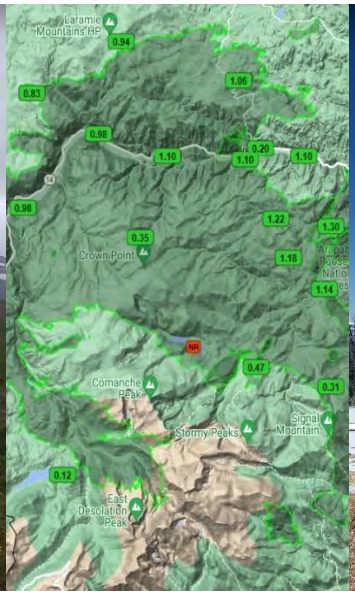
Larimer County Emergency Flood Warning System
Cameron Peak Expansion – Phase II

Final Report



Prepared for:
Colorado Healthy Rivers Fund Grants
Attn: Chris Sturm

June 28, 2022

Larimer County
Grant Amount: $100,000
Prepared by: Eric Tracy

LARIMER COUNTY
COMMITTED TO EXCELLENCE

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Introduction

[1]The Cameron Peak Fire was reported on Thursday, August 13, 2020. The fire burned an area of 208,913 acres over several months in Larimer County, affecting both private and public lands until being fully contained on December 2, 2020. Weather and fuel conditions influenced fire growth, behavior, and effects of the Cameron Peak Fire. Extreme temperatures, low humidity, rough terrain and gusty winds reaching over 70 miles per hour were just some of the elements that were contributing factors influencing fire development.

Within its burn perimeter, the Cameron Peak Fire reduced or eliminated above ground vegetation cover and altered soil structure, resulting in varying degrees of post-fire hydrophobicity. These direct changes to vegetation, structure, composition, and density will lead to reduced precipitation interception, decreased soil infiltration capacity, and elevated runoff compared to pre-fire conditions. The Soil Burn Severity (SBS), soil erosion, hydrology and debris flow modelling results obtained and used in the risk analysis indicate that post-fire there will be an increase in watershed response. This means:

- Increased erosion and sedimentation
- Areas that flood or had debris flows pre-fire will have larger magnitude events
- Areas that occasionally flood or had debris flows pre-fire will see more frequent events
- Areas that previously did not have streamflow or debris flow may now flood or have debris flows
- Private and public infrastructure are at an increased risk of damage to post-fire flood events
- Additional impacts to aquatic and terrestrial habitats are likely to occur

Expansion of the Larimer County Emergency Flood Warning System (EFWS) to include rainfall and stream gaging sites located in the Cameron Peak Fire burn scar is expected to help inform emergency response personnel to the potential risks in real-time and aid in the effort to protect life, property, and the environment.

Background

The Larimer County Emergency Flood Warning System provides real-time, mission-critical information for rainfall events measuring precipitation intensity, duration and corresponding stream channel discharge response.

A Flood Warning System Master Plan was in progress when the Cameron Peak Fire started. When it was clear that gaging sites would be needed in the burn scar, the consultant expanded the Master Plan to include the burn area. Reference to the original USGS Burn Area Emergency Response (BAER) report was made while evaluating potential sites in the burn scar. Ultimately, the Larimer County Master Plan was updated to include these sites.

The Cameron Peak Fire Expansion (Phase II) provides additional gaging sites located within the burn scar to monitor the watershed response to rainfall events. Data from these sites will be transmitted in real-time to emergency personnel and directly to the National Weather Service for use in their release of accurate flood related warnings. These sites provide real, empirical data to be used in the future design of rehabilitation project, mitigation projects, future planning and research purposes.

The Larimer County EFWS – Cameron Peak Fire Expansion Phase II project included the following sites:

- La Poudre Pass Creek below Long Draw Reservoir ID 11526000 (rain)
- Joe Wright Creek below Joe Wright Reservoir ID 11528000 (rain)
- Joe Wright Creek below Chambers Reservoir ID 11529000 (rain)
- Kilpecker ID 11511000 (rain)
- Manhattan Road ID 11512000 (rain)
- CLP River @ Crown Point Drive Bridge ID 11514000 (rain/stream)
- Old Flowers Road ID 11520000 (rain)
- Salt Creek Cabin ID 11521000 (rain)
- South Fork CLP River @ Pingree Park ID 11523000 (rain/stream)
- Sevenmile Creek @ Mouth ID 11519000 (rain/stream)

Methods

Task 1 - Project Management

The Larimer County Engineering Department managed the project from the beginning to completion. Contracts, purchase orders and workorders with the consultant were processed, invoices collected and paid in a timely manner. All contracts were done in compliance with the Larimer County Procurement standards and processes. Pre-installation site visits occurred with all parties. Meetings with the consultant occurred regularly.

Task 2 – Master Planning

The Larimer County Emergency Flood Warning System Master Plan was in progress before the Cameron Peak Fire started. After it was obvious that additional rain and stream gages were going to be needed in the fire burn scar, the consultant added analysis to the Master Plan to include the burn scar area. Stakeholder outreach was a big part of the Master Plan process. The consultant utilized the initial USDA Burn Area Emergency Response (BAER) Report in their analysis of additional sites within the burn scar area. The Master Planning task was completed before the contract for this grant and was not a part of the proposed budget.

Task 3 – Equipment Procurement

The contractor ordered, received, and checked for shipping damage all equipment associated with the post fire expansion. All work and procurement of equipment was initiated after the contract start date.

CWCB funds were used to purchase general hardware, installation materials, cables, antennas, solar equipment, Campbell Scientific Data Loggers, traffic poles and bases, NEMA Boxes, pressure transducers, batteries, concrete mix, rebar, groundrods, modulators, encoders, environmentally safe antifreeze (for all-weather station), wind screens, etc. Quantities and more detailed descriptions can be found on the contractor invoices.

Task 4 – Implementation

An initial United States Forest Service (USFS) Standard Form 299 application was submitted and the USFS CAN 727 permit was issued for the Sheep Mountain repeater site. USFS approval of the other site locations within Phase I and Phase II was obtained by amending the Sheep Mountain Repeater permit to include the new sites. Radio licenses were obtained from the Federal Communications Commission (FCC) for each station that transmits using VHF radio.

The contractor constructed, configured, programed and bench tested all monitoring equipment prior to installation. This consisted of installing equipment onto backplanes of the monitoring enclosures, programming data loggers, programming radios and satellite modems, programming sensor inputs and testing sensor configurations. A plan was developed for the ALERT2 Time Division Multiple Access (TDMA) plan integration for data transmissions using the existing radio frequencies employed by the County, the City of Fort Collins and the City of Loveland. The plan identified the best available cooperative regional utilization of frequencies, developed the associated FCC licensing requirements, and identified any changes to existing frequency utilization that would be required.

Utility locates were conducted at each station prior to any earth work associated with installation. Each monitoring station was installed upon completion of utility locates and bench testing. Each station was installed and tested to ensure accurate and reliable data transmission and reception of data at the base stations located in Fort Collins. All sensors were calibrated in the field as part of installation.

Each new station was defined in the base stations receiving data in Fort Collins. Data was received from the stations using ALERT2 VHF radio protocol. Alarm thresholds for rainfall rates and water level/flow conditions were configured on the base stations with input from Larimer County, the National Weather Service and USFS. Real-time notifications were configured for these alarm conditions using email and texts to cell phones. Contact lists for emergency personnel was updated. A feed of real-time data for these stations was implemented to the NWS in Boulder to support their mission of forecasting and issuance of weather alerts for emergency managers and community at large.

Stream channel cross section surveying was performed at each of the stream monitoring stations. The cross-section survey data was used to develop theoretical stage-discharge relationships to convert readings of stream level to flow. Manual flow measurements were taken at the time of cross-section surveying to aid in the development of the stream rating. A final Stream Rating report was prepared by the consultant.

Task 5 – Maintenance & Operations

As the sites were all installed this year and site visits, calibration and testing were all part of the installation process, additional site visits were not needed for most sites.

All the sites were added to the WETMap interface as they were installed. Some of the sites have already reported data for this flood season and the data was used in the Emergency Operations Center during these events.

Results

All the proposed gages were procured, constructed, configured, installed and put into operation as expected. The inclusion of these sites into the existing Larimer County Emergency Flood Warning System was seamless. Data is being transmitted as expected and was used in decision-making processes for some of the rainfall events that occurred this summer.

Below is an example of data received from a recent rain storm event. Real time data can be viewed on either WETMap or the TriLynx Operator on the following weblink…

https://larimerco-ns5.trilynx-novastar.systems/novastar/operator/#/map

Figure 1: South Fork CLP River @ Pingree Park

Conclusions and Discussion

All proposed stations have been installed and are operational as intended. These gages are producing real-time data that is being transmitted to Larimer County's consultant Water & Earth Technology, the City of Fort Collins, the City of Loveland and to the National Weather Service. Other partners such as the City of Greeley, Weld County, Town of Estes Park and the Town of Wellington also have access to this data with appropriate emergency personnel on the alert notification list. This data is available to the public for viewing via the TriLynx Operator website.

https://larimerco-ns5.trilynx-novastar.systems/novastar/operator/#/map

The addition of these gaging sites has already provided valuable information to emergency response personnel in the Larimer County Emergency Operations Center during rainfall events this flood season.

These sites have been added to Larimer County's annual maintenance program and will continue to be maintained and operated as part of the Larimer County Emergency Flood Warning System for the expected lifespan of the equipment of approximately 10-years. The general operations will include spring installation (for equipment that is winterized), calibration and radio checks, general summer site visits with re-calibration, post-flood event site visits and fall take-down, again for sites that need to be winterized. Larimer County owns spare equipment that can be used in the event that something malfunctions.

Overall the project costs were slightly higher than the proposed budget. Larimer County was able to provide the additional match requirement to keep the CWCB portion at $100,000. The final match split was CWCB – 46.51% and Larimer County – 53.49%

Current requests are submitted for the Emergency Watershed Protection Program grants to help fund additional sites in the burn scar. Larimer County has also partnered with the Colorado Department of Transportation to install additional gages along Highway 14 and also two emergency Flash Flood Warning signs located on the bottom of the Poudre Canyon at Ted's Place and also just outside of Walden, CO as you enter the Poudre Canyon. Lessons learned from this project will help with the timely implementation of those additional sites. Larimer County has also partnered with the City of Fort Collins, Town of Timnath, Town of Wellington and the North Poudre Irrigation Company to install rain and stage gaging as part of the emergency operations of the NRCS dams located in the northern part of Larimer County.

The installation of these additional gaging sites will continue to benefit the citizens of Larimer County and others throughout the recovery period of the Cameron Peak Fire burn area.

Actual Expense Budget

(Invoices Attached Separately)

Budget Estimate vs. Actual Budget

COLORADO
Colorado Water Conservation Board
Department of Natural Resources

Colorado Water Conservation Board
Watershed Restoration Program Grant - Detailed Budget Estimate
Fair and Reasonable Estimate

Prepared Date: 5/10/2021
Name of Applicant: Larimer County
Name of Water Project: Larimer County (EFWS) – Cameron Peak Fire Expansion (Phase II)

EXAMPLE C: Construction

							ACTUAL	
Task 1 - Project Management								
Sub-task	Unit	Quantity	Unit Cost	Total Cost	CWCB Funds	Matching Funds	CWCB Funds	Matching Funds
Project Manager (Senior Civil Engineer)	Hour	-	$ 75	$ -	$ -	$ -		
Task 2 - Master Planning								
Sub-task	Unit	Quantity	Unit Cost	Total Cost	CWCB Funds	Matching Funds		
EFWS Master Planning (COMPLETE)	EA	-	$ 20,000	$ -	$ -	$ -		
Task 3 - Equipment Procurement								
Sub-task	Unit	Quantity	Unit Cost	Total Cost	CWCB Funds	Matching Funds		
Rain Station	EA	7	$ 6,500	$ 45,500	$ 22,750	$ 22,750	$ 22,750.00	$ 28,873.67
Rain/Stream Station	EA	3	$ 9,000	$ 27,000	$ 13,500	$ 13,500	$ 13,500.00	$ 17,133.83
Task 4 - Implementation								
Sub-task	Unit	Quantity	Unit Cost	Total Cost	CWCB Funds	Matching Funds		
Rain Gage	EA	7	$ 10,000	$ 70,000	$ 32,500	$ 37,500	$ 32,500	$ 35,076.76
Rain/Stream Gage	EA	3	$ 22,500	$ 67,500	$ 31,250	$ 36,250	$ 31,250	$ 33,913.31
Task 5 - Maintenance & Operations								
Sub-task	Unit	Quantity	Unit Cost	Total Cost	CWCB Funds	Matching Funds		
Rain Station	EA		$ 1,425	$ -	$ -	$ -		
Rain/Stream Station	EA		$ 2,500	$ -	$ -	$ -		
TOTAL				$ -	$ 100,000	$ 110,000	$ 100,000.00	$ 114,997.57

Inv #	Labor	Equipment	Total
4213	$ -	$ 62,800.00	$ 62,800.00
4236	$11,100.00	$ 20,202.01	$ 31,302.01
4267	$10,552.50	$ 27,386.64	$ 37,939.14
4324	$ 3,360.00	$ 912.69	$ 4,272.69
4397	$ 3,843.75	$ -	$ 3,843.75
4420	$ 5,100.00	$ 24.33	$ 5,124.33
4466	$ 2,672.50	$ 11,772.22	$ 14,444.72
4498	$14,722.50	$ 9,012.88	$ 23,735.38
4521	$30,906.25	$ 629.30	$ 31,535.55
	$82,257.50	$132,740.07	$214,997.57

Summary …

Total Project Cost: $214,997.57

CWCB Match : $100,000 (46.51%)

Larimer County Match: $114,997.57 (53.49%)

Appendix A – Photos

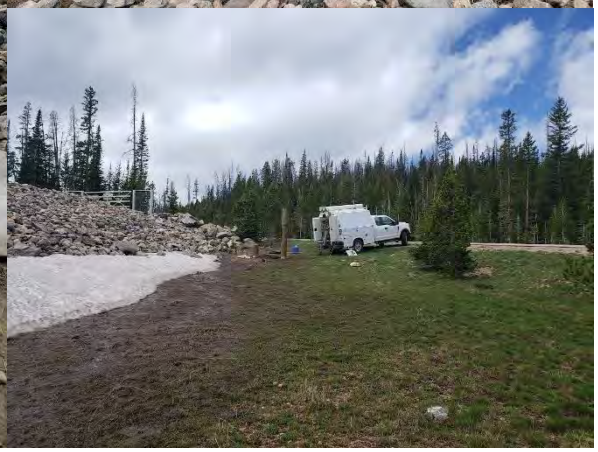
(Additional Photos included in Google Drive Link)

La Poudre Pass Creek below Long Draw Reservoir

ID 11526000 (rain)

Joe Wright Creek below Joe Wright Reservoir

ID 11528000 (rain)

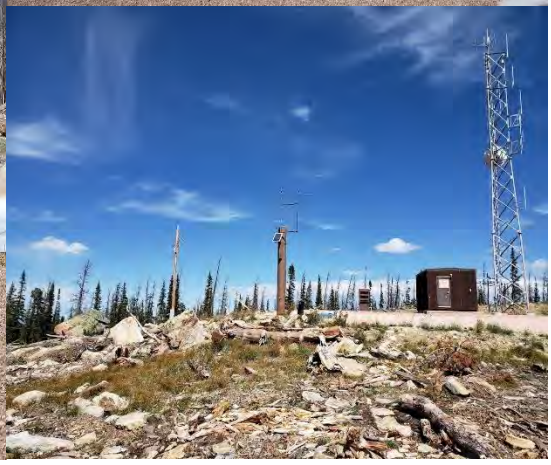


Joe Wright Creek below Chambers Reservoir

ID 11529000 (rain)

Kilpecker

ID 11511000 (rain)



Manhattan Road

ID 11512000 (rain)

CLP River @ Crown Point Drive Bridge

ID 11514000 (rain/stream)

Old Flowers Road

ID 11520000 (rain)

Salt Creek Cabin

ID 11521000 (rain)

South Fork CLP River @ Pingree Park

ID 11523000 (rain/stream)

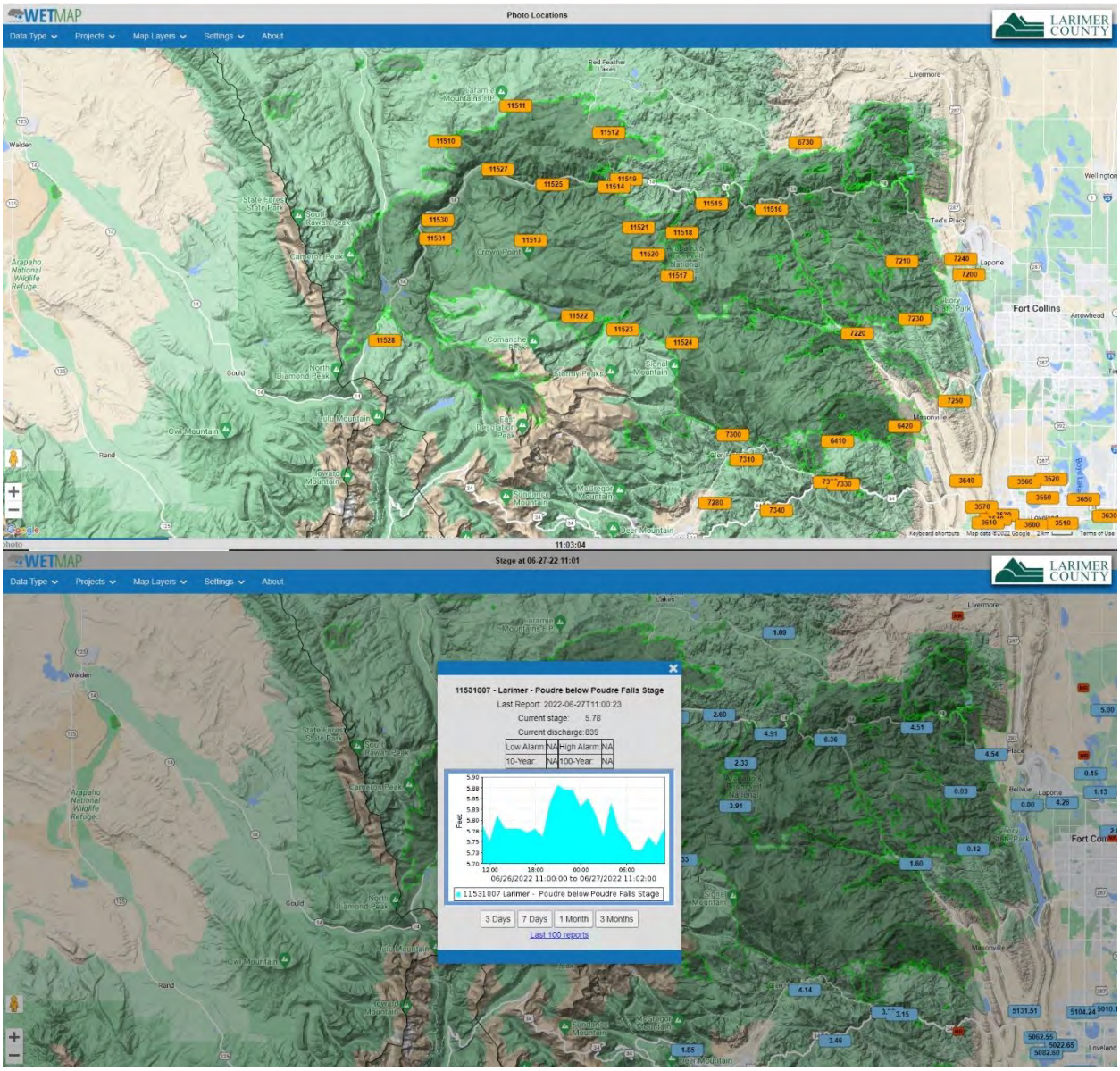
Sevenmile Creek @ Mouth

ID 11519000 (rain/stream)

Appendix B – WETMap Screenshots

Additional Information and Real-Time data can be viewed at
https://wetmapgc.wetec.us/WETMapV3/LarimerCounty/#

WETMap Screenshots



Appendix C – Stream Rating Report

(Cover Sheet)

WATER & EARTH TECHNOLOGIES

Date:	June 27, 2022
Prepared For:	Eric Tracy, P.E., Larimer County
By:	Kate Malers P.E., WET
Subject:	Rating development for the Cameron Peak Fire Burn Expansion II ALERT stream gages

I. Background

Due to the Cameron Peak Fire's impact on the Cache La Poudre River (CLP River) and its subwatersheds, Larimer County sought funding for an expansion of the planned Early Warning System (EWS) that had been designed to detect developing flood threats on the CLP River. The County contracted with Water & Earth Technologies, Inc. (WET) to complete the expansion project, including:

- 11519 Sevenmile Creek @ Manhattan Road (precip and stream monitoring)
- 11520 Old Flowers Road (precip monitoring)
- 11523 S. Fork Cache La Poudre River at CSU Mountain Campus (precip and stream monitoring), and
- 11526 Long Draw Reservoir (all-season precip monitoring)
- 11528 Joe Wright Reservoir (all-season precip monitoring)
- 11529 Chambers Lake (all-season precip monitoring)

WET was tasked with providing stage-discharge ratings for the two stream gage locations, to allow estimates of discharge to be provided for each measured record of stream stage. This memorandum briefly describes how the stage-discharge rating for each stream gage was developed and documents each rating in writing. Technical details including survey data in XCEL spreadsheet workbook files and HEC-RAS model input and output files are available upon request.

For each stream gage location, WET conducted a reach- and cross-section survey to obtain the data required for a local hydraulic model (using the U.S. Army Corps of Engineers' HEC-RAS hydraulic modeling software). In some cases it was difficult to complete surveys that provide ground surface data for a model that extends into the magnitude of peak flows that are possible from these burn-impacted watersheds. Areas that are inaccessible during WET's reach and cross-section surveying typically include overbank areas that are on private property, that extend beyond busy roadways or that simply extend so far beyond the top-of-bank that sightlines cannot be maintained for the full distance that would be required to characterize the cross-section. Where available and needed, LIDAR data were used to extend the local hydraulic model cross-sections beyond what could reasonably be surveyed in the field.

Ratings extending into high flood flows provide only initial estimates of discharge, since flows of high magnitude frequently *cause* channel geometry changes that render ratings obsolete, and/or may involve the formation of temporary hydraulic phenomena, including debris dams and road collapses, that are NOT reflected in the theoretical rating development. To fully characterize peak flood flows after specific flow events, forensic hydraulic analysis may be required.

II. Sevenmile Creek @ Manhattan Road (ID 11519)

County Station 11519 monitors precipitation and streamflow above the culvert that carries Sevenmile Creek under Manhattan Road, at 40.704346 N, -105.585340 W.

Appendix D – Permits

(Full Permits Attached Separately)

References

1. Larimer County Office of Emergency Management, Cameron Peak Fire Risk Assessment – Summary results of the Cameron Peak Fire Risk Assessment and Hydrology Analysis, May 2021
2. Cameron Peak Fire Forest Service Burned Area Emergency Response (BAER) Report - Arapaho Roosevelt National Forest

COLORADO
Colorado Water Conservation Board
Department of Natural Resources

Colorado Water Conservation Board

Watershed Restoration Program Grant - Detailed Budget Estimate
Fair and Reasonable Estimate

Prepared Date: 5/10/2021
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