.34	1.48	3.4	2.75	13	45	585	3.3	1.99	714	714	Yes		Mod		74			FA
3-Jun	0.5	0.8	0.74	0.94	1.5	1.52	0	0	2	1.25	1.77	13	13								
4-Jun	1.7	1.86	1.12	1.29	2.14	1.61	4	19	43	1.69	2.02	77	77	Yes	1	Mod		45		LSR	Hit
5-Jun	1.87	2.26	1.37	1.78	4	2.07	35	78	160	3.71	1.63	124	160	Yes	1	Mod		54		LSR	Hit
6-Jun	1.42	1.82	1.6	2.05	2.72	3.66	29	69	317	1.85	2.39	121	317	Yes	1	Mod		37		LSR	Hit
7-Jun	0.05	0.05	0.54	0.55	0.09	0.61	0	0	0	0.03	0.51	0	0								
8-Jun	0.07	0.07	1.57	1.64	0.1	1.8	4	8	31	0.08	1.21	7	31						BIAS		
9-Jun	0.45	0.45	1.69	1.79	0.49	2.04	12	22	23	0.49	1.42	13	23		1					GRIDDED	Miss
10-Jun	0.55	0.6	0.77	1	0.82	1.16	0	1	3	0.52	0.89	0	3								
11-Jun	1.84	2.45	1.16	1.33	2.84	1.55	11	33	41	3.07	1.25	21	41	Yes					BIAS		
12-Jun	1.51	1.73	1.27	1.67	1.87	2.28	5	22	27	2.02	1.65	17	27						BIAS		
13-Jun	1.68	1.98	1.03	1.07	2.11	1.2	11	28	41	1.65	0.89	7	41			Low		6	BIAS		FA

NSSL MRMS Quantitative Precipitation Estimate							NOAA ST4 Quantitative Precipitation Estimate	QPE	Rain Gauges	Flood Reports
---	--	--	--	--	--	--	--	-----	-------------	---------------

Date	Max 1hr E	Max2hr E	Max 1hr W	Max2hr W	Max24hr E	Max24hr W	Max24hr E	Max24hr W	24hr Flood Area (Max)	NStats	Max-E	Max-W	Reports	NWS Warning or Advisory	Flood Day	Threat AM	Threat PM	Total Threat Area	Flags	FD Classification	Outcome
Units	inches	inches	inches	inches	inches	inches	inches	inches	points	number	inches	inches	number					x1000 Miles			
14-Jun	1.56	2.28	0.46	0.54	2.98	0.75	1	22	54	2.34	0.57	44	54		1					GRIDDED	Miss
15-Jun	1.49	2.49	1	1.35	3	1.44	1	10	10	2.41	1.09	6	10	Yes					BIAS		
16-Jun	1.83	1.92	1.52	2.05	2.13	2.31	22	44	47	1.74	1.94	29	47		1					GRIDDED	Miss
17-Jun	2.26	2.84	1.71	1.96	3.92	2.21	62	147	330	2.04	2.31	132	330		1	Mod		42		LSR	Hit
18-Jun	0	0	0.49	0.49	0	0.49	0	0	0	0	0.27	0	0								
19-Jun	1.57	1.64	1.17	1.56	1.7	1.57	4	11	11	1.51	1.44	6	11						BIAS		
20-Jun	0.49	0.49	0.21	0.32	0.57	0.37	0	0	0	0.42	0.25	0	0								
21-Jun	0	0	0	0	0	0	0	0	0	0	0.03	0	0								
22-Jun	0.76	0.86	0.61	0.76	1.13	0.99	0	0	0	0.94	0.93	0	0								
23-Jun	1.38	1.67	0.82	0.85	2.41	1.11	0	2	14	2.2	1.09	4	14			Low		16			FA
24-Jun	1.65	2.94	1.63	2.07	3.65	3.27	39	164	345	3.64	1.84	261	345	Yes	1	Mod		47		GAUGE	Hit
25-Jun	2.39	2.52	2.24	2.36	2.97	2.64	49	97	151	1.94	2.53	97	151	Yes	1	Mod		32		LSR	Hit
26-Jun	0.76	0.94	0.86	1.11	0.98	1.13	0	1	1	1.04	0.81	0	1								
27-Jun	1.7	2.25	0.78	0.82	2.56	0.95	5	19	22	2.35	0.94	13	22						BIAS		
28-Jun	1.11	1.48	0.98	0.98	1.53	0.98	0	0	0	0.85	0.73	0	0								
29-Jun	1.93	2.84	1.56	2.22	3.17	2.35	50	105	138	2.43	2.09	64	138	Yes	1	Low		21		GRIDDED	Hit
30-Jun	1.17	1.33	1.7	1.96	1.74	2.04	26	54	74	1.34	1.66	38	74		1	Mod		26		GAUGE	Hit
1-Jul	1.8	2.63	1.1	1.18	2.7	1.34	4	11	20	2.41	1.22	8	20						BIAS		
2-Jul	0	0	0.69	0.82	0	0.95	0	0	0	0	0.53	0	0								
3-Jul	0.74	1.22	1.12	1.57	1.89	1.94	4	7	9	1.77	1.66	8	9	Yes	1	Low		27		LSR	Hit
4-Jul	1.31	1.31	0.95	0.96	1.48	1.55	0	0	3	1.07	0.96	0	3								
5-Jul	1.72	2.59	1.53	1.53	3.53	1.88	19	61	152	5.47	1.51	85	152	Yes	1					GAUGE	Miss
6-Jul	2.28	3.17	2.28	2.75	4.47	3.08	104	220	302	3.71	2.59	326	326	Yes	1	Low		33		GAUGE	Hit

NSSL MRMS Quantitative Precipitation Estimate							NOAA ST4 Quantitative Precipitation Estimate	QPE	Rain Gauges			Flood Reports									
Date	Max 1hr E	Max2hr E	Max 1hr W	Max2hr W	Max24hr E	Max24hr W	Max24hr E	Max24hr W	24hr Flood Area (Max)	NStats	Max-E	Max-W	Reports	NWS Warning or Advisory	Flood Day	Threat AM	Threat PM	Total Threat Area	Flags	FD Classification	Outcome
Units	inches	inches	inches	inches	inches	inches	inches	inches	points	number	inches	inches	number					x1000 Miles			
7-Jul	1.43	1.74	0.82	0.91	1.86	1.12	0	6	6	1.19	0.73	0	6			Low		16			FA
8-Jul	1.02	1.02	0.91	1.15	1.08	1.18	0	1	1	0.87	0.92	0	1								
9-Jul	0.37	0.59	0.51	0.76	0.61	0.76	0	0	0	0.41	0.42	0	0								
10-Jul	2.33	2.33	1.98	1.98	2.33	2.05	23	27	34	1.2	1.33	2	34						BIAS		
11-Jul	2.72	3.73	2.94	3.28	3.74	3.71	134	298	542	3.05	2.42	201	542	Yes	1	Mod		5		GAUGE	Hit
12-Jul	0.38	0.38	2.06	3.77	0.46	5.54	24	77	105	0.36	2.61	31	105		1	Low		3		GRIDDED	Hit
13-Jul	0.14	0.21	1.35	1.7	0.3	1.78	8	33	54	0.27	1.11	6	54		1					GAUGE	Miss
14-Jul	1.72	2.41	2.21	2.87	2.49	3	65	126	152	1.5	1.97	52	152		1	Low		1		GAUGE	Hit
15-Jul	1.16	1.97	0.88	0.98	2	1.25	0	2	2	1.01	0.81	0	2								
16-Jul	2.73	3.3	2.66	2.82	3.87	3.46	147	233	327	2.77	3.6	239	327	Yes	1	High		38		LSR	Hit
17-Jul	1.56	1.57	2.17	2.44	1.89	2.89	62	82	92	1.05	1.65	21	92	Yes	1	Mod		31		LSR	Hit
18-Jul	1.78	1.84	1.61	1.78	2.29	1.81	8	14	17	2.09	1.57	13	17	Yes		Low		5	BIAS		FA
19-Jul	2.32	2.62	1	1.29	3.41	1.73	10	38	77	2.71	1.53	74	77			Low		13	BIAS		FA
20-Jul	3.25	3.98	1.59	1.59	5.84	2.15	58	134	183	4.57	1.84	126	183	Yes	1					GAUGE	Miss
21-Jul	1.83	1.95	1.45	1.78	2.29	3.05	14	37	56	1.84	2.41	30	56	Yes	1	Low		8		GRIDDED	Hit
22-Jul	2.15	2.77	1.91	2.44	3.16	3.6	51	150	401	2.67	2.74	314	401	Yes	1	Mod		36		LSR	Hit
23-Jul	2.29	2.49	2.48	2.6	2.91	2.6	53	133	191	2.26	2.88	127	191	Yes	1	High		42		GAUGE	Hit
24-Jul	2.22	2.64	2.85	3.96	3	4.29	132	225	313	2.54	2.99	194	313	Yes	1	High		45		LSR	Hit
25-Jul	0.6	0.67	1.22	1.52	1.21	1.97	6	14	20	0.54	1.91	7	20						BIAS		
26-Jul	1.54	2.35	0.53	0.6	2.67	0.62	2	7	12	2.2	0.44	10	12		1				BIAS	GRIDDED	Miss
27-Jul	0.13	0.13	0.01	0.01	0.28	0.02	0	0	0	0.13	0.01	0	0								
28-Jul	0.58	1	1.22	1.65	1	2.08	6	14	23	0.76	1.41	6	23						BIAS		
29-Jul	2.6	2.84	2.81	3.7	4.6	4.78	105	255	390	3.25	3.28	229	390	Yes	1	Mod		34		LSR	Hit
30-Jul	1.88	1.99	1.47	2.28	2.28	2.66	35	102	147	2.06	2.26	61	147	Yes	1	High		18		LSR	Hit

NSSL MRMS Quantitative Precipitation Estimate							NOAA ST4 Quantitative Precipitation Estimate	QPE	Rain Gauges			Flood Reports									
Date	Max 1hr E	Max2hr E	Max 1hr W	Max2hr W	Max24hr E	Max24hr W	Max24hr E	Max24hr W	24hr Flood Area (Max)	NStats	Max-E	Max-W	Reports	NWS Warning or Advisory	Flood Day	Threat AM	Threat PM	Total Threat Area	Flags	FD Classification	Outcome
Units	inches	inches	inches	inches	inches	inches	inches	inches	points	number	inches	inches	number					x1000 Miles			
31-Jul	2.68	4.99	2.45	2.93	6.96	3.02	144	303	390	4.9	2.81	187	390	Yes	1	Mod		24		LSR	Hit
1-Aug	1.84	2.91	2.11	2.53	2.98	3.24	62	103	112	2.92	1.98	101	112	Yes	1	High		33		GRIDDED	Hit
2-Aug	1.49	1.67	1.49	1.69	2.25	1.84	8	26	66	1.9	1.63	26	66		1	Low		18		GRIDDED	Hit
3-Aug	1.2	1.27	0.14	0.23	1.44	0.63	0	0	0	0.81	0.17	0	0								
4-Aug	2.01	3.49	1.95	2.87	3.87	2.94	56	134	135	1.99	1.55	14	135	Yes	1					GRIDDED	Miss
5-Aug	1.48	1.54	0.3	0.42	1.58	0.96	0	1	1	1.57	0.13	0	1								
6-Aug	0.13	0.13	0.59	0.59	0.17	0.69	0	0	0	0.13	0.37	0	0								
7-Aug	0.65	0.8	0.52	0.73	0.91	0.73	0	0	0	0.48	0.39	0	0								
8-Aug	0.46	0.62	0.44	0.44	0.64	0.65	0	0	0	0.46	0.53	0	0								
9-Aug	2.37	2.65	1.85	2.62	3.98	3.34	98	273	478	3.37	2.86	383	478	Yes	1	Mod		24		GAUGE	Hit
10-Aug	1.75	2.35	2.19	2.27	3.15	3.54	75	182	433	2.55	2.52	223	433	Yes	1	Mod		43		LSR	Hit
11-Aug	1.17	1.17	1.3	1.5	1.21	1.79	4	9	9	1.05	1.41	3	9						BIAS		
12-Aug	0	0	0.65	0.77	0	0.86	0	0	0	0	0.41	0	0								
13-Aug	0.26	0.26	0.13	0.17	0.32	0.2	0	0	0	0.18	0.08	0	0								
14-Aug	1.2	1.2	0.68	0.97	1.21	1.07	0	0	0	1.07	0.68	0	0								
15-Aug	1.22	1.71	0.93	1.57	1.82	2.12	0	7	11	1.4	0.77	0	11								
16-Aug	1.5	1.7	1.4	1.47	1.95	1.54	5	8	9	1.4	0.93	0	9			Low		4	BIAS		FA
17-Aug	0.6	0.77	0.62	0.83	1.07	1.05	0	0	0	0.6	0.7	0	0								
18-Aug	1.72	2.32	2.39	3.01	2.95	3.9	53	122	175	2.42	2.69	97	175	Yes	1	Low		19		GRIDDED	Hit
19-Aug	1.19	1.26	2.18	2.33	1.37	2.84	24	36	40	0.75	1.58	21	40	Yes	1	Low		7		GAUGE	Hit
20-Aug	0.57	0.57	0.61	0.61	0.57	0.8	0	0	0	0.24	1.04	1	1								
21-Aug	0.46	0.59	0.69	0.76	0.68	0.9	0	0	0	0.29	0.66	0	0								
22-Aug	1.14	1.34	1.15	1.54	1.52	1.85	7	32	122	0.85	5.14	257	257		1	Mod		2		GRIDDED	Hit

NSSL MRMS Quantitative Precipitation Estimate							NOAA ST4 Quantitative Precipitation Estimate	QPE	Rain Gauges			Flood Reports									
Date	Max1hr E	Max2hr E	Max1hr W	Max2hr W	Max24hr E	Max24hr W	Max24hr E	Max24hr W	24hr Flood Area (Max)	NStats	Max-E	Max-W	Reports	NWS Warning or Advisory	Flood Day	Threat AM	Threat PM	Total Threat Area	Flags	FD Classification	Outcome
Units	inches	inches	inches	inches	inches	inches	inches	inches	points	number	inches	inches	number					x1000 Miles			
23-Aug	2.04	2.31	1.22	1.62	2.63	2.04	11	53	90	1.48	3.09	73	90	Yes	1	Mod		15		GAUGE	Hit
24-Aug	2.13	3.43	2.1	3.44	3.66	4.09	84	190	293	2.45	3.49	164	293	Yes	1	Mod		37		GRIDDED	Hit
25-Aug	1.09	1.35	2.46	2.85	1.82	4.13	30	99	296	1.72	3.66	248	296	Yes	1	Mod		43		LSR	Hit
26-Aug	1.26	1.73	2.35	3.05	2.2	4.11	38	117	349	2	4.25	295	349	Yes	1	Mod		29		LSR	Hit
27-Aug	2.04	2.53	1.44	1.74	2.84	2.18	11	18	39	1.83	1.31	14	39	Yes	1	Mod		3		LSR	Hit
28-Aug	2.15	2.39	1.67	1.99	2.77	2.16	51	113	212	2.44	1.79	106	212	Yes	1	Mod		35		LSR	Hit
29-Aug	1.87	2.72	1.12	1.68	3.21	2.21	23	95	210	3.24	1.97	181	210	Yes	1	Mod		18		LSR	Hit
30-Aug	1.1	1.11	0.99	1.33	1.17	1.35	0	1	1	0.93	1.3	6	6								
31-Aug	0	0	0.59	0.61	0	0.81	0	0	0	0	0.69	0	0								
1-Sep	0	0	0.43	0.54	0	0.66	0	0	0	0	0.93	0	0								
2-Sep	0.08	0.09	1.02	1.13	0.12	1.22	1	1	1	0.07	0.93	0	1								
3-Sep	0.02	0.02	0.35	0.35	0.02	0.43	0	0	0	0	0.43	0	0								
4-Sep	0.57	0.61	1.02	1.68	0.69	2.16	1	5	6	0.79	1.77	5	6	Yes	1					LSR	Miss
5-Sep	0.4	0.56	0.89	1.24	0.94	1.74	0	2	19	1.25	1.25	10	19			Low		4			FA
6-Sep	0.14	0.17	0.87	1.3	0.19	1.65	0	3	5	0.11	1.86	18	18			Low		1			FA
7-Sep	1.88	2.25	1.76	2.06	2.33	2.06	17	28	32	2.14	1.6	19	32						BIAS		
8-Sep	0.91	1.35	0.32	0.32	1.46	0.43	0	0	0	2.18	0.31	7	7								
9-Sep	2.66	3.54	1.03	1.03	3.72	1.24	35	71	117	2.74	0.79	44	117	Yes	1	Low		7		GRIDDED	Hit
10-Sep	1.1	1.17	1.33	1.51	1.19	1.76	3	3	8	1.09	2.41	9	9								
11-Sep	2.4	2.76	2.49	2.99	3.61	3.47	16	23	61	0.99	1.56	56	61	Yes	1					GAUGE	Miss
12-Sep	0.55	0.57	0.93	0.98	0.69	1.18	0	0	18	0.48	2.13	145	145	Yes	1	Low		15		LSR	Hit
13-Sep	1.32	2.18	1.17	1.91	3.36	2.37	2	21	70	2.54	2.03	95	95	Yes	1	Low		17		LSR	Hit
14-Sep	0.67	0.72	0.25	0.3	0.75	0.73	0	0	0	0.55	0.66	0	0								

NSSL MRMS Quantitative Precipitation Estimate							NOAA ST4 Quantitative Precipitation Estimate	QPE	Rain Gauges	Flood Reports
---	--	--	--	--	--	--	--	-----	-------------	---------------

Date	Max 1hr E	Max2hr E	Max 1hr W	Max2hr W	Max24hr E	Max24hr W	Max24hr E	Max24hr W	24hr Flood Area (Max)	NStats	Max-E	Max-W	Reports	NWS Warning or Advisory	Flood Day	Threat AM	Threat PM	Total Threat Area	Flags	FD Classification	Outcome
Units	inches	inches	inches	inches	inches	inches	inches	inches	points	number	inches	inches	number					x1000 Miles			
15-Sep	0.07	0.07	0.55	0.72	0.09	0.76	0	0	0	0.05	0.79	0	0								
16-Sep	1.81	2.29	0.97	1.87	3.45	2.21	8	46	93	3.02	1.51	81	93	Yes	1					GAUGE	Miss
17-Sep	1.04	1.57	1.69	1.93	2.61	2.34	27	62	171	1.7	2.03	90	171	Yes	1	Low		19		LSR	Hit
18-Sep	0.21	0.21	0	0	0.21	0.01	0	0	0	0.14	0.01	0	0								
19-Sep	0.09	0.09	0.63	0.79	0.16	0.93	0	0	0	0.05	0.49	0	0								
20-Sep	1.88	2.24	1.85	2.04	2.5	2.27	32	47	58	1.75	1.42	21	58		1					GAUGE	Miss
21-Sep	0.25	0.32	0.89	0.89	0.33	1.05	0	0	0	0.33	0.74	0	0								
22-Sep	1.49	1.75	0.83	0.98	2.78	1.51	0	9	60	2.08	1.5	61	61			Low		7	BIAS	FA	
23-Sep	0.53	0.78	0.97	1	2.95	2.87	0	2	1340	2.38	2.23	1403	1403								
24-Sep	0.02	0.02	0.08	0.08	0.02	0.09	0	0	0	0.02	0.05	0	0								
25-Sep	0	0	0.03	0.04	0	0.04	0	0	0	0	0.08	0	0								
26-Sep	0.11	0.11	0.16	0.16	0.19	0.23	0	0	0	0	0.25	0	0								
27-Sep	0.31	0.35	0.31	0.48	0.39	0.6	0	0	0	0.33	0.57	0	0								
28-Sep	0.35	0.43	0.75	0.75	0.75	0.89	0	0	0	0.51	0.87	0	0								
29-Sep	1.56	1.71	0.93	1	1.96	1.41	1	8	14	1.66	1.32	11	14						BIAS		
30-Sep	0.21	0.23	0.24	0.24	0.29	0.24	0	0	0	0.25	0.32	0	0								
13-Oct	0.22	0.28	0.58	0.87	0.32	4.31	854	0	1496	0.37	4.28	987	1496	Yes	1	Mod		11		LSR	Hit

APPENDIX B – BURN AREA VERIFICATION WORKSHEET

Table 14 is a daily verification worksheet documenting heavy precipitation and associated debris flow/flash flooding reports over burn areas featured in the FBF. Shading within a cell indicates that a flood threat was issued with the color corresponding to the Program’s four-tier threat system. The color yellow corresponds to a “Low” threat, orange to a “Moderate” threat, red to a “High” threat and purple to a “High Impact” threat. A blank cell indicates that no specific burn area threat was issued for that day. The text provided in Table 14 are described below.

Note that there was a discussion with Steven Griffin (CDOT) who supplied all debris flow events for the East Troublesome burn area. All debris flow events were minor or very minor in nature, but his work had extremely detailed runoff and rainfall accounts. More details on these recorded events can be found in the 2025 FBF Assessment Technical Memo.

Burn Area: The names of the six burn areas that were forecast this season. More forecast information can be found in Table 3.

FLOOD: Indicates that a debris flow report was recorded from a LSR (see Appendix C), social media reports (X and Facebook) or personal contacts.

QPE: Marks days that the QPE threshold was exceeded. These thresholds are set at the beginning of the season using historical data from the previous season. If the burn area is new, the threshold is set to 0.25 inches per hour. Thresholds used for this worksheet are:

Alexander Mountain (2024) & Stone Canyon (2024): **0.25 inches per hour**

Cameron Peak (2020), East Troublesome (2020), Grizzly Creek (2020) & Pine Gulch (2020): **1 inch per hour**

Table 14: Daily Burn Area Verification Worksheet

Date	0.25 in/hr		1.0 in/hr			
	Alexander Mountain	Stone Canyon	Cameron Peak	East Troublesome	Grizzly Creek	Pine Gulch
1-May						
2-May						
3-May						
4-May						
5-May	QPE					
6-May	QPE	QPE				
7-May	QPE					
8-May						
9-May						
10-May						
11-May						
12-May						
13-May						
14-May	QPE	QPE				
15-May						
16-May						
17-May						
18-May	QPE					
19-May						
20-May						
21-May						
22-May						
23-May						
24-May	QPE	QPE				
25-May	QPE	QPE				
26-May	QPE					
27-May	QPE					
28-May	QPE	QPE				
29-May						
30-May	QPE	QPE	QPE			
31-May						
1-Jun	QPE					
2-Jun	QPE	QPE	QPE			
3-Jun						
4-Jun						
5-Jun	QPE		QPE			
6-Jun	QPE					
7-Jun						
8-Jun						
9-Jun						
10-Jun						
11-Jun	QPE					
12-Jun	QPE		QPE			
13-Jun						
14-Jun						
15-Jun						
16-Jun						
17-Jun	QPE	QPE	QPE	FLOOD		

Date	0.25 in/hr		1.0 in/hr			
	Alexander Mountain	Stone Canyon	Cameron Peak	East Troublesome	Grizzly Creek	Pine Gulch
18-Jun						
19-Jun						
20-Jun						
21-Jun						
22-Jun						
23-Jun						
24-Jun						
25-Jun	QPE					
26-Jun						
27-Jun						
28-Jun						
29-Jun	QPE		QPE			
30-Jun						
1-Jul	QPE					
2-Jul						
3-Jul		QPE		FLOOD		
4-Jul		QPE		QPE		
5-Jul	QPE					
6-Jul						
7-Jul						
8-Jul						
9-Jul						
10-Jul						
11-Jul	QPE	QPE		QPE		
12-Jul						
13-Jul				FLOOD		
14-Jul						
15-Jul						
16-Jul	QPE	QPE				
17-Jul	QPE					
18-Jul	QPE					
19-Jul						
20-Jul						
21-Jul						
22-Jul	QPE		QPE			
23-Jul			QPE	FLOOD		
24-Jul			QPE			
25-Jul						
26-Jul						
27-Jul						
28-Jul						
29-Jul				FLOOD		
30-Jul						
31-Jul		QPE				
1-Aug					QPE	
2-Aug	QPE	QPE		FLOOD		
3-Aug						
4-Aug						
5-Aug						
6-Aug						

Date	0.25 in/hr		1.0 in/hr			
	Alexander Mountain	Stone Canyon	Cameron Peak	East Troublesome	Grizzly Creek	Pine Gulch
7-Aug						
8-Aug						
9-Aug						
10-Aug	QPE	QPE				
11-Aug						
12-Aug						
13-Aug						
14-Aug						
15-Aug						
16-Aug						
17-Aug						
18-Aug						
19-Aug						
20-Aug						
21-Aug						
22-Aug				FLOOD		
23-Aug						
24-Aug	QPE			FLOOD		
25-Aug						QPE
26-Aug		QPE	QPE			
27-Aug	QPE	QPE	QPE	FLOOD		
28-Aug	QPE	QPE				
29-Aug						
30-Aug	QPE	QPE				
31-Aug						
1-Sep						
2-Sep	QPE					
3-Sep						
4-Sep						
5-Sep						QPE
6-Sep						
7-Sep						
8-Sep						
9-Sep						
10-Sep						
11-Sep	QPE					QPE
12-Sep						QPE
13-Sep			QPE			
14-Sep						
15-Sep						
16-Sep	QPE		QPE			
17-Sep						
18-Sep						
19-Sep						
20-Sep						
21-Sep						
22-Sep	QPE	QPE				
23-Sep	QPE	QPE				
24-Sep						
25-Sep						

	0.25 in/hr		1.0 in/hr			
Date	Alexander Mountain	Stone Canyon	Cameron Peak	East Troublesome	Grizzly Creek	Pine Gulch
26-Sep						
27-Sep						
28-Sep						
29-Sep						
30-Sep						

APPENDIX C – DATA SOURCES

Below are the data sources used for verification in this final report. Questionable observations within each data source were noted and discarded based on comparison with other data.

Data Source	Additional Information	Access
Rain Gauges		
CoCoRaHS	Community Collaborative Rain, Hail and Snow Network. Daily precipitation accumulations from up to 1,300 observers across Colorado. This data is generally reported in the morning and encompasses the previous 24 hours of precipitation accumulation. Only reports received from 6AM to 9AM are used to ensure that measurements are consistent with the forecast period.	https://www.cocorahs.org
NRCS	Natural Resources Conservation Service. SNOTEL hourly precipitation data was used and also aggregated into daily accumulations at approximately 65 high-elevation sites across Colorado.	https://www.nrcs.usda.gov/wps/portal/wc/c/home
MesoWest	University of Utah’s hourly precipitation data, which has many contributing networks. The major networks include: Colorado Agricultural Meteorological Network (CoAgMet), Climate Reference Network (CRN), Hydrometeorological Automated Data System (HADS), interagency Remote Automatic Weather Stations (RAWS) and Soil Climate Analysis Network (SCAN). Secondary networks (i.e. lower quality) also include the Citizen Weather Observer Program (CWOP). Hourly precipitation data was used along with aggregated 24-hour totals.	https://mesowest.utah.edu
USGS	United States Geological Survey. Sub-hourly precipitation data was aggregated into a rolling 1-hour totals and daily accumulations. This data source is particularly helpful over the high terrain fire burn areas and the more populated areas of Teller and El Paso Counties.	https://co.water.usgs.gov/infodata/COPrecip/index.html
Personal Weather Stations (Table 1)	In addition to using CWOP station data via MesoWest (see above), other personal weather station network data was accessed via the Ambient Weather network, Weather Underground and Aeri Weather. At this time, PWS data is only used subjectively to inform on heavy rainfall that occurs in poorly gauged areas. However, subject matter expert judgment could have affected the BIAS flag in Appendix A.	http://www.ambientweather.net https://www.weatherunderground.com https://www.pwsweather.com
Gridded Quantitative Precipitation Estimate (QPE)		
MRMS	NSSL Multi-Radar Multi-Sensor. This is a near real-time hourly gridded product based on an initial best-guess of radar, satellite and weather model rainfall estimates that is corrected with gauge data. The resolution of the product is roughly 1km; however, due to Colorado’s large spatial extent (~100,000 square miles, or roughly 300,000 MRMS grid points), the native grid was re-sampled to roughly 4 km (2.6 mile) resolution to be directly comparable to Stage IV QPE (see below). MRMS 24-hour, maximum 1-hour, and maximum 2-hour QPE were used for verification.	https://mrms.nssl.noaa.gov
Stage IV	NOAA Stage IV. This is an hourly product based on a radar-estimated, gauge-adjusted technique using all NWS NEXRAD radars and many quality-controlled rain gauges. The horizontal resolution is about 4 km (2.6 mile). Due to the availability of more consistent MRMS data at the 1-hour and 2-hour interval, only 24-hour Stage IV QPE was used.	https://data.eol.ucar.edu/dataset/21.093

Data Source	Additional Information	Access
Storm Reports		
LSR	Local Storm Report. Obtained from the four NWS offices that are responsible for Colorado: Boulder, Pueblo, Grand Junction, and Goodland (KS) using the IEM. Reports were only included if they contained the following phrases: "Heavy Rain", "Flash Flood", "Flood" or "Debris Slide". Reports involving the term "Heavy Rain" were retained only when the magnitude of rainfall exceeds 0.50 in. Like CoCoRaHS data, reports of 24-hour accumulation were only retained if the report ending time was between 6AM and 9AM. If a "Heavy Rain" report did not specify a magnitude, it was dismissed unless the observer's note contained a specific reference to flooding.	https://mesonet.agron.iastate.edu/lst/
Flood Reports	Flood reports obtained from the Program's web-based report submission system, subject to quality control by the Team.	No Public Access
NWS Warning and Advisory Products		
NWS	National Weather Service warning and advisory Geographic Information Systems (GIS) data. Obtained from the IEM, this data source includes metadata such as the location and when the product was issued. Flash Flood Warning, Riverine Flood Warning and Areal Flood Advisory products were included for verification.	https://mesonet.agron.iastate.edu/request/gis/watchwarn.phtml

APPENDIX D - COLORADO CLIMATE

Colorado’s geographic position and over 10,000 feet of topographic contrast can be conducive to both short-term flash flooding from single thunderstorms and prolonged heavy rainfall and flooding as most recently occurred over the Front Range during September of 2013. Moreover, the placement of the Continental Divide separates the state into contrasting climates. To the east, the relatively close proximity of Gulf of Mexico moisture supports higher rainfall intensity, especially over shorter durations compared to areas west of the Continental Divide. However, the hillier terrain to the west implies that less rainfall is required to generate problematic runoff. For example, over the eastern Plains, hourly rainfall rates of 1.5 inches or more are typically required to cause excessive runoff. For western areas, hourly rainfall rates of less than 1 inch could cause issues. Furthermore, hillier terrain can play host to mud and debris flows, in addition to the usual flash flooding concerns that are experienced statewide. The following section summarizes key aspects of Colorado’s physiographic features that play an essential role in daily flood forecasting.

a) Importance of Continental Divide

The most important control of heavy rainfall potential in Colorado (even more important than elevation, by itself) is arguably the position relative to the Continental Divide. Figure 19 (Atlas 14, 2017) shows the stark differences in rainfall recurrence statistics at Denver (east of the Continental Divide) compared to Silt (west of the Continental Divide). While both locations have a similar elevation of about 5,300 feet, the 30-minute 10-year rainfall at Denver (1.09 inches) is 81% higher than the analogous value for Silt (0.60 inches). Similarly, the 30-minute 100-year rainfall at Denver (1.91 inches) is 80% higher than the analogous value at Silt (1.06 inches). In short, despite other possibly counteracting factors, this contrast consistently results in more flood threats east of the Continental Divide compared to its Western counterpart (also see Appendix E).

Denver, CO										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.217 (0.174-0.270)	0.267 (0.214-0.334)	0.358 (0.286-0.448)	0.439 (0.349-0.552)	0.562 (0.435-0.737)	0.665 (0.500-0.877)	0.774 (0.561-1.04)	0.892 (0.619-1.22)	1.06 (0.704-1.48)	1.19 (0.770-1.68)
10-min	0.317 (0.255-0.396)	0.392 (0.314-0.489)	0.524 (0.418-0.656)	0.644 (0.511-0.808)	0.823 (0.637-1.08)	0.973 (0.732-1.28)	1.13 (0.821-1.52)	1.31 (0.906-1.79)	1.55 (1.03-2.17)	1.75 (1.13-2.46)
15-min	0.387 (0.310-0.483)	0.478 (0.383-0.597)	0.639 (0.510-0.800)	0.785 (0.623-0.986)	1.00 (0.776-1.32)	1.19 (0.892-1.57)	1.38 (1.00-1.86)	1.59 (1.11-2.19)	1.89 (1.26-2.65)	2.13 (1.37-3.00)
30-min	0.545 (0.437-0.680)	0.670 (0.537-0.837)	0.892 (0.713-1.12)	1.09 (0.868-1.37)	1.39 (1.08-1.82)	1.64 (1.23-2.17)	1.91 (1.38-2.56)	2.19 (1.52-3.01)	2.60 (1.73-3.64)	2.93 (1.89-4.11)
60-min	0.683 (0.548-0.853)	0.834 (0.669-1.04)	1.10 (0.881-1.38)	1.35 (1.07-1.69)	1.71 (1.33-2.25)	2.02 (1.52-2.67)	2.35 (1.70-3.16)	2.71 (1.88-3.72)	3.21 (2.14-4.50)	3.62 (2.33-5.09)
2-hr	0.822 (0.666-1.02)	0.998 (0.807-1.23)	1.31 (1.06-1.63)	1.60 (1.28-1.99)	2.04 (1.59-2.65)	2.40 (1.83-3.14)	2.80 (2.05-3.72)	3.22 (2.26-4.38)	3.83 (2.57-5.31)	4.32 (2.81-6.02)

Silt, CO (near Glenwood Springs)										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.116 (0.091-0.147)	0.148 (0.116-0.188)	0.205 (0.159-0.261)	0.255 (0.198-0.327)	0.329 (0.248-0.447)	0.391 (0.287-0.537)	0.456 (0.323-0.645)	0.525 (0.356-0.768)	0.623 (0.406-0.941)	0.701 (0.443-1.07)
10-min	0.170 (0.133-0.215)	0.217 (0.170-0.276)	0.299 (0.233-0.382)	0.373 (0.289-0.479)	0.482 (0.364-0.654)	0.572 (0.420-0.787)	0.667 (0.473-0.945)	0.769 (0.522-1.13)	0.912 (0.594-1.38)	1.03 (0.649-1.57)
15-min	0.207 (0.162-0.263)	0.264 (0.207-0.336)	0.365 (0.285-0.466)	0.455 (0.353-0.584)	0.588 (0.443-0.798)	0.698 (0.512-0.960)	0.814 (0.578-1.15)	0.938 (0.637-1.37)	1.11 (0.725-1.68)	1.25 (0.792-1.91)
30-min	0.264 (0.207-0.336)	0.346 (0.270-0.440)	0.484 (0.377-0.617)	0.604 (0.468-0.775)	0.776 (0.583-1.05)	0.915 (0.670-1.25)	1.06 (0.748-1.49)	1.21 (0.819-1.76)	1.42 (0.923-2.14)	1.58 (1.00-2.42)
60-min	0.343 (0.269-0.436)	0.431 (0.337-0.548)	0.580 (0.452-0.741)	0.710 (0.550-0.911)	0.897 (0.674-1.21)	1.05 (0.768-1.44)	1.21 (0.852-1.70)	1.37 (0.928-2.00)	1.60 (1.04-2.41)	1.78 (1.12-2.72)
2-hr	0.422 (0.334-0.532)	0.516 (0.407-0.651)	0.677 (0.532-0.856)	0.817 (0.638-1.04)	1.02 (0.772-1.36)	1.18 (0.874-1.60)	1.35 (0.965-1.88)	1.53 (1.05-2.20)	1.78 (1.17-2.64)	1.97 (1.26-2.97)

Figure 19: Subset of NOAA Atlas 14 rainfall recurrence statistics for (top) Denver and (bottom) Silt. Note that the elevation of both locations is about 5,300 feet above sea level. Note that the intensities shown here are broadly similar to the more recent Colorado / New Mexico Regional Extreme Precipitation Study (2018).

b) Seasonality

Seasonality is likely the second most important factor in controlling heavy rainfall potential in Colorado. As shown in Figure 20, early in the operational season (May), the highest potential for heavy rainfall is almost exclusively east of the Continental Divide, and in particular the northeast quadrant of the state (PRISM, 2017). During early June (not shown), snow is a significant factor in the Front Range and Gore Mountains. Meanwhile, by August (Figure 20 bottom), average rainfall decreases sharply north of the Palmer Ridge and increases significantly over the southeast quadrant of the state as well as in the San Juan Mountains (due to moisture transport into the region by the North American Monsoon). The flood threat largely evolves in a similar fashion.

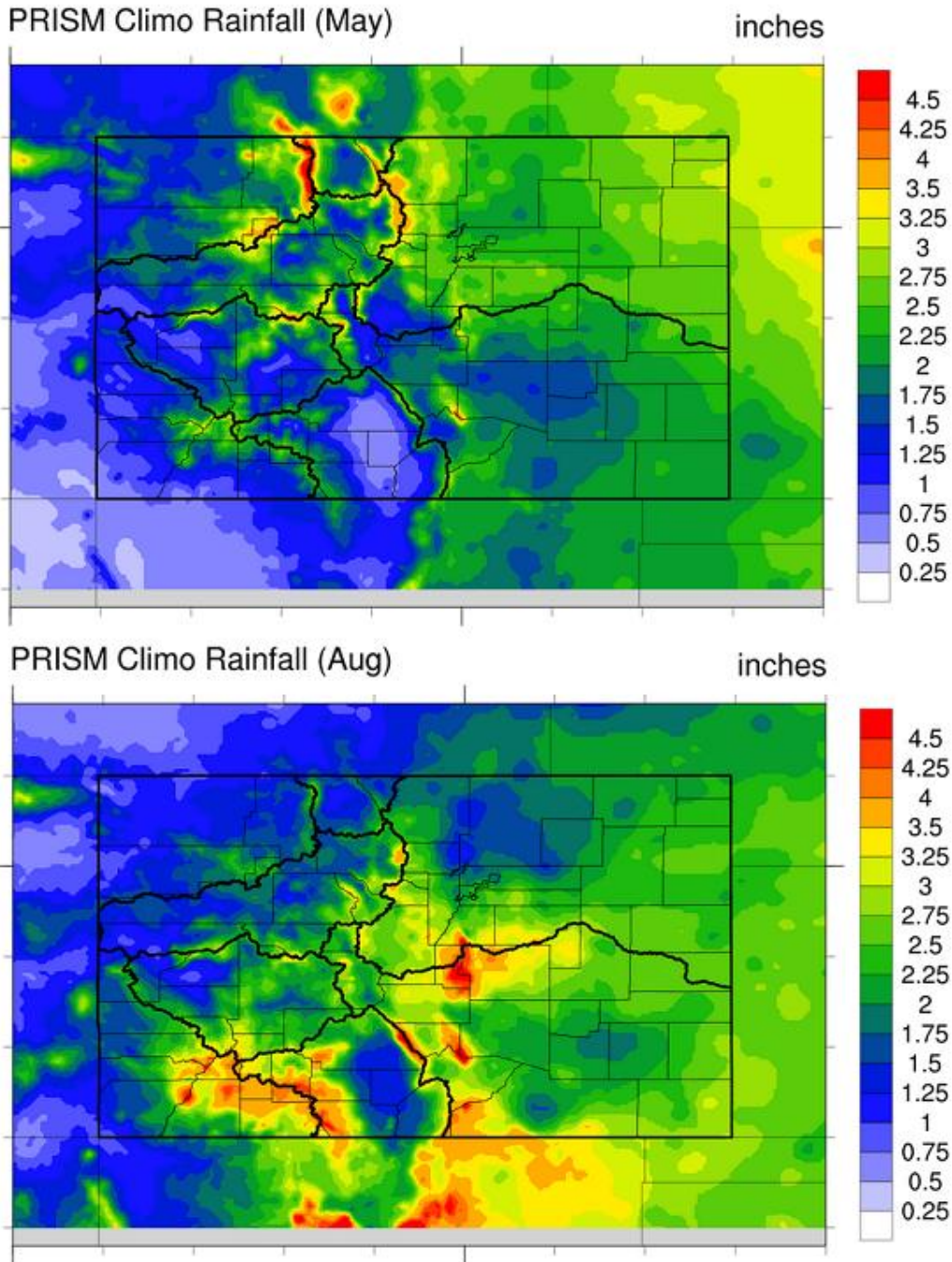


Figure 20: Monthly average precipitation for (top) May and (bottom) August. Source: Oregon State University PRISM group.

c) Surface characteristics

While a significant focus of the Flood Threat Bulletin is heavy rainfall potential, an equally important factor is surface characteristics such as slope, ground cover type, soil type, antecedent rainfall, etc. Collectively, these factors can cause significant sensitivity when translating between rainfall and runoff. Figure 21 shows the 1-hour Flash Flood Guidance (FFG) for central and eastern Colorado from their respective River Forecast Centers. These products are updated daily by the National Weather Service River Forecast Centers. Note that, in general, FFG is significantly higher over the eastern Plains compared to the higher terrain. For example, along the Kansas border, the 1-hour FFG could be just under 6 inches, while over the northern Front Range, it is between 1 and 2 inches. An even starker example of the importance of surface characteristics is over a fresh fire burn area, where the burnt, and now resultant hydrophobic soil mass, can cause significant flooding concerns for even 0.25 inches of rainfall per hour. This can be seen over Huerfano and Fremont County where the Spring Creek and Decker burn areas reside, respectively (pink in the top figure). Surface characteristics play an integral role in translating the heavy rainfall threat to a flooding potential.

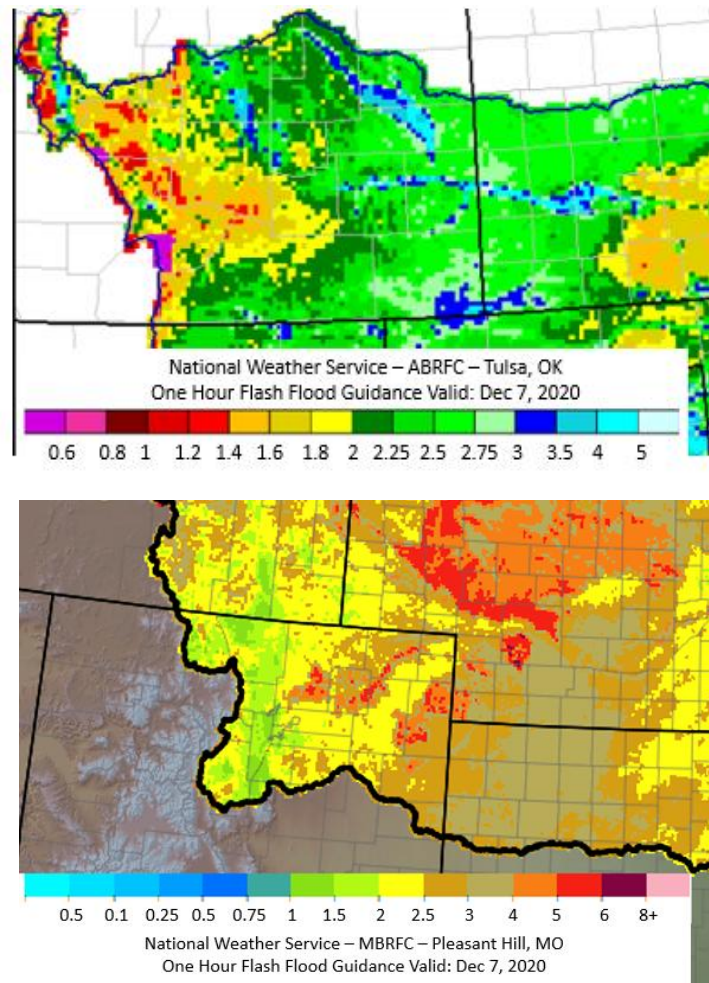
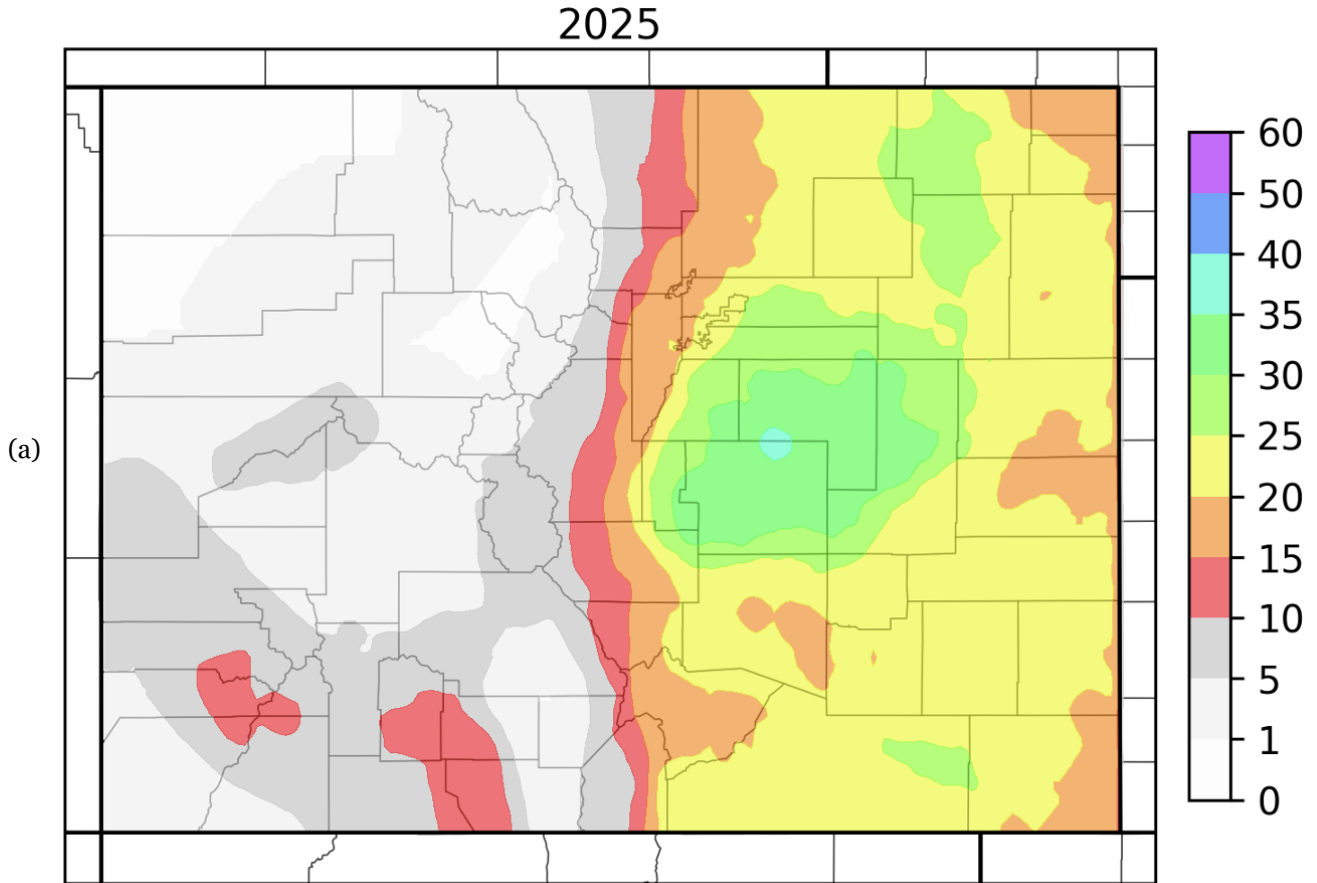


Figure 21: 1-hour Flash Flood Guidance for central and eastern Colorado, valid December 7th, 2020. Source: National Weather Service River Forecast Centers.

APPENDIX E – FLOOD THREATS ISSUED

Figure 22a showed the total number of days when a given location was under a flood threat during the 2025 operational season with the historical seasons from 2017 to 2024 on the following page. Note that this does not distinguish the type of flood threat (e.g., Low versus Moderate). For reference, there are normally 153 days during the forecast season with 154 days during 2018. Prior to 2025, maps also include riverine NWS Flood Warnings which were present a total of 21 days of the 2023 season. As a result, portions of Elkhead Creek and the Elk River in Routt County can be seen in 2023 image.



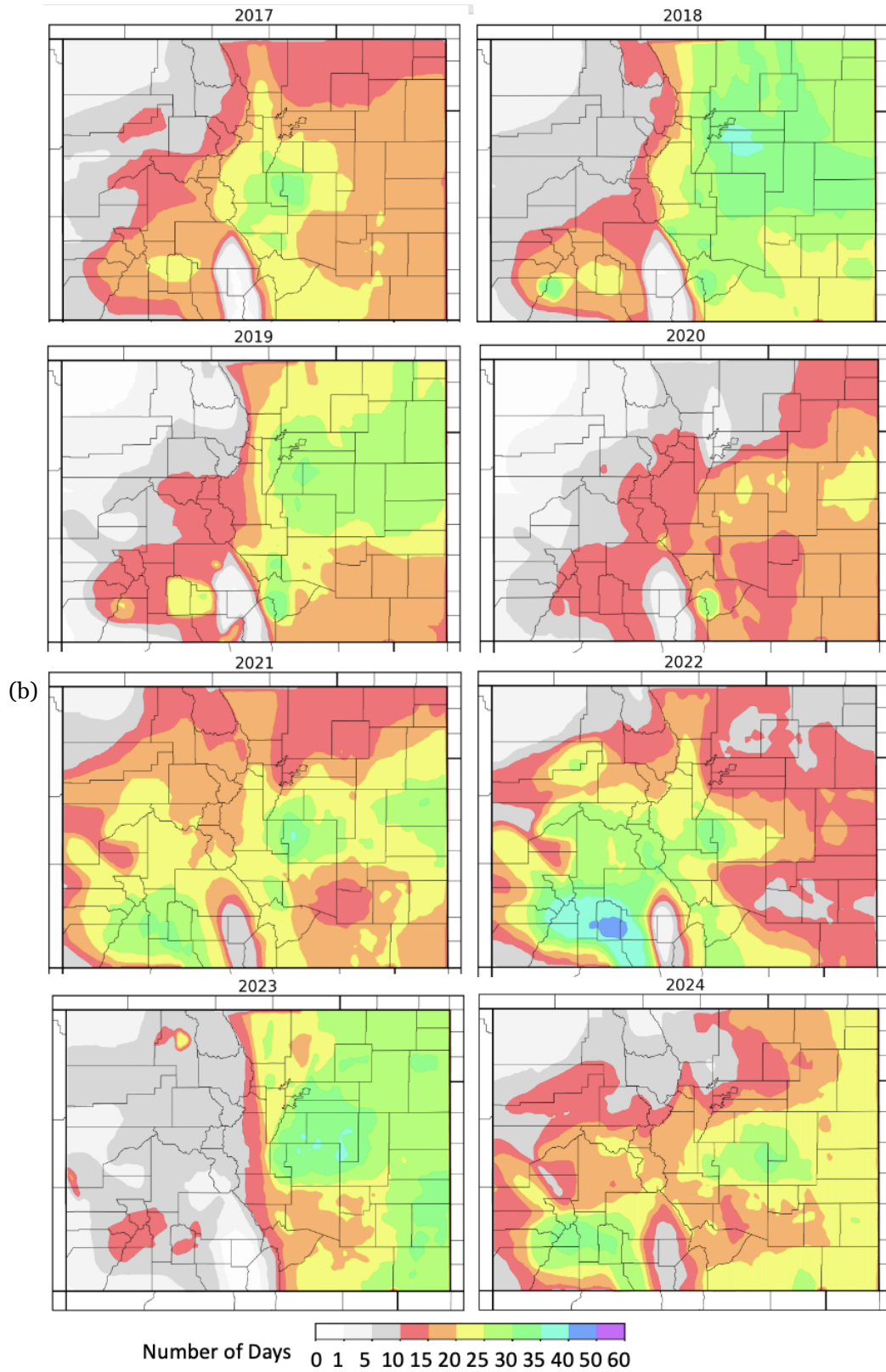


Figure 22: (a) Number of days with a flood threat issued in 2025. (b) Same as (a) except from 2017 to 2024. Note that until 2021, burn areas were considered within the FTB. After 2020, they were covered by the FBF.

APPENDIX F – QPE BIAS ASSESSMENT

As with previous seasons, an assessment of QPE product bias showed a systematic tendency for both the MRMS and Stage IV to *overestimate* precipitation when compared directly to gauges, in situations where over 0.25 inches of precipitation were estimated OR observed. Interestingly, the Top 10 Bias is less than last season, and much less for MRMS than Stage IV (0.88 inches and 1.33 inches, respectively), but the mean bias has increased to 13% (Figure 23).

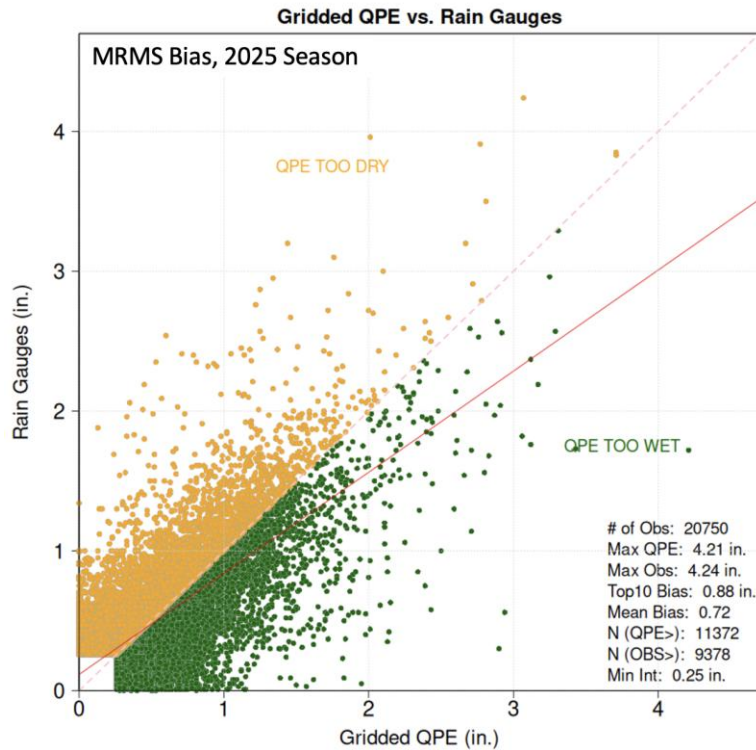


Figure 23: 2025 Seasonal (May-September) MRMS QPE vs Rain Gauge plot that shows overestimation of the gridded QPE product.

However, despite the overall bias shown above, there were significant variations on an event-by-event basis. These likely arose from numerous factors known to affect QPE, including but not limited to variations in the atmospheric moisture profile, sub-cloud layer depth, dynamic Z-R relationships within a storm, distance from radar sites, the presence or absence of hail, as well as cloud temperature. To gain some perspective on how the overall MRMS bias can vary, two events are provided below (Figure 24). On August 27th (top) diurnal flow and a shortwave were expected to combine over the Front Range by early afternoon and spark numerous storms with Precipitable Water values slightly above 1 inch. A couple limiting factors to the rainfall forecast were ongoing cloud cover and moderate steering flow, but pockets of instability were still expected to develop. Of the 662 stations with measurable rainfall of at least 0.10 inches, QPE overestimated rainfall at 333 stations, while underestimating at 340 stations. However, the mean bias was 0.72 inches, but the top 10 bias decreased to 0.45 inches indicating the larger station observations were close to MRMS QPE values. Or stated differently, the overestimation bias by MRMS was reduced near the stronger storm cores that were sampled by rainfall gauges. Conversely, on August 22nd (bottom), heavy rainfall was expected to develop over the Palmer Ridge and Front Range where instability, increasing moisture and enhanced dynamics (cold front) overlapped. Several observations over 1 inch in 1 hour were recorded, including at PWS sites (not shown). The mean bias (0.99 inches) was much higher than top 10 bias (0.36 inches) with the number of observations was close to 400 stations. Overall, MRMS did a pretty good job when compared to observations, minus MRMS being too dry for a handful of the higher end observations (>2 inches). This indicates that a larger warm layer depth was present, which helped aid in higher totals. This feature is often not well captured in gridded QPE.

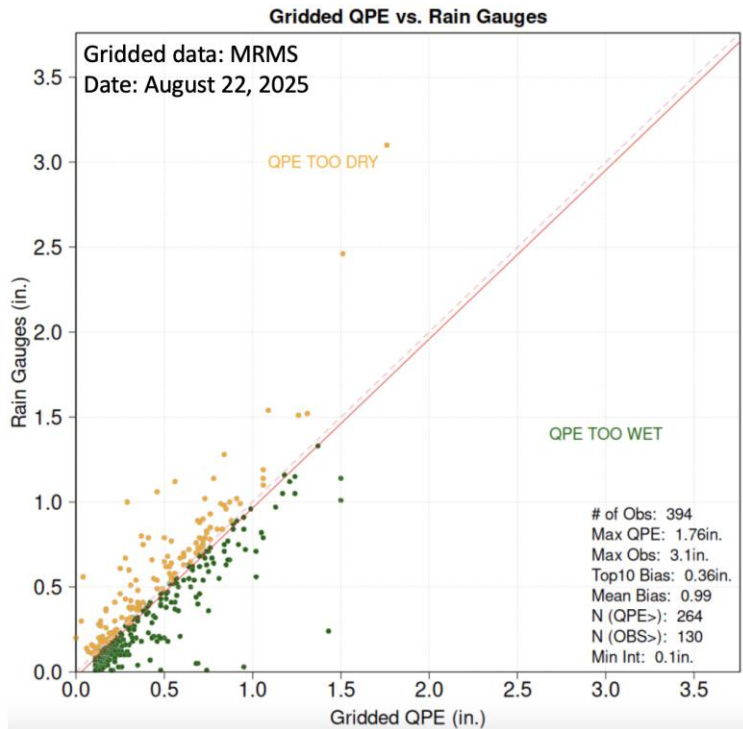
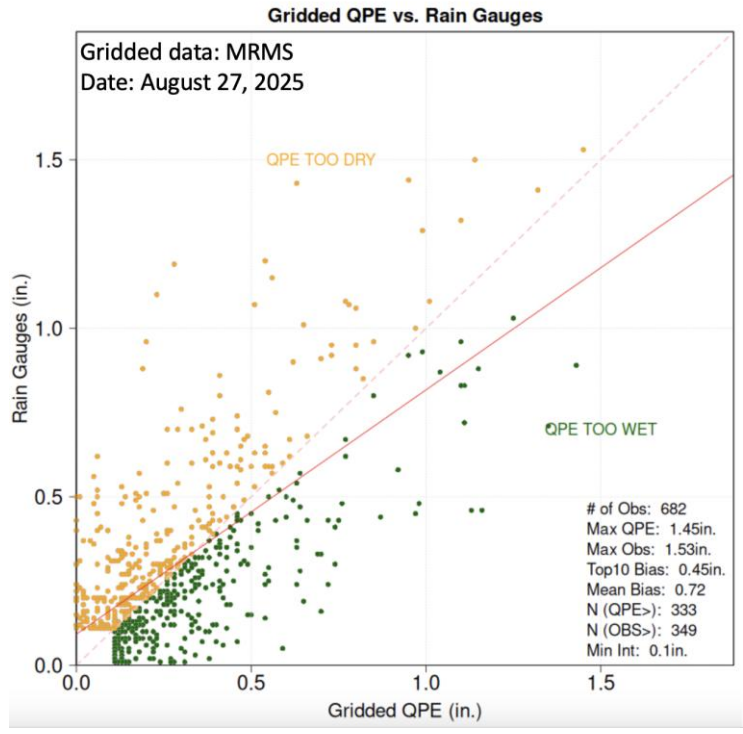


Figure 24: An example of MRMS gridded QPE versus rain gauge scatter plots from August 27th (top) and August 22nd (bottom). The images show that the QPE bias is not constant and must be assessed on a daily level to help assign the Flood Day classification.

Finally, Figure 25 looks at the MRMS mean daily bias across each county for the 2025 forecast season from June to September. May was excluded due to snowfall events skewing 24-hour totals. The blue shades, mostly east of the Continental Divide, indicate once again an overestimation of precipitation for select counties. There continues to be a 0.1 to 0.25 inch bias for Conejos County, indicating a slight overestimation by MRMS. Last season, this may have been related to the lack of sample size with only 12 observations available, but this season there were 152 observations. This overestimation could be related to the Alamosa radar and sampling of higher cloud tops, which is ingested into the MRMS data. The light red shades indicate a slight underestimation of rainfall by MRMS with dark red, as seen over southwest Colorado, indicating as much as a 0.25 to 0.50 inch underestimation of daily precipitation for days where rainfall exceeded 0.25 inches. The bias over northwest Colorado was reduced from last season, which is likely a stronger signal due to many more observations this season. The same analysis, but for Stage IV in Figure 26 indicates a similar spatial pattern though the mean bias trends lower than MRMS. There is a bit more of a wet bias in eastern Colorado this season, but most noteworthy is the lack of bias over southwest Colorado. The ingestion of CoCoRaHS data into this QPE data set likely Stage IV outperform in this region.

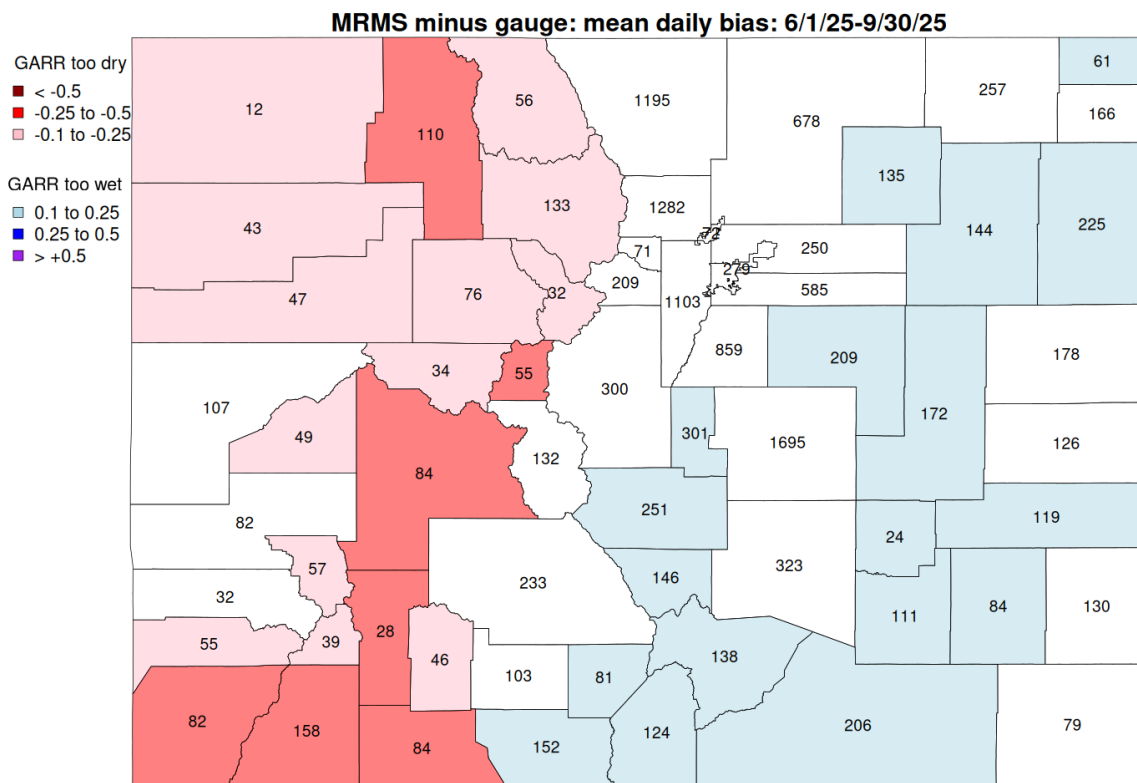


Figure 25: MRMS mean daily bias within each county from June to September of 2025. Blue (red) shading represents an overestimation (underestimation) of precipitation and the numbers in each county represent the number of observations OR estimates over 0.25 inches going into the calculation.

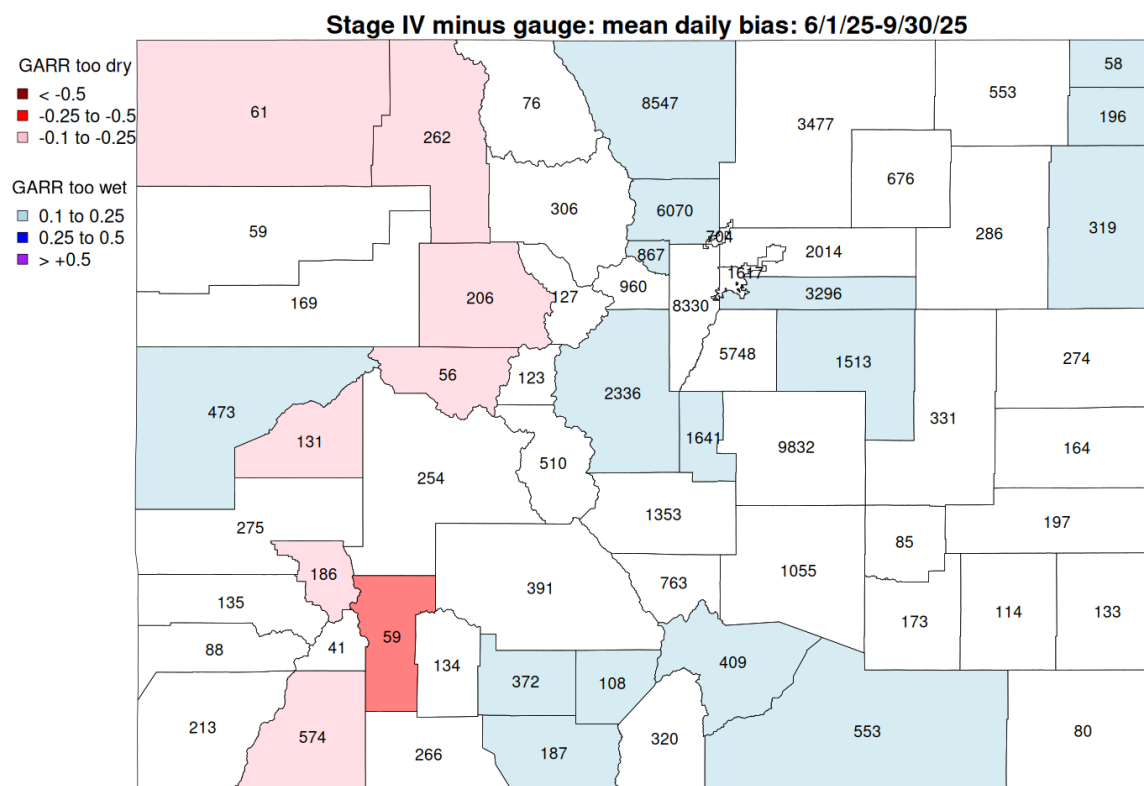


Figure 26: Stage IV mean daily bias within each county from June to September of 2025. Blue (red) shading represents an overestimation (underestimation) of precipitation and the numbers in each county represent the number of observations OR estimates over 0.25 inches.

As a takeaway, the general underestimation of precipitation by both datasets across western Colorado has been noted in past seasons, and it is likely directly related to lack of radar coverage due to beam blockage from the complex topography over the area. Additionally, the number of observations within a given county can vary quite drastically. Counties that have only a few observation points should be interpreted with caution. The ingestion of CoCoRaHS data seems to greatly improve the Stage IV QPE product when compared to MRMS. As seen in past seasons, higher population centers, where more gauges are available, tend to have much lower to no bias (-0.10 to 0.10 inches). This continues to be true over the Front Range and Urban Corridor where CoCoRaHS was founded. Note these plots are also created daily (not shown) to help with the bias assessment of heavy rainfall storm cores.

APPENDIX G – OUTREACH SURVEY

For the 2025 season, a portion of the outreach budget was used to conduct a user survey, which was sent out as an email on July 1st. The survey was open for one month. A total of 26 responses were provided, and respondents ranged from city, county, and state officials, members of the media, and the general public. Twenty-two of the respondents were already email subscribers, suggesting this form of communication represents the most engaged end-user. Questions asked, a summary of responses, and key takeaways are seen in Figure 27 through Figure 35 and discussion below.

How often do you access and use each of the current suite of Flood Threat Bulletin products on the website?

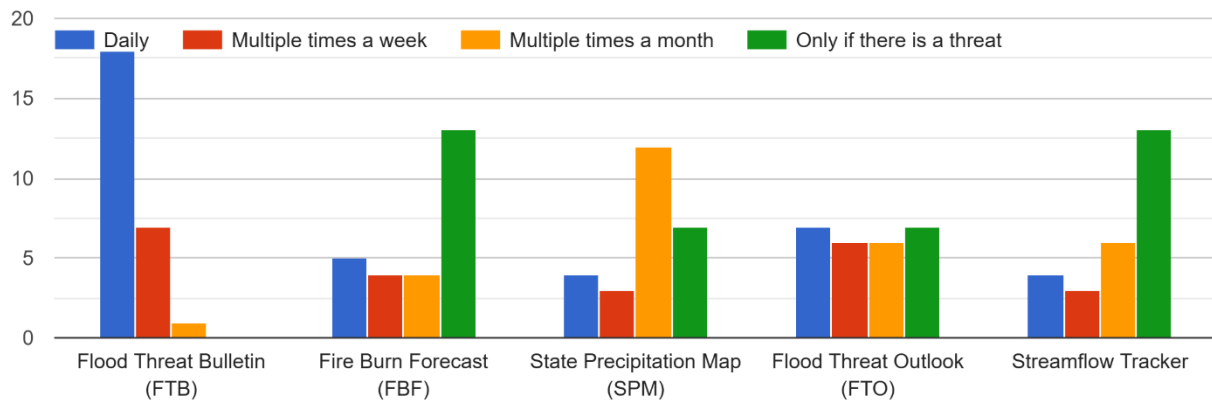


Figure 27. Question 1 and responses from the outreach user survey.

Question 1 was aimed at understanding the frequency at which each of the FTB products are used. Most respondents indicated they access the FTB daily or multiple times a week, however all other products are accessed less often, and some only when there is an FTB threat issued. No respondents indicated that they only access the FTB “only if there is a threat.”

Please rate your level of understanding of the Flood Threat Bulletin (FTB)

26 responses

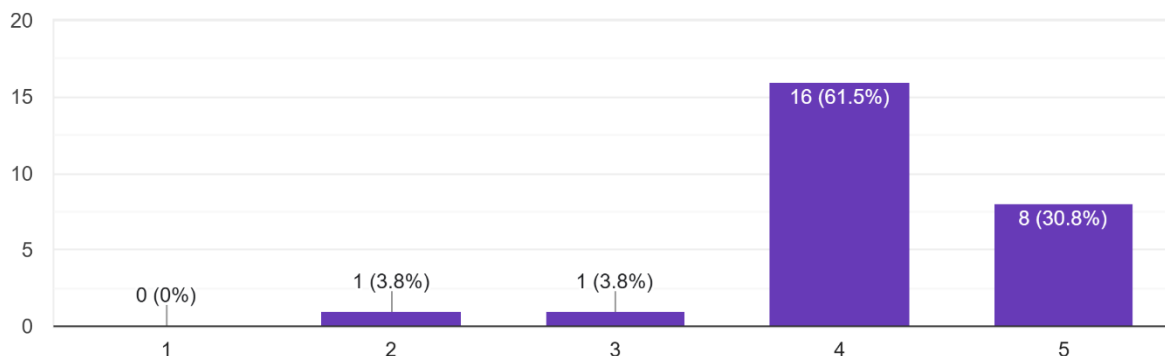


Figure 28. Question 2 and responses from the outreach survey.

Question 2 was aimed at understanding end user’s understanding of the FTB, with scores ranging from 1 “Do not understand product” to 5 “Understand product completely”. Two respondents that reported only 2 or 3 level of understanding were from the State of Colorado. **Results indicate that end-users generally understand the FTB, though there could still be some improvement.**

How likely is it that the Flood Threat Bulletin (FTB) forecast affects your decision making?

26 responses

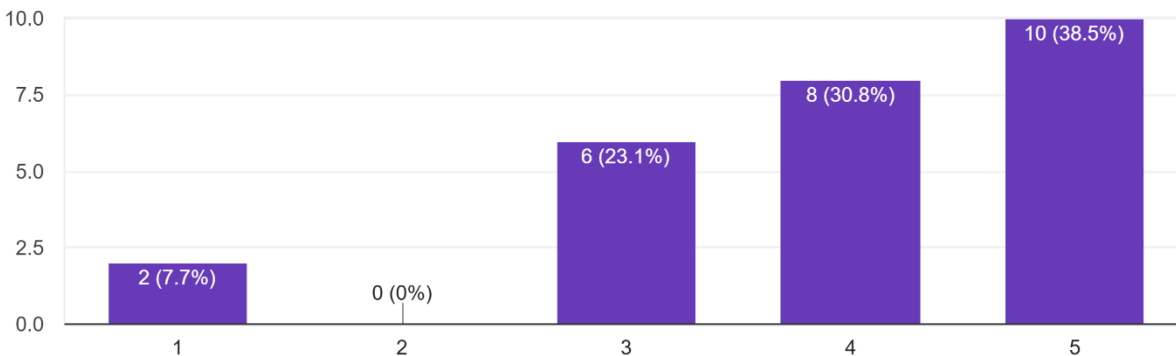


Figure 29. Question 3 and responses from the outreach survey.

Question 3 was aimed at understanding how likely the FTB forecast affects decision-making, ranging from 1 “Very Unlikely” to 5 “Very Likely”. Results indicate a mix of responses from no impact to high impact, but the largest number of responses suggest that the FTB plays a significant role in decision making by end-users. Notable 5 “Very Likely” responses came from email domains from Chaffee County Sheriff, Weld, Larimer, and Alamosa Counties, Spanish Peaks Regional Health, and the towns of Cripple Creek and Ignacio.

Please rate your level of understanding of the Fire Burn Forecast (FBF)

26 responses

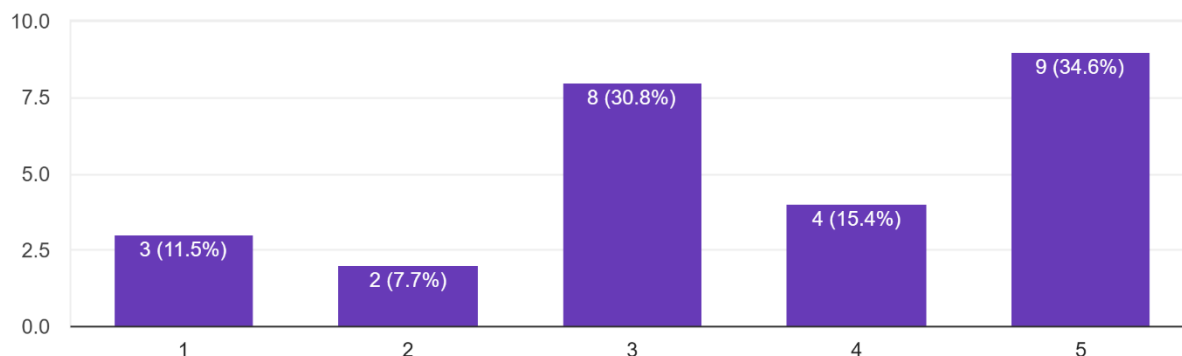


Figure 30. Question 4 and responses from the outreach survey.

Question 4, like question 2 above, was aimed at understanding end user’s understanding of the Fire Burn Forecast (FBF), with scores ranging from 1 “Do not understand product” to 5 “Understand product completely”. Responses indicate a mixed understanding of the FBF product, though the majority indicated some level of understanding. Respondents that indicated 3 or less level of understanding came from Colorado Public Radio, Alamosa, Adams, and Morgan Counties, Chaffee County Sheriff, along with multiple respondents from the State of Colorado and the general public. Indicating across the board there is less understanding of the FBF. **Based on these results, additional information will be added to the table overview on the FBF page, and the link to the table overview will be made more prominent.**

How likely is it that the Fire Burn Forecast (FBF) affects your decision making?

26 responses

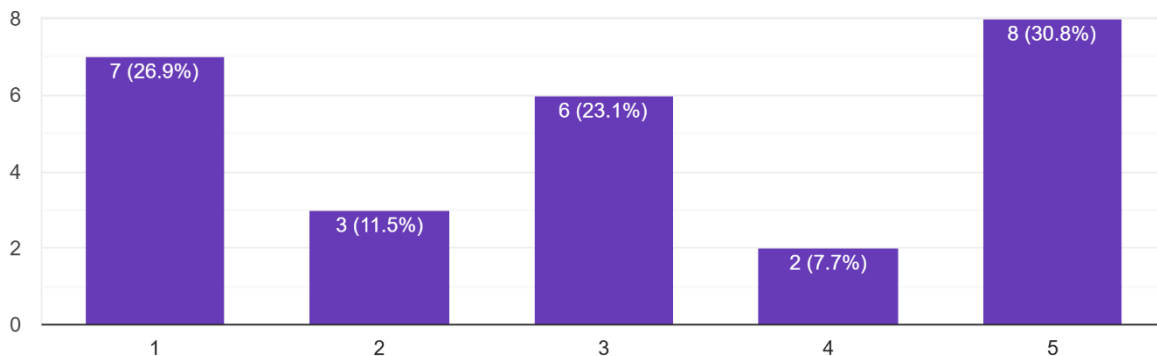


Figure 31. Question 5 and responses from the outreach survey.

Question 5, like question 3 above, was aimed at understanding how likely the FBF forecast affects decision-making, ranging from 1 “Very Unlikely” to 5 “Very Likely”. Like the responses to question 4 for the FBF, responses were mixed. Of the 16 respondents that gave a value of 3 or less, 5 came from the State of Colorado, with others from Adams, Alamosa, and Morgan Counties. Larimer County and Chaffee County respondents were among the 4 and 5 values. The nature of the FBF product, tailored to the individual burns, likely means that this product is not applicable to all end-users, but may be reaching the appropriate counties. These results also support the need for additional information about the products added to the FBF table overviews.

Please rate your level of understanding of the State Precipitation Map (SPM)

26 responses

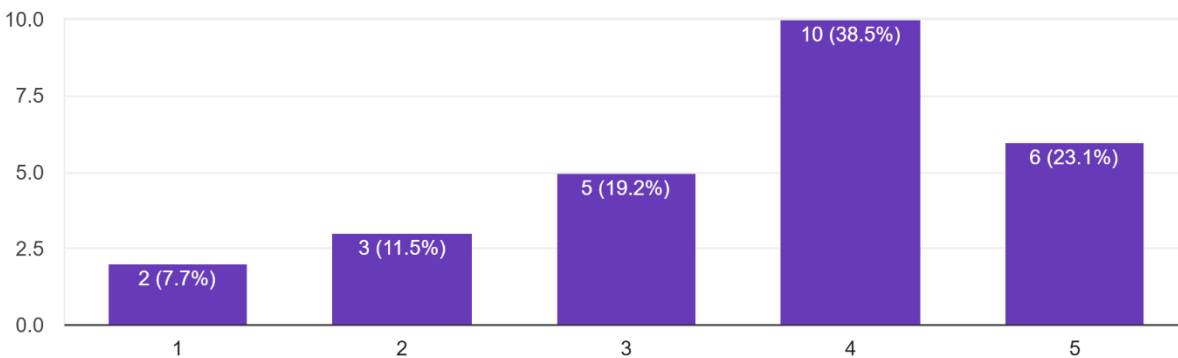


Figure 32. Question 6 and responses from the outreach survey.

Question 6 was aimed at understanding end user’s understanding of the SPM, with scores ranging from 1 “Do not understand product” to 5 “Understand product completely”. Overall, most respondents indicated that they had some understanding of the SPM product. However, like the FBF, the SPM page could benefit from additional information in the map overview or have the link featured more prominently. **Combined results from this question and question 1 also indicate that the SPM could be more widely advertised to end-users.**

Please rate your level of understanding of the Flood Threat Outlook (FTO)

26 responses

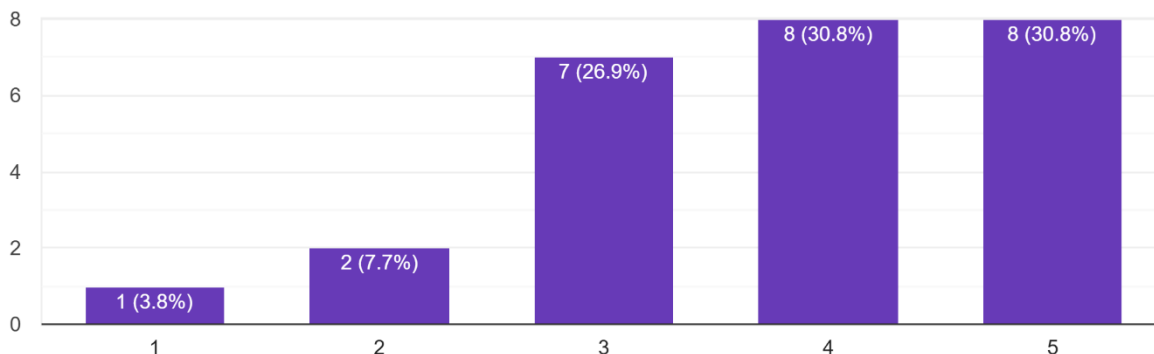


Figure 33. Question 7 and responses from the outreach survey.

Question 7 was aimed at understanding end user’s understanding of the FTO, with scores ranging from 1 “Do not understand product” to 5 “Understand product completely”. Overall, most respondents indicated that they had some understanding of the FTO product though there is some room for improvement. The only description currently of the FTO is on the ‘About’ page, so additional information on the FTO page itself will be considered. Like the SPM, the FTO page could also benefit from more advertising to end-users.

Please rate your level of understanding of the Streamflow Tracker

26 responses

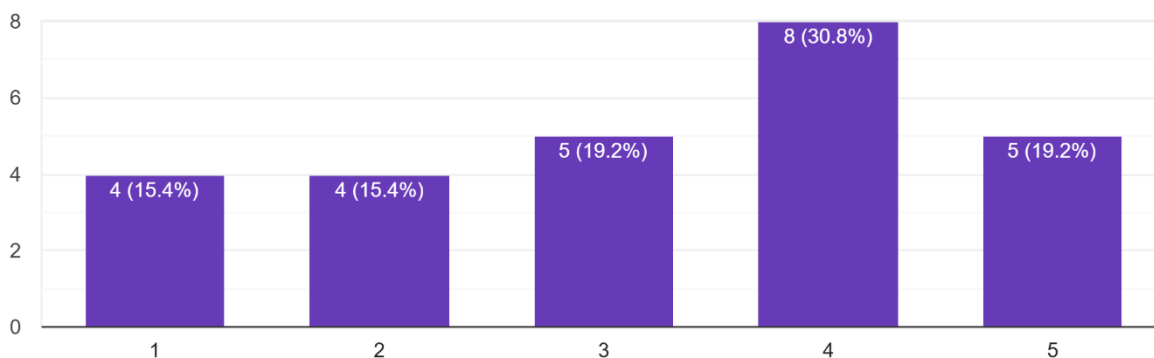


Figure 34. Question 8 and responses from the outreach survey.

Question 8 was aimed at understanding end user’s understanding of the Streamflow Tracker, with scores ranging from 1 “Do not understand product” to 5 “Understand product completely”. Results from this question were the most mixed compared to similar questions about products, indicating the Streamflow Tracker is the least understood product. The table overview is concise on the Streamflow Tracker page but could be more prominently displayed. Combined with results of question 9 (below), there is high interest in an email update when the Streamflow Tracker is published, which could include information about the product and discussion of the results.

We currently send daily emails to subscribers with the updated Flood Threat Bulletin. Are there any other products you would be interested in receiving by email? Check all that apply.

26 responses

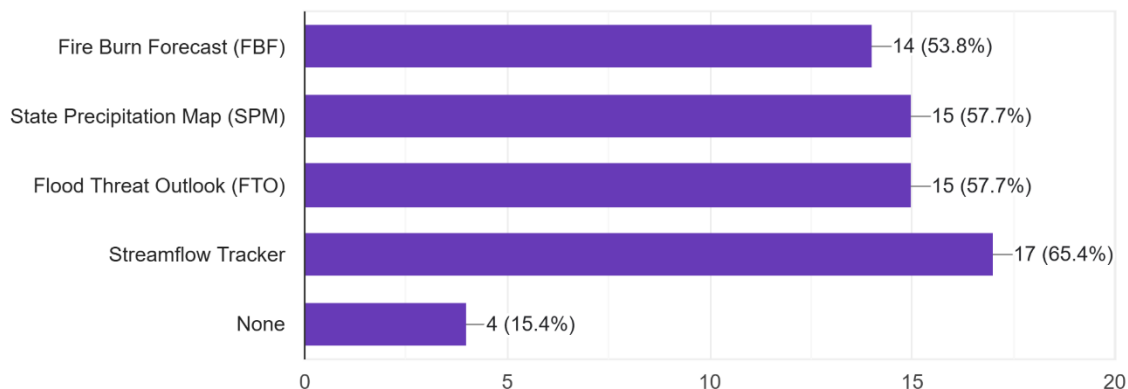


Figure 35. Question 9.

Question 9 asked users if there is interest in an email subscription for the other products (FBF, SPM, FTO, and Streamflow Tracker). Most respondents indicated that they would be interested in separate email subscriptions, especially for the Streamflow Tracker. Adding additional subscription services would include both front-end and back-end updates to the current website and underlying databases, but the level of effort will be investigated and considered this off-season.

Open-ended responses:

“The [Report-a-Flood Tool](#) is available to directly send flood and heavy reports to us for forecast verification and discussion in the State Precipitation Map, but is often underutilized by our subscribers. What would make you more likely to send flood reports?”

Answers generally indicated that users did not know the Report-a-Flood tool existed. The tool is mentioned at the end of each SPM post, however responses from questions 1 and 6 indicate that the SPM isn’t regularly accessed or understood compared to the FTB. Based on these results, **it is recommended that the reminder about the ‘Report-a-Flood’ tool is included in the daily FTB discussion, or the tool is discontinued entirely.** There have only been 11 flood reports provided by the public since the tool was created with zero reports during the 2025 season. This is despite an X social media request for reports sent out after the October 2025 flooding in Southwest Colorado.

“Do you have any other comments or feedback for the Program?”

The 6 responses were overwhelmingly positive, indicating they appreciate and value the Programs products and work involved. One respondent asked for the FTB maps to be included in the daily email, which will also be considered for off-season improvements prior to starting the 2026 season.

Overall results from the outreach survey indicate that end-users regularly use the FTB product through the website and email, while other products are accessed and understood less often. Throughout several of questions aimed and gauging end-user understanding, multiple respondents from the State of Colorado indicated less than ideal understanding. It is not clear if these end-users are with CWCB or other state agencies. Based on the above findings, the following suggestions are made for Program improvement prior to the start of the 2026 FTB season:

- Add informative links on each product page
- Focus the preseason campaign on State of Colorado, particularly CWCB employees and CDOT employees, as well as county emergency managers.
- Update the email layout to include FTB threat maps
- Add additional emails subscription options for all FTB products & develop email layouts for each