



**HDR**

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# Douglas County, Colorado Flood Warning Assessment

Project No. CI 03-037

Prepared for:  
Douglas County Public Works  
Parker Stormwater Utilities  
Castle Rock Stormwater Utilities  
Colorado Water Conservation Board

September 2004

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## Douglas County, Colorado Flood Warning Assessment – Executive Summary

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HDR performed a flood warning assessment for Douglas County, Colorado with the main focus of the assessment being on the Cherry Creek and Plum Creek drainage basins (project area) including the population areas of Larkspur, Castle Rock, Sedalia, Louviers, Franktown and Parker. The project was performed under the guidance of Douglas County Engineering (County).

Multiple tasks were accomplished in order to perform the assessment and are described in detail in the Final Project Report and Technical Addendum that accompanies the report. A description of these tasks are described as follows. Interviews were held in order to obtain an inventory of existing response agencies, flood detection resources, flood prediction resources, flood warning resources, and communications resources involved in flood related actions and activities within the project area. Existing hydrologic/hydraulic information within the project area was obtained and reviewed for the purpose of identification of potential flood hazard areas. A web site was developed that contains weather information that is currently available on the Internet and is applicable to Douglas County. A flood orientation was held for Douglas County agencies/departments that demonstrated the existing weather detection, prediction and warning resources within Douglas County.

All the information that was gathered on the response agencies, Incident Command System, flood detection resources, flood prediction resources, flood warning resources, communications resources, potential flood hazard areas, and hydrologic/hydraulic characteristics of the watercourses were reviewed and evaluated. Recommendations were made to enhance these components, if it was felt that if the recommended enhancement was implemented, the benefit would outweigh the cost associated with the implementation of the recommendation.

One of these benefits would include a higher rating by Federal Emergency Management Agencies Community Rating System resulting in lower flood insurance rates for residents and business located within FEMA defined 100-year floodplains. Other benefits would include more accurate prediction of flooding events, increased lead time of flooding events, and pre-defined knowledge of areas at risk from flooding, possibly resulting in a reduced threat of loss of life.

The following are a summary of the key recommendations made in the final project report:

- Re-evaluate the recommendations made in the 1993 document 'Flash Flood Warning Planning for Douglas County Meteorological and Hydrological Support' to expand the existing Douglas County flood detection network and make new recommendations if needed.
- Determine basin average rainfall criteria, specific to individual major drainage basins for the 2-year, 5-year, 10-year, 25-year, 50-year, 100-year, and 500-year recurrence intervals for durations of 1-hour, 3-hours, 6-hours, 12-hours and 24-hours.
- Determine drainage basin hydrologic characteristics such as soil types, time of concentration, percent of imperviousness, area, and slope. Determine antecedent moisture affects on basin time of concentration.
- Determine watercourse discharge, velocities, and depths.
- Determine stream gage information that is consistent with National Weather Service E-19 procedures for the stream gages owned and maintained by the Urban Drainage and Flood Control District and the United States Geological Survey.
- Develop Flood Warning Templates which are currently used by the Urban Drainage and Flood Control District to provide real-time assessment of streamflow.
- Develop GIS-based flood maps that depict water inundation and water depths associated with a 25-year, 50-year, 100-year, and 500-year recurrence interval.
- Determine flood risk and vulnerability to residents, business, County and local jurisdiction infrastructure and critical facilities in and around the East Plum Creek, Plum Creek, East Cherry Creek, West Cherry Creek and Cherry Creek watercourses.
- Determine depth and duration rainfall criteria that if predicted would prompt flood advisories watches and warnings.
- Develop Flood Threat Recognition criteria (rain gage rainfall depth/time and stream gage criteria water discharge, water stage height), which if reached or exceeded would prompt information dissemination to key personnel.
- Develop levels or preparedness (Modes) based on potential flood depths and/or time until potential flooding. Develop actions for departments/agencies to perform with regard to flood response for each level of preparedness. Incorporate this information into the Douglas County, Castle Rock and Parker Emergency Operation Plans (EOP's).
- Develop evacuation procedures and policies based on the levels of preparedness. Develop specific actions for departments/agencies to perform with regard to evacuations. Incorporate this information into the Douglas County, Castle Rock and Parker EOP's.

- Calculate potential bridge scour depths using an appropriate scour depth calculation methodology.
- Host a flood orientation on an annual basis to assist in flood awareness and make participants aware of any new flood detection, flood prediction and flood warning information that may be available in Douglas County.
- Implement video cameras (images transmitted by radio frequency) on bridges determined to have a high flood hazard danger index value.
- Implement content from the Douglas County Weather website into the Douglas County website <http://www.douglas.co.us> or have the web site hosted by a third party website hosting company.
- Review agency websites for updated or new weather information that is deemed applicable to Douglas County on a bi-monthly basis. Provide internet links to this information so it is made accessible by the Douglas County Weather website.
- Determine the feasibility and cost associated with incorporating the rain gage and weather station network maintained by the Castle Rock Parks and Recreation Department, into the Urban Drainage and Flood Control District's real time flood detection network.

These and other recommendations can be found in the Final Project Report. The recommendations listed above are depicted in more detail in the Final Project Report and reference other recommendations that may have to be completed before a recommendation can be implemented.

Funding considerations, outside of funding from Douglas County, include alternative funding sources such as Castle Rock through their storm water utility fee, Parker through their storm water utility fee. Urban Drainage and Flood Control District provides matching funds on capital, planning and maintenance projects and Colorado Water Conservation Board provides funding for planning, public awareness, and hydrological mapping projects.

Bryan Rappolt

HDR Project Manager

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## **1.0 Introduction**

HDR Hydro-Meteorological (HDR) performed a flood warning assessment for Douglas County, Colorado with the main focus of the assessment being on the Cherry Creek and Plum Creek drainage basins (project area) including the population areas of Larkspur, Castle Rock, Sedalia, Louviers, Franktown and Parker. The project was performed under the guidance of Douglas County Engineering (County).

Multiple tasks were accomplished in order to perform the assessment. A description of these tasks are as follows. Interviews were held in order to obtain an inventory of existing response agencies, flood detection resources, flood prediction resources, flood warning resources, and communications resources involved in flood related actions and activities within the project area. Existing hydrologic/hydraulic information within the project area was obtained and reviewed for the purpose of identification of potential flood hazard areas. A web site was developed that contains weather information that is currently available on the Internet and is applicable to Douglas County. A flood orientation was held for Douglas County agencies/departments that demonstrated the existing weather detection, prediction and warning resources within Douglas County.

This report summarizes all of the tasks, assess existing flood related resources and contains recommendations to enhance existing resources.

## **2.0 Interviews/Information Gathering**

Interviews were held with local towns, county, state and federal agencies/departments that have flood related responsibilities within the project area. Interview questionnaires were prepared by HDR that contained a myriad of questions related to flood prediction, flood detection, flood response, flood preparedness, flood warning, communications, and incident management systems that were posed to the departments/agencies. The vast majority of the interviews were conducted in-person, while the remainder of the interviews were accomplished over the telephone or the questionnaires were filled out and returned to HDR by e-mail, and/or facsimile. These interviews yielded useful information that included, but was not limited to, the following with respect to flooding events:

- Existing policies
- Existing procedures
- Existing weather/hydrologic detection resources and the flow of the information
- Existing weather/hydrologic predictive information resources and the flow of the information
- Existing weather warning resources and the flow of the information
- Existing communication infrastructure
- Existing interagency, interdepartmental, multi agency, and departmental coordination
- Existing resource allocations
- Existing response actions
- Existing evacuation policies and procedures

There were a total of twenty-seven department/agencies contacted for an interview request. Of the twenty-seven department/agencies contacted a total of twenty-six participated in the interview process. Table 1 lists the departments/agencies and personnel that were interviewed.

<b>Agency</b>	<b>Contact</b>	<b>Title</b>
National Weather Service - Boulder	Robert Glancy	Warning Coordination Meteorologist
Skyview Weather	Tim Tonge	Manager
Urban Drainage and Flood Control District	Kevin Stewart	Floodplain Manager
Douglas County Emergency Services	James Raymond	Emergency Services Manager
Douglas County Emergency Services	Jamie Moore	Emergency Services Coordinator
Douglas County Emergency Services	Rebecca Martinez	Emergency Services Coordinator
Douglas County Public Works	Denny Gibson	Operations Manager
Douglas County Public Works	Shawna Patte	Road & Bridge
Douglas County Public Works	Fred Pemberton	Road & Bridge
Douglas County Public Works	John Lamb	Road & Bridge
Douglas County Public Works	Rocky Taylor	Road & Bridge
Douglas County Public Works	Bill Gabriel	Road & Bridge
Douglas County Public Works	Jerry Easley	Assistant Traffic Services Supervisor
Douglas County Public Works	Randy Teague	Road & Bridge Manager
Douglas County Sheriff	Ken Rost	Lieutenant
Douglas County Engineering	Brad Robenstein	Drainage and Flood Control Engineer
Douglas County Engineering	Jim Dederick	Environmental Engineer/Hydrologist
Parker Fire Protection District	John York	Operations Chief
Parker Fire Protection District	Bob Baker	Administration Chief
Parker Police Department	Ron Combs	Captain
Parker Police Department	Barbara Hennessey	Communications Supervisor
Parker Stormwater Utilities	Tom Williams	Stormwater Utility Manager
Castle Rock Fire and Rescue Department	Norris Croom	Operations Division Chief
Castle Rock Police Department	John Anderson	Captain
Castle Rock Utilities Department	Jennie Ducker	Project Manager
Castle Rock Public Works	Dave Frost	Streets Department Supervisor
Larkspur Fire District	Randy Johnson	Fire Marshall
Douglas County Search & Rescue	Randy Johnson	Vice President
West Douglas Fire District	Steve Smith	Chief
Franktown Fire District	Lee Willis	Chief
Jackson 105 Fire Department	Randy Rafferty	Chief
South Metro Fire Rescue	Dennis Wehling	Deputy Chief of Operations
State Patrol	Steve Powell	District 1 Commander
The Salvation Army	Mike Gelski	Disaster Specialist
Red Cross	Marty Reid	Disaster Specialist

Table 1: Interviewed agencies/departments.



## **Description of Agency/Department Flood Related Roles**

### **Douglas County, Colorado Departments and Agencies**

All Douglas County agencies/departments mobilize resources and conduct activities in response to a major disaster or emergency, including flooding, under the guidance of the 'Douglas County Incident Management Guidelines & Standards (IMGS). The Douglas County IMGS outlines the structure and process for the coordinated, systematic delivery of public safety services in accordance to a major disaster or emergency in Douglas County.

The incident management structure described in the Douglas County IMGS is based on the National Incident Management System (NIMS) and the National Response Plan (NRP). The NIMS and NRP were established in response to the Homeland Presidential Directive 5 (HSPD-5) by the United States Department of Homeland Security. The system provides a consistent nationwide approach to prepare, prevent, respond to, and recover from domestic incidents.

Listed below are the Douglas County departments/agencies that were interviewed along with a summary of the major roles that they have with respect to flood related responsibilities within the project area.

- **Emergency Services Division**  
Serve as an advisor to the Multi-Agency Coordination group (MAC) on implementation of the IMGS and Incident Command System (ICS) framework. Assist with the coordination between the Emergency Operations Center (EOC) personnel and support agencies. Maintain the Douglas County IMGS. Assist towns, special districts, business and industry in emergency preparedness and the coordination of response and recovery activities. Monitor information on potential, developing and in progress flooding events and provide notification of potential or pending flooding events. Provide information on the status and progress of flood response and recovery activities.
  
- **Sheriff's Department**  
Serve on the MAC group and coordinate law enforcement matters between the county, state, municipal, and federal law enforcement organizations. Mobilize the Douglas County Incident Management Team (IMT). Activate the County EOC and coordinate its operation. Maintain law and order within unincorporated areas of the county and provide assistance to the local jurisdictions if requested. Warn the public, government officials, emergency personnel of potential or actual emergencies. Provide response agencies with communication dispatching, including mobile communication capability. Provide traffic control, evacuation, search and rescue and other requested services such as hazmat operations in coordination with other law enforcement agencies. Provide security for the County EOC.

- **Public Works Department (includes the Engineering Division)**  
Serve on the MAC group. Protect and maintain County infrastructure, roads and county facilities through the provision of heavy equipment, vehicles and personnel. Assist the Sheriff's Office in marking and identifying dangerous public areas. Coordinate with the Douglas County School District to provide busses for transportation of people, supplies, and equipment. Close streets and re-route traffic. Assist with damage assessment information gathering. Provide assistance to other jurisdictions if requested. Design and construct damaged infrastructure. Construct new facilities by the County Road and Bridge crews or contracted private contractors. Educate the public on weather related issues. Place and operate weather detection devices. Management of structural flood mitigation projects. FEMA floodplain administration for the county. Post flood investigation and studies.

### **Town of Castle Rock, Colorado Departments**

The structure, overall procedures, chain of command, and town policies relating to the preparation, response, and recovery in response to a major disaster or emergency, including flooding, falls under the guidance of the 'Castle Rock Emergency Operations Plan' (EOP), department Standard Operating Procedures (SOP's) and the Douglas County IMGS. The Castle Rock EOP and the Douglas County IMGS outlines the structure and process for the coordinated, systematic delivery of public safety services in accordance to a major disaster or emergency in the town of Castle Rock.

The Incident Management Structure described in the Castle Rock EOP is based on the NIMS described earlier.

Listed below are the Castle Rock departments that were interviewed along with a summary of the major roles that they have with respect to flood related responsibilities within the project area.

- **Fire**  
Provide fire protection and emergency medical/ambulance services to a 75 square mile area in central Douglas County (West Plum Creek, East Plum Creek and Plum Creek drainage areas and the population area of Castle Rock). A combination of volunteer and full-time staff respond to emergencies. Provide Advanced Life Support (ALS) paramedic services, fire protection services, hazardous or toxic materials spill response, search and technical rescue (high/low angle rope, trench, confined space, building collapse, and water) services. Administer the Castle Rock Fire Chief's Association.
- **Police**  
Provide law enforcement that includes patrol and investigations. Provide traffic control in and around flooded areas and along evacuation routes. Provide direction and control of evacuation effort. Serves as the Public Safety Answering Point (PSAP) for Castle Rock.

- **Public Works**  
Maintain and repair road systems, mark and identify dangerous public areas, removal of debris to permit emergency rescue and emergency vehicle access, assist with damage assessment information gathering. Assist with emergency repairs to public building and other essential facilities. Assist with the temporary restoration or supply of utility services to County buildings or facilities during emergency conditions.
- **Stormwater Utilities**  
Asses flood threat to the town through use of hydrological studies. Oversee flood control projects to mitigate flooding.

### **Town of Parker, Colorado Departments**

The structure, overall procedures, chain of command, and policies relating to the preparation, response, and recovery in response to a major disaster or emergency, including flooding, falls under the guidance of the 'Parker Emergency Operations Plan' (EOP), department SOP's and the Douglas County IMGS. The Parker EOP and the Douglas County IMGS outlines the structure and process for the coordinated, systematic delivery of public safety services in accordance to a major disaster or emergency in the town of Parker.

Listed below are the Parker departments that were interviewed along with a summary of the major roles that they have with respect to flood related responsibilities within the project area.

- **Fire**  
Provide fire protection and emergency medical/ambulance services to a 105 square mile area in northeast Douglas County (Cherry Creek drainage area and the population area of Parker and southeast Aurora). A full time staff responds to emergencies. Respond to mutual aid requests, perform evacuations, and perform search and rescue operations for missing, endangered, or trapped persons including swiftwater rescue operations. Provide ALS paramedic services, and hazardous or toxic materials spill response services.
- **Police**  
Provide law enforcement at shelters, evacuation reception areas, and mass-feeding and lodging areas. Provide traffic control in and around flooded areas and along evacuation routes. Provide security and access control for the Parker EOC, field Command Posts, town facilities, resource staging and storage areas, and evacuated areas. Serves as the PSAP for Parker.

- **Public Works**  
Maintenance of drainage systems and public infrastructure. Barricading of flooded streets for purpose of traffic re-routing. Emergency flood control work that includes such things as sandbagging efforts and the implementation of other methods to mitigate flooding.
- **Stormwater Utilities**  
Asses flood threat to the town through use of weather prediction and weather detection information. Initiate phone calls to stormwater utilities, public works, police and fire regarding flood threat. Oversee flood control projects to mitigate flooding.

### **Other Douglas County Entities**

The structure, overall procedures, chain of command, and policies relating to the preparation, response, and recovery in response to a major disaster or emergency, including flooding, falls under the guidance of each entities SOP's and the Douglas County IMGS. The SOP's and the Douglas County IMGS outlines the structure and process for the coordinated, systematic delivery of public safety services in accordance to a major disaster or emergency in each entities jurisdiction.

All entities are able to assist other county mutual aid agencies if requested, under the Douglas County Mutual Aid Agreement.

Listed below are entities located in Douglas County that were interviewed along with a summary of the major roles that they have with respect to flood related responsibilities within the project area.

- **Larkspur Fire District**  
Provide fire protection and emergency medical/ambulance services to 120 square mile area in southern Douglas County (West Plum and East Plum Creek drainage areas and the population area of Larkspur). A combination of volunteer and paid staff responds to emergencies. Provide rescue services from collapse of buildings, trenches, or other damage. Provide a representative to the county EOC that would represent the Castle Rock Fire Chief's Association, Inc. for operations coordination. Inform the county when emergencies or disasters threaten the town of Larkspur.
- **Douglas County Search & Rescue**  
Provide search and rescue support within Douglas County including map, compass and GPS use; climbing, rappelling, low and high angle rescue; patient evaluation, packaging and handling. Staff is composed of volunteers that respond to search and rescue requests that operate under the authority of the Douglas County Sheriff's Office.
- **West Douglas Fire District**  
Provide fire protection and emergency medical services to 115 square mile area in western Douglas County (West Plum and Plum Creek drainage areas and the population area of Sedalia). Staff is composed of

44 volunteers that respond to emergencies. Perform all regularly assigned duties relating to the protection of life and property from fire. Provide and direct all emergency medical services, including triage, treatment, and transportation. Provide rescue services from collapse of buildings, trenches, or other damage. Provide a representative to the county EOC that would represent the Castle Rock Fire Chief's Association, Inc. for operations coordination. Inform the county when emergencies or disasters threaten the town of Sedalia.

- **Franktown Fire District**  
Provide fire protection and emergency medical services to 155 square mile area in eastern Douglas County (Cherry Creek, West Cherry Creek and East Cherry Creek drainage areas and the population area of Franktown). A combination of volunteer and paid staff respond to emergencies. Provide and direct all emergency medical services, including triage, treatment, and transportation. Provide rescue services from collapse of buildings, trenches, or other damage. Provide a representative to the county EOC that would represent the Castle Rock Fire Chief's Association, Inc. for operations coordination. Inform the county when emergencies or disasters threaten the town of Franktown.
- **Jackson 105 Fire Department**  
Provide fire protection and emergency medical services to 49 square mile area in western Douglas County (Plum Creek drainage area and the population area of Sedalia and Louviers). A staff composed entirely of volunteers responds to emergencies. Provide and direct all emergency medical services, including triage, treatment, and transportation. Provide rescue services from collapse of buildings, trenches, or other damage. Provide a representative to the county EOC that would represent the Castle Rock Fire Chief's Association, Inc. for operations coordination. Inform the county when emergencies or disasters threaten the towns of Sedalia and/or Louviers.
- **South Metro Fire Rescue**  
Provide fire protection and emergency medical services to 76 square mile area which includes northern Douglas County (Plum Creek drainage area and the population area of Louviers). A fulltime staff of 175, all trained as Emergency Medical Technicians (EMT) respond to emergencies. Provide hazardous materials, high angle rescue, and dive rescue response. Provide a representative to the county EOC that would represent the Castle Rock Fire Chief's Association, Inc. for operations coordination.

#### **Private Agencies/Local Government**

- **Skyview Weather**  
Provide weather prediction, detection and notification services, including the relay of National Weather Service (NWS) watches and warnings to Douglas County departments/agencies, Castle Rock departments and Douglas County population areas of Parker, Highlands Ranch, Lone Tree and Franktown.

- **Urban Drainage and Flood Control District**  
 Manages drainage master planning projects, drainage design and structural flood mitigation projects, and floodplain management. Owns and maintains a district wide flood detection network including stream gages, rain gages and weather stations in Douglas County. Area of responsibility includes northern Douglas County including the population areas of Parker, Highlands Ranch, Lone Tree, Castle Pines, Sedalia, and Louviers. Onerain, located in Longmont, Colorado currently holds the contract to perform maintenance of the district wide flood detection network.
  
- **Urban Drainage and Flood Control District's Flash Flood Prediction Program (F2P2)**  
 Provide weather prediction, detection and notification services to northern Douglas County that includes the population areas of Parker, Highlands Ranch, Lone Tree, Castle Pines, Sedalia, and Louviers. Site specific rainfall prediction produced for the West, East and Plum Creek watercourses as well as the Cherry Creek watercourse within the district. HDR, located in Denver, Colorado currently the Meteorological Services Provider for the F2P2.

#### **State of Colorado Agencies**

- **Office of Emergency Management**  
 Allocation of resources for flood fighting activities, financial assistance during and after flooding events. Acts as a liaison between local governments and federal agencies.
  
- **Department of Transportation**  
 Responsible for storm drainage conveyance of existing drainage areas and removal of debris in storm drains in and around state roadways. Barricading of flooded streets for purpose of traffic re-routing away from flooded areas on state roadways.
  
- **Department of Public Safety – State patrol**  
 Responsible for state highway safety including road closures. Area of responsibility includes Interstate 25 within the East Plum Creek drainage area and State Highway 83 within the East Cherry Creek and Cherry Creek drainage areas.
  
- **Colorado Water Conservation Board**  
 Responsible water supply protection, flood protection, water supply planning and finance, stream and lake protection, and conservation and drought planning.

## **Federal agencies**

- National Weather Service Forecast Office – Boulder, Colorado (NWSFO-BOU) and Pueblo, Colorado (NWSFO-PUB)  
Produce and disseminate flood advisories, watches, warnings, hydrologic and precipitation depth and duration forecasts to the public, government agencies and private businesses.
- National Weather Service - Missouri River Basin Forecast Center (MRBFC)  
Produce and disseminate hydrologic and precipitation depth and duration forecasts as guidance to the NWSFO-BOU. Produce hydrologic forecast for river stage and flow at the stream gage located on Plum Creek near Sedalia.
- United States Geological Survey (USGS)  
Own and maintain the stream gages located within the project area.
- American Red Cross, Colorado Chapter  
Coordinate activities with the County Department of Health & Human Services. Provide disaster relief needs and assist with mass care. Open and manage shelters for displaced persons. Register victims that are provided shelter. Provide food and beverages to victims. Work with logistics section to provide food and beverages to emergency workers. Assist with damage assessment.
- The Salvation Army, Colorado Chapter  
Coordinate activities with the County Department of Health & Human Services. Assist victims with emergency relief needs in conjunction with the American Red Cross. Provide food and beverages to victims. Work with logistics section to provide food and beverages to emergency workers.

## **3.0 Weather Prediction and Warning Resources**

The weather prediction and weather warning components for Douglas County are comprised of information from three main sources. These sources include the National Weather Service Forecast Office in Boulder, Colorado (NWSFO-BOU) Skyview Weather in Castle Rock, Colorado and the Urban Drainage and Flood Control District's (UDFCD) Flash Flood Prediction Program (F2P2), in Denver Colorado.

### **National Weather Service Forecast Office – Boulder and Pueblo**

The NWSFO-BOU is responsible for providing weather forecasts, special weather statements, and watches/warnings for flooding and severe weather events to the public that reside in Douglas County and northern Teller County (Hayman Burn Area) as well as emergency response agencies within Douglas County.

## Product Descriptions

The following are the meteorological products that are produced by the NWSFO-BOU and a description of these products. Included in the product descriptions are 'WMO Headers' (example: FPUS55 KBOU), followed by an identifying sequence of 8 or 9 characters that are used internally in the NWS known as 'AFOS-PIL Headers' (example: ZFPBOU). Examples of these products can be found Section 2.0 in the Technical Addendum. All of these products can be accessed through the NWSFO-BOU website as well as the Douglas County Weather Website that will be discussed later in this report.

Gridded Forecast products (only available via Internet – no header available)

The NWS National Digital Forecast Database (NDFD) Experimental Graphic Forecast Displays are web-based presentations of digital forecast data originating from local Weather Forecast Office (WFO) digital databases and the NDFD server. The data are displayed in a mosaic form on national and regional scales. The WFO digital forecast data are uploaded to the NDFD server where regional and national mosaics are formed. These mosaic graphic images will display the following specific forecasted weather parameters:

- Maximum temperature
- Minimum temperature
- Probability of precipitation
- Sky cover
- Wind direction and speed
- Significant wave height
- Temperature
- Dewpoint
- Quantitative precipitation forecast /qpf/
- Snow accumulation

Depending upon the element, forecast time projections will extend out to a maximum of 168 hours from initial issuance. Initially, the available elements (and their temporal and spatial resolutions) will be limited to those listed above, but additional data fields having greater temporal and spatial resolution will be added as the NDFD matures.

Public Zone Forecast ZFPBOU (FPUS55 KBOU)

Details the overall forecast weather conditions for an area. This product includes forecasts for temperature, wind, cloud cover, and precipitation along with other conditions considered relevant to the general public. Any active watches/warnings of any meteorological or hydrological conditions that the NWSFO-BOU is responsible for will be highlighted. This product is issued twice daily, and is updated as needed.

Hazardous Weather Outlook HWOBOU (FLUS45 KBOU)

Details forecasted weather conditions that could present a meteorological hazard. Typically an outlook will present a more detailed outlook for the ensuing day with another sections detailed the general outlook for potentially hazardous conditions for



the next 2-7 days as well. This product is generally issued once to twice daily, regardless of forecasted conditions.

#### Short Term Forecast FPUS75 KBOU (BOUNOWBOU)

A synopsis and/or short-term (from the present time to over the next couple of hours) forecast of meteorological conditions that are/will be impacting the area of interest. This product is typically issued on an event-driven basis and may not be available at any given time.

### **Advisories/Watch/Warning Products**

#### Flood Watch FFABOU (WGUS65 KBOU)

Used to inform of current or developing conditions that pose a threat of flooding but the occurrence is neither certain or imminent.

#### Flood/Flash Flood Warnings

##### 1) Flood Warning FLWBOU (WGUS55 KBOU)

Issued when flooding of main stem rivers/creeks is occurring or imminent. Main stem river/creek flooding refers to flooding of gaged and forecasted rivers/creeks.

##### 2) Flash Flood Warning FFWBOU (WGUS55 KBOU)

Issued when flooding is reported; when precipitation capable of causing flooding is observed by radar/satellite; when observed rainfall exceeds flash flood guidance or criteria known to cause flooding; or when a dam or levee failure has occurred or is imminent. A flash flood is defined as a flood caused by heavy or excessive rainfall in a short period of time, and occurring generally within 6 hours of the causative event.

#### Flood/Flash Flood Statements FFSBOU (WGUS75 KBOU) and FLSBOU (WGUS85 KBOU)

Follow-up statements to keep the public fully informed of the most current information. Statements can be used to remove geographical areas covered by the original Flood Warning when flooding is no longer a threat or has ended in that area. Statements are not used to extend the length of time or add an area to a warning. In those cases, a new Flood Warning will be issued.

#### Urban and Small Stream Advisory FSSBOU (FGUS55 KBOU)

Issued when minor widespread urban or flooding along small streams is occurring or imminent. This type of flooding is generally an inconvenience and not life-threatening.

### **Product Dissemination Methods**

The methods by which the forecast/watch/warning products issued by the NWSFO-BOU are disseminated include NWS National Oceanic and Atmospheric Administration (NOAA) Weather Radio (NWR), Emergency Managers Weather Information Network (EMWIN), Internet (<http://www.crh.noaa.gov/den/>), local media using the Emergency Alert System (EAS), Colorado Crime Information Center (CCIC) and Metropolitan Telephone System (NWS – METS).

It should be noted that the NWR continuously distributes forecast/watch/warning products on a '24/7' basis. The responsibility of monitoring the information from NWR lies primarily with the end-user of a NWR receiver. However, in terms of a 'pro-active' notification, (ex: an audio alert or tone) there are only certain products that trigger such alerts. Typically, any NWR receiver should be triggered with the issuance of any watch or warning in the area of responsibility of the NWSFO-BOU, including Douglas County. A user can limit the geographical area of interest that triggers an alarm given they have a NWR receiver that has such programmable features. In regards to the utilization of the EAS, not every NWS watch and/or warning product is disseminated over the system. Typically there is some local control and discretion that is exercised over what information is transmitted through the EAS.

### **Criteria That Prompts the Issuance of the Advisory, Watch and Warning Products**

#### **Flash Flood Guidance FFGCO (FOUS63 KKRF)**

Flash Flood Guidance (FFG) produced by the NWSMRBFC to quantify the amount of rainfall in various time periods that may initiate flash flooding. This product is utilized to offer guidance to the potential of flooding in particular basins by quantifying criteria of critical precipitation amounts to generate such conditions in 1-, 3-, and 6-hour intervals.

The above information along with some localized alteration of values is merged into a system called the Flash Flood Monitoring and Prediction product (FFMP). This system overlays Doppler radar rainfall estimates and real time Doppler radar over a projection of various sub-basins in an area. The observed/forecast information is used in concert with the FFG provided by NWSMRBFC. The NWSFO-BOU staff can alter the guidance locally for individual sub-basins given more specific information (i.e. basin characteristics, local rainfall amounts). The use of the FFMP is driven by the program utilizing the Doppler radar estimated rainfall with (where applicable) some ground truth values and the forecast to determine if the precipitation in the basin is or will exceed FFG.

### **Hydrological Forecasts**

The NWSMRBFC produces both basin-specific quantitative precipitation forecasts (QPF) and site-specific hydrologic forecast guidance to the NWSFO-BOU.

There is one hydrological forecast point in Douglas County, which is located at a USGS stream gage on Plum Creek, near Sedalia. The point is identified by the following 5 character ID: LOVC2 : Plum Creek near Sedalia

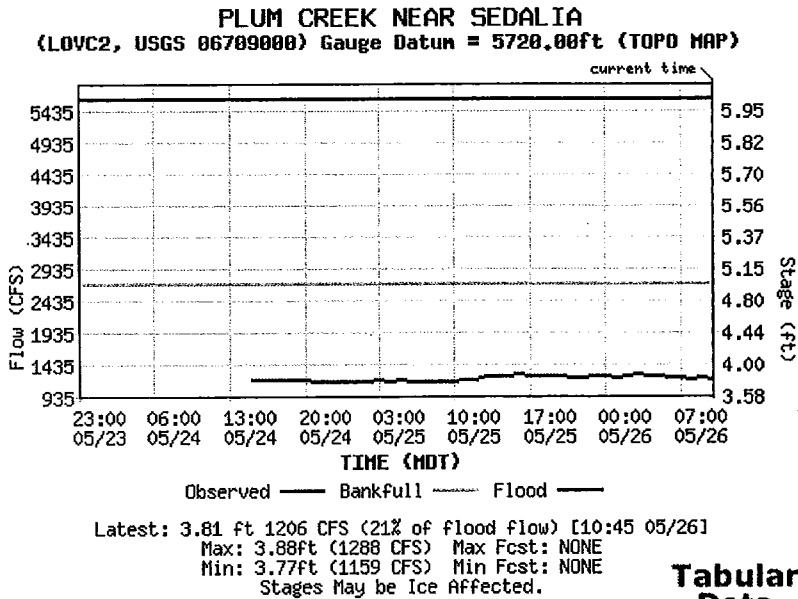


Figure 1: Plum Creek near Sedalia observed/predicted hydrograph.

The hydrograph shows past river level and river discharge. A forecast hydrograph is produced when flooding is expected, otherwise the hydrograph for the past few days is provided. This information is accessible by Internet at <http://www.crh.noaa.gov/cgi-bin/ahps.cgi?den&lovc2>.

### Advanced Hydrologic Prediction Services

Advanced Hydrologic Prediction Services (AHPS) are a new and essential component of the NWS. AHPS is a web-based suite of information-rich forecast products. They display the magnitude and uncertainty of occurrence of floods or droughts, from hours to days and months, in advance. These graphical products are useful information and planning tools for many economic and emergency managers. These new products enable government agencies, private institutions, and individuals to make more informed decisions about risk based policies and actions to mitigate the dangers posed by floods and droughts.

The current group of AHPS products covers forecast periods ranging from hours to months. It also includes valuable information about the chances of flood or drought. This information is presented through graphical products. The information, such as the flood forecast level to which a river will rise and when it is likely to reach its peak or crest, is shown through hydrographs. Other information includes,

1. The chance or probability of a river exceeding minor, moderate, or major flooding.
2. The chance of a river exceeding certain level, volume, and flow of water at specific points on the river during 90 day periods.

3. A map of areas surrounding the forecast point that provides information about major roads, railways, landmarks, etc. likely to be flooded, the levels of past floods, etc.

An additional feature of the AHPS Web is a map of the river basin and various points along the river for which information is available. The data are not limited to information about floods, but can also provide information about potential droughts.

### **Skyview Weather – Castle Rock, Colorado**

Skyview Weather located in Douglas County (Castle Rock) is contracted by the county and Castle Rock to provide weather related services that augment NWSFO-BOU information. The services that Skyview provides the county and Castle Rock includes the following:

- Weather predictions that are independent of predictions issued by NWSFO-BOU.
- Operational monitoring of current weather conditions.
- Pass through service of NWSFO-BOU Watches and Warnings.
- Coordination and deployment of real-time weather spotters.
- Monitoring of UDFCD F2P2 products.
- Independent evaluation of federal forecast products.
- Act as liaison to the NWSFO-BOU.
- Monitor statements from the NWSFO - Pueblo, due to the abutment of the NWSFO-Pueblo area of responsibility with Douglas County and the Hayman Burn Area.

### **Product Descriptions**

The following are the meteorological products that are produced by Skyview Weather. Examples of these products can be found in the technical addendum.

- A written forecast product is issued on a standard form. There is at least one product issued per day.
- Product covers general weather factors such as precipitation, precipitation type, temperatures, winds, etc.
- Updates are issued for this product on an as needed basis.
- Temporal/spatial precipitation prediction is noted in the forecasts products if deemed necessary.

- If there is a significant weather event in the county, rapid communication takes place through three mechanisms. 1) Pager 2) Two-way radio (800 MHz State of Colorado network) 3) Telephone.

### **Criteria That Prompts the Issuance of Products**

There are no particular criteria tied to the issuance of a specific product except for that it is issued once-a-day and the updates are issued on a discretionary basis.

The UDFCD Flood Detection Network (FDN) data is helpful at times to issue products. The information utilized most heavily includes Doppler radar and lightning data.

### **Product Dissemination Methods**

Products and information are disseminated within the county by use of the following mediums.

Facsimile

- 1) E-mail
- 2) Pager \* (see below)
- 3) Two-way radio # (see below)
- 4) Internet (webpage)
- 5) Telephone

\* The pager service provided to the county is limited to 230 characters per transmission

# The 2-way radio is on the statewide 800 MHz system. This system is made up of special groups (similar to internet chat rooms). There is a weather talk group known as the Douglas Weather Talk Group where communications related to weather are held. The use of the weather talk group is limited to certain users (i.e. the general public can not access this system).

The re-dissemination of NWS-BOU Watches and Warnings is done by e-mail and is automated (no human intervention). As for the monitoring of UDFCD F2P2 products, there is no explicit re-dissemination of products unless the Skyview weather forecaster feels that it is needed.

### **Product Dissemination Reception Points**

Voice communications by telephone and the Douglas Weather Talk Group are the primary means of relaying critical information disseminated by Skyview Weather. The primary communication reception points include

1. Douglas County Sheriff's office Dispatch Center (DCSDC).
2. Douglas County Emergency Services.
3. Douglas County School District/Risk Management.
4. Castle Rock Fire Department.

Information is also distributed by e-mail and pager with distribution points being quite numerous and includes the Douglas County Sheriff's Office, Douglas County Public Works, Douglas County Emergency Services, Castle Rock Fire Police and Public Works, Parker Fire, Police and Public Works, Franktown Fire, Larkspur Fire, West Douglas Fire, Jackson 105 Fire, and West Metro Fire. The DCSDC is the main reception point where some relaying of the Skyview information is performed through e-mail and pager groups.

Information is also disseminated by facsimile to multiple locations within Douglas County. The main reception points include the DCSDC, Douglas County Emergency Services, Douglas County Public Works, Castle Rock Fire, Parker Fire, and Franktown Fire. Information is relayed to additional facsimile recipients by these main facsimile reception points. Web products are also remotely accessible through a password protected web site.

### **Urban Drainage and Flood Control District's Flash Flood Prediction Program**

The UDFCD F2P2 provides rainfall prediction and notification services to a seven county area outlined in purple on Figure 2. Only northern Douglas County, that includes the population areas of Parker, Highlands Ranch, Lone Tree, Louviers, Sedalia, and Castle Pines receives direct support by the F2P2. The remainder of the county located south of the UDFCD boundary that is located in the Plum Creek and Cherry Creek drainage basins receives indirect support by the F2P2. This occurs when heavy rainfall is predicted south of the UDFCD boundary that would lead to flooding on West Plum Creek, Plum Creek and or Cherry Creek within the UDFCD district. Direct support is rendered to the District basin-specific warning plans that are in place. However, there are currently no basin-specific warning plans in place in Douglas County.

The F2P2 is designed to offer rainfall prediction and warning service concerning urban flooding and flash flooding threats to the seven District counties and the cities and towns within those counties. The F2P2 provides basin specific rainfall prediction and emergency response notification of flooding potential that augments NWSFO-BOU predictions, watches and warnings.

### **Product Descriptions**

A description of the products produced by the F2P2 is outlined below. Product examples can be found in the technical addendum.

### Heavy Precipitation Outlook (HPO)

This text product is available by 1100 AM every day from April 15 through September 15. It provides a weather forecast for the District with emphasis on possible rainfall amounts and where storms are most likely to occur. When flood potentials threaten the District, this product will be revised and renamed "Internal Message Status" or IMS. This report will indicate the message status for each county within the District. Those counties include Adams, Arapahoe, Boulder, Broomfield, Denver, Douglas and Jefferson. An example of the HPO product can be found on page 61 in the Technical Addendum.

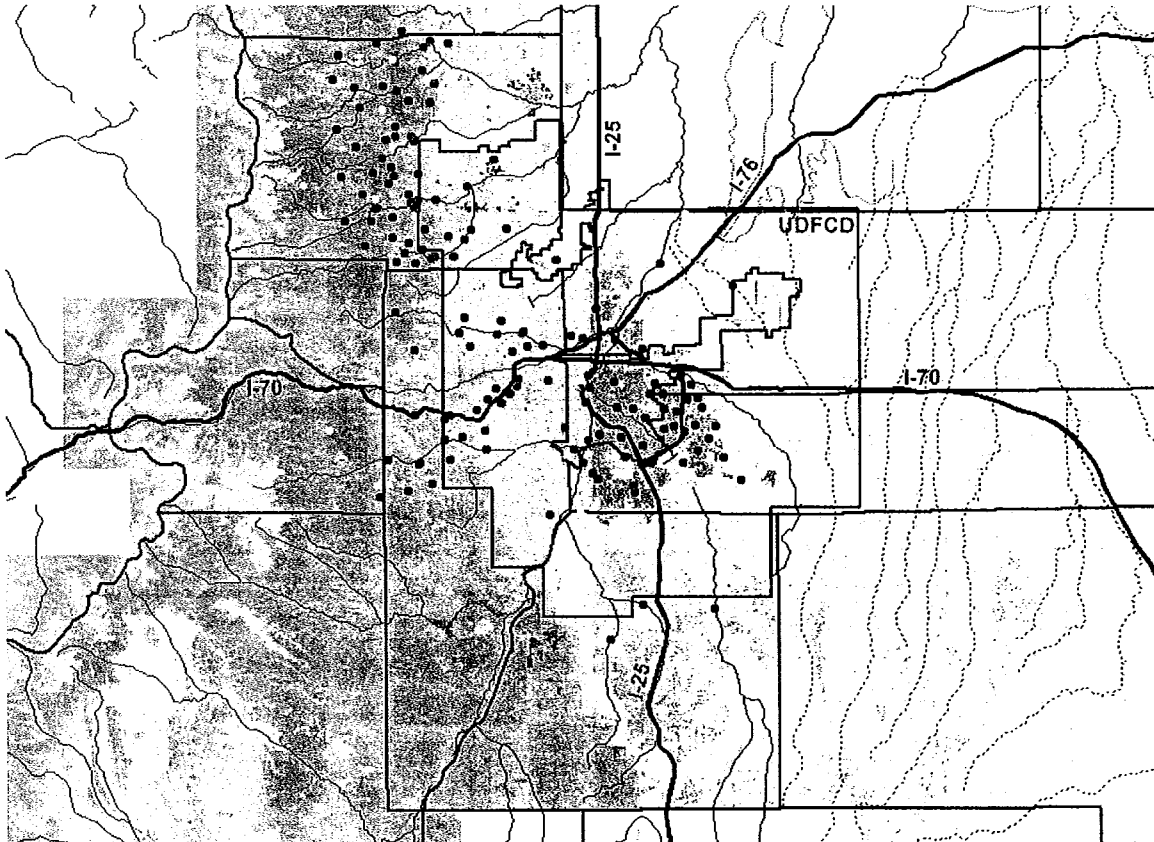


Figure 2: The Urban Drainage and Flood Control District area, depicted in the color purple.

### Quantitative Precipitation Forecast (QPF)

This text product is only produced on days when the rainfall potential is predicted to exceed 1.5 inches in one-hour or less. The QPF product contains more basin-specific information than the HPO or IMS and requires some knowledge of the regional major drainage basins, streams and associated flood hazards that impact the District. Storm types, expected rainfall totals, storm duration, peak intensities and associated probabilities of occurrence are presented in this forecast product. An example of the QPF product can be found on page 62 in the Technical Addendum.

### StormTrak (ST)

This combination Geographic Information System (GIS) based map/text product is a short lead-time prediction showing where a storm has formed or is forming, the approximate size of the storm, the direction (or track) of the storm, and the estimated

arrival times along the predicted track. This product is only available within an hour or less of storm impact. Also, the ST is not prepared for storms that do not pose a flood threat. An example of the StormTrak product can be found on page 73 in the Technical Addendum.

### **Message Definitions**

Standardized messages are issued to emergency communication centers in each of the seven District counties. Dispatchers disseminate the information according to SOP unique to each jurisdiction. Below is a description of different messages.

#### **Message 1 (Internal Alert)**

This is an advisory message which is meant to inform key people that weather conditions are such that flood producing storms could develop later in the day. It will be issued after coordination with the NWSFO-BOU.

#### **Message 1 – Red Flag (Internal Alert)**

This is an advisory message which is meant to inform key people that weather conditions are such that flood producing storms capable of producing rainfall equal to or exceeding 1.00"/30 minutes and is considered imminent.

#### **Message 2 (Flash Flood Watch)**

This message indicates that a Flash Flood Watch has been issued by the NWSFO-BOU and/or that the F2P2 meteorologist feels the risk is high that a life-threatening flood may occur later in the day. If it is determined that this watch requires priority dissemination, it will be identified as a **RED FLAG** message.

#### **Message 3 (Flash Flood Warning)**

This message indicates that a Flash Flood Warning has been issued by the NWSFO-BOU and/or that the F2P2 meteorologist feels that a life-threatening flood is imminent. This warning message requires priority dissemination (i.e. **AUTOMATIC RED FLAG**).

#### **Message update**

This message will be used to update any of the previous messages, particularly in the event of a disagreement between the F2P2 meteorologist and the NWSFO-BOU. For example, this message can be used to narrow a watch or warning area as more information becomes available or to provide more site-specific data and direction during an event. If it is determined that this update requires priority dissemination by the communications dispatcher, it will be identified as a **RED FLAG** message.

#### **Message 4 (All Clear)**

This message cancels the flood potential status. This message is issued after coordination with NWS-BOU and other entities.

### **Criteria that prompts the issuance of each product**

The F2P2 products are issued based on predicted rainfall criteria that were developed by the UDFCD using sound hydrological practices under the assumption that the



predicted rainfall has a reasonable chance (30% or greater) of occurrence. This criteria is outlined in the Table 2 below:

<b>Message 1: M-1</b>	Issued primarily to alert local governments to the threat of nuisance flooding of streets and low lying areas due to thunderstorm rainfall when storm total rainfall is 0.50" - 1.00" in one hour or less. When rainfall is 1.00" to < 3.00" in one to three hours, urban street and stream flooding becomes significant. M-1 lead-times of >1 hour are desirable.
<b>Message 1 Rainfall Intensity Criteria:</b>	Any of the predicted rainfall intensities below prompt a Message 1 issuance 1.00"/ 60 minutes 0.75"/ 30 minutes 0.50"/ 10 minutes
<b>Message 1: RED FLAG RED FLAG Rainfall Intensity Criteria:</b>	Issued to identify storm events, which fall just short of producing life-threatening rainfall, but produce significant runoff. Rainfall rates are predicted or observed to equal or exceed 1.00"/30 minutes and the storm is considered imminent.
<b>Message 2: M-2</b>	Issued when the threat of potential life threatening flooding is predicted or the NWS issues a Flash Flood Watch. An M-2 is the equivalent of a Flash Flood Watch. M-2 lead-times of several hours are desirable.
<b>M-2 Rainfall Intensity Criteria:</b>	>3.00"/hour or a lower value based on mutual discussion between NWS, District and F2P2 meteorologist due to antecedent rainfall impacts on soil saturation and/or runoff characteristics.
<b>Message 3: M-3</b>	Issued when a life-threatening flash flood is imminent or the NWS issues a Flash Flood Warning. M-3's are issued in accordance with basin-specific warning plans if available or at the discretion of the meteorologist.
<b>Message 4:</b>	Issued when the flooding threat has passed.

Table 2: UDFCD Flash Flood Prediction Program Message Criteria.

### Product dissemination methods

All products are delivered to F2P2 participants within Douglas County using Xpedite Internet-based broadcast fax service and are also uploaded and available from UDFCD's ALERT web site, <http://alert.udfcd.org/udebb.html>. Message forms are the only F2P2 product not available on the UDFCD's ALERT web site due to the fact that Messages (internal alerts) are only intended to be utilized by F2P2 participants and are not intended for the public.

Voice communication is the primary form of communication within the F2P2 between F2P2 meteorologist's and F2P2 participants within Douglas County.

The dissemination points in within Douglas County include the DCSDC, Parker Public Works (engineering), Parker Public Works (operations), Parker Fire Department, Parker Police Department, and Skyview Weather.

### **Weather Prediction and Warning Resources - Recommendations**

The following recommendations, if implemented by the County and adopted by the prediction agencies listed in Section 3.0, should provide assistance with regard to meteorological, hydrological prediction and flood warning, within Douglas County.

- 3-1 Determine basin average rainfall criteria, specific to individual major drainage basins for the 2-year, 5-year, 10-year, 25-year, 50-year, 100-year, and 500-year recurrence intervals for durations of 1-hour, 3-hours, 6-hours, 12-hours and 24-hours. Develop criteria through depth/duration/frequency (DDF) and intensity/depth/frequency (IDF) analysis using precipitation observation from UDFCD rain gages, NWS Cooperative Observer rainfall observations and Design Storm information.
- 3-2 Determine drainage basin hydrologic characteristics such as soil types, time of concentration, percent of imperviousness, area, and slope. Determine antecedent moisture affects on basin time of concentration.
- 3-3 Determine watercourse discharge, velocities, and depths based on all the basin average rainfall criteria information calculated in recommendation 3-1.
- 3-4 Develop GIS-based flood maps that depict water inundation and water depths associated with a 25-year, 50-year, 100-year, and 500-year recurrence intervals on East Plum Creek, Plum Creek, East Cherry Creek, West Cherry Creek and Cherry Creek.
- 3-5 Determine depth and duration rainfall criteria utilizing the information calculated in recommendations 3-1 through 3-4, that if predicted would prompt flood advisories watches and warnings.

### **4.0 Weather Detection Resources**

Weather detection information within Douglas County that can be utilized in real-time and near real-time to assist predictors and county decision makers includes rain gages, stream gages, weather stations, fixed location video cameras and a trained weather spotter network. Other weather detection information that is not located specifically in Douglas County, but has been determined to be useful on an operational basis, includes the Front Range (FTG) NWS Nexrad 88-D Doppler radar, Pueblo (PUX) NWS Nexrad 88-D Doppler Radar and Cloud to Ground lightning data. The following is a description of the detection information within Douglas County, listed by the agency that is responsible for the information.

**Stream Gages**

Information measured by the stream gages in the project area include gage height, measured in feet and streamflow, measured in cubic feet per second (cfs).

**Gage height** (also known as stage) is the height of the water in the stream above a reference point. Gage height refers to the elevation of the water surface in the specific

pool at the streamgaging station, not along the entire stream. Gage height also does not refer to the depth of the stream.

**Streamflow** (also known as discharge) is the volume of water flowing past a given point in the stream in a given period of time. Streamflow is measured in cubic feet per second (ft<sup>3</sup>/s). Streamflow values are better indicators than gage height of conditions along the whole river.

**United States Geological Survey**

The USGS owns and maintains five stream gages within the project area. The table and figures below provides information on the gages.

Agency	Site Number	Site Name
USGS	06712000	Cherry Creek near Franktown, CO.
USGS	393109104464500	Cherry Creek near Parker, CO
USGS	06708800	East Plum Creek below Haskins Gulch near Castle Rock, CO
USGS	06709530	Plum Creek at Titan Road near Louviers, CO
USGS	06709000	Plum Creek near Sedalia, CO

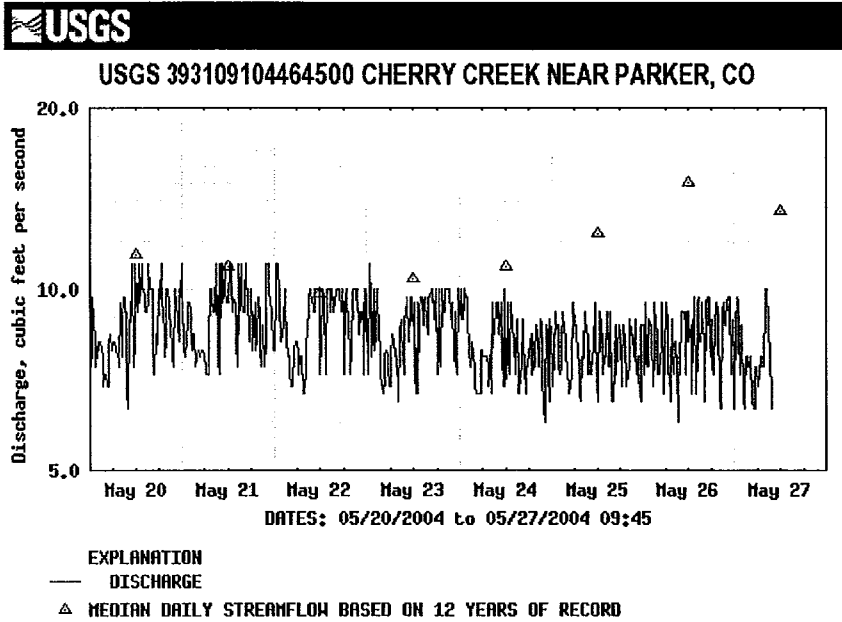
Table 3: United States Geological Survey stream gages located in Douglas County.

The figure and table below depicts how the USGS stream gage information is displayed, and is accessible by the internet at <http://waterdata.usgs.gov/co/nwis/rt>. Real-time data typically are recorded at 15-60 minute intervals, stored onsite, and then transmitted to USGS offices every 1 to 4 hours, depending on the data relay technique used. Recording and transmission times may be more frequent during critical events. Data from real-time sites are relayed to USGS offices via satellite, telephone, and/or radio and are available for viewing within minutes of arrival.

Date / Time (LT)	Gage height (feet)	Stream-flow (ft <sup>3</sup> /s)
05/21/2004 00:00	3.58	11.0
05/21/2004 00:15	3.54	9.70
05/21/2004 00:30	3.47	7.90
05/21/2004 00:45	3.46	7.70
05/21/2004 01:00	3.46	7.70
05/21/2004 01:15	3.48	8.20

05/21/2004 01:30	3.51	8.90
05/21/2004 01:45	3.53	9.50
05/21/2004 02:00	3.53	9.50
05/21/2004 02:15	3.52	9.20
05/21/2004 02:30	3.48	8.20
05/21/2004 02:45	3.47	7.90
05/21/2004 03:00	3.49	8.40

Table 4: United States Geological Survey Stream Gage Information in Tabular Format.

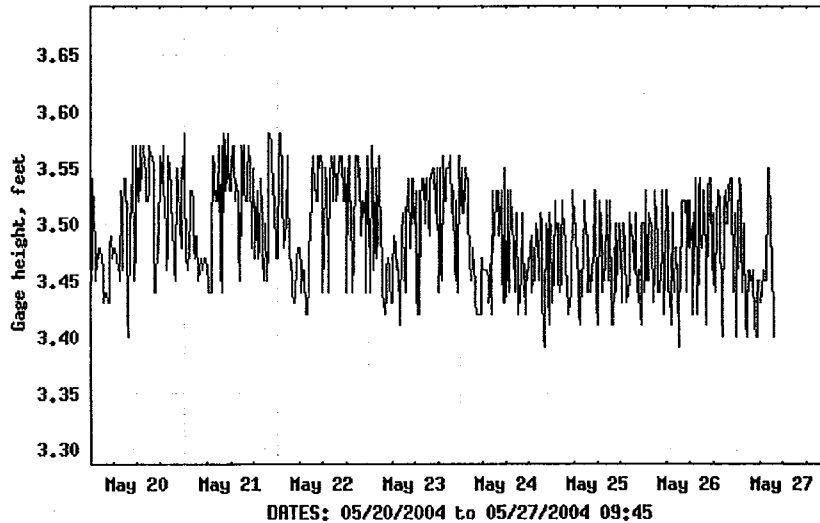


**Provisional Data Subject to Revision**

Figure 3: United States Geological Survey stream gage water volume on Cherry Creek near Parker, Colorado.



USGS 393109104464500 CHERRY CREEK NEAR PARKER, CO



Provisional Data Subject to Revision

Figure 4: United States Geological Survey stream gage water height on Cherry Creek near Parker, Colorado.

### Urban Drainage and Flood Control District

The UDFCD owns and maintains four stream gages within the project area. The table and figure below provides information on the gages.

The stream gages are part of a large network of gages owned and maintained by the UDFCD that that operate in the NWS ALERT (Automated Local Evaluation in Real Time) format, and is commonly referred to as an ALERT system.

The gages transmit their information to a UDFCD base computer via VHF radio. The computer quickly compiles the information, displays the information and publishes the information to the Internet. The gages are powered by 12-volt batteries, which are recharged using small solar panels attached to the top or sides of the gages.

Agency	Site Number	Site Name
UDFCD	2820	East Plum Creek near Sedalia
UDFCD	2810	Pine Cliff Road and West Plum Creek
UDFCD	2830	Castle Oaks Road and Cherry Creek
UDFCD	2823	Sulpher Gulch (Major Tributary to Cherry Creek)

Table 5: Urban Drainage and Flood Control District stream gages in Douglas County.

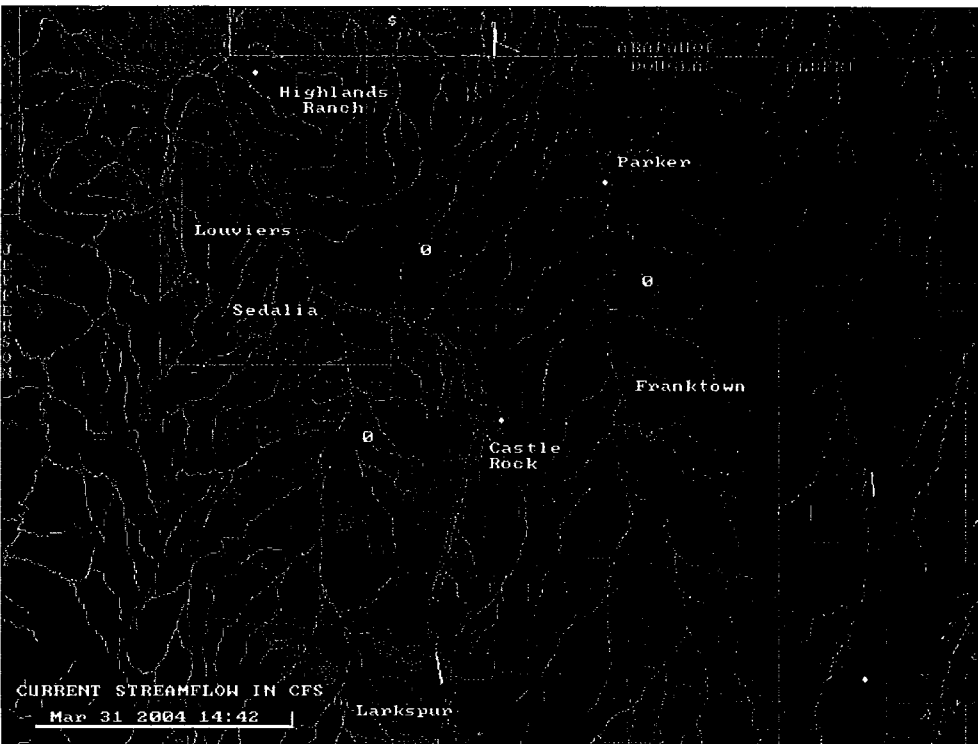


Figure 5: Urban Drainage and Flood Control District stream gages locations in Douglas County. The Sulphur Gulch gage in Parker does not appear on the map due to the fact that the map has not yet been updated by UDFCD.

Figure 5 shows current stream flow in cubic feet per second (CFS) and water levels in feet. Blank objects indicate that no current data is available.

Surveys are performed on the UDFCD stream gages to provide information about these sites in a manner consistent with NWS E-19 procedures. E-19 procedures include measuring elevations of critical points in the vicinity of the site, estimates of stages causing flood damage in vicinity of the gage, and where available past history of the sites including historic high water marks and other critical flood information. UDFCD stage (gage height) readings represent one of the following: water level depth above some physical feature, a relative gage height above an arbitrary datum, gage height reflecting mean sea level datum (NGVD).

UDFCD Flood Warning Templates (FWT) are created based on the surveyed information, historic records, and other information supplied by the UDFCD and the NWS. The templates are made available on the UDFCD web site. Figure 6 shows an example of a UDFCD stream gage FWT.

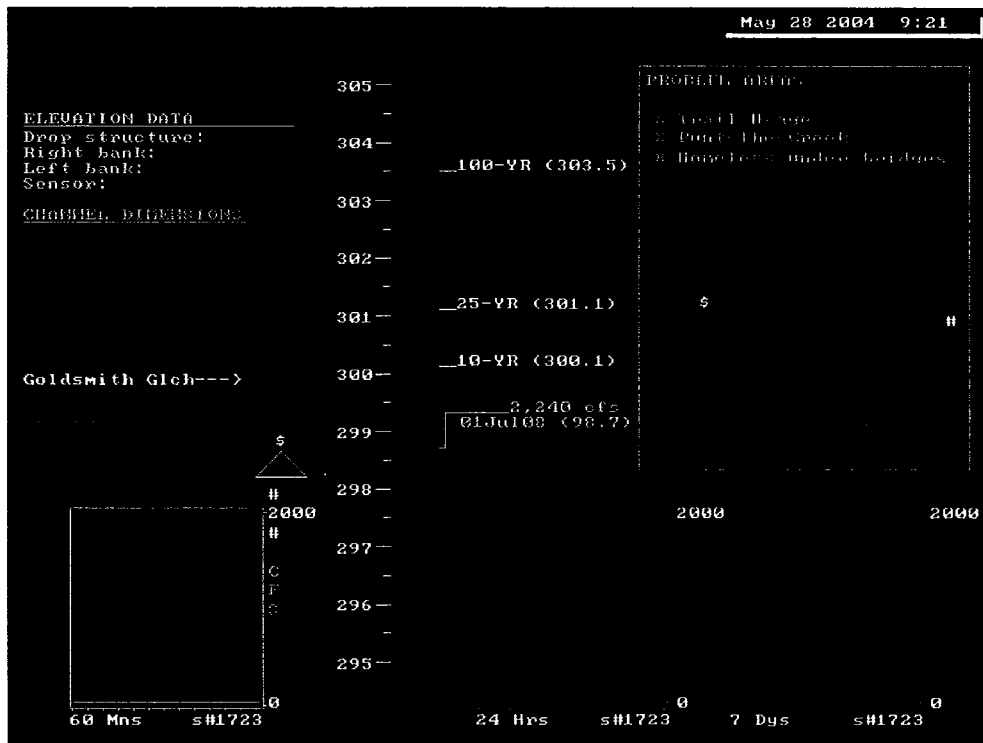


Figure 6: Urban Drainage and Flood Control District Flood Warning Template.

### Rain Gages

Information measured by the rain gages in the project area includes precipitation depth, measured in inches.

### Urban Drainage and Flood Control District

The UDFCD owns and maintains seven rain gages within the project area. The table and figure below provides information on the gages.

Agency	Site Number	Site Name
UDFCD	2820	East Plum Creek near Sedalia
UDFCD	2810	Pine Cliff Road and West Plum Creek
UDFCD	2830	Castle Oaks Road and Cherry Creek (Franktown/Parker)
UDFCD	2823	Sulphur Gulch (east Parker)
UDFCD	2750	Castle Rock
UDFCD	2710	Highlands Ranch
UDFCD	2730	Parker

Table 6: Urban Drainage and Flood Control District rain gages in Douglas County.

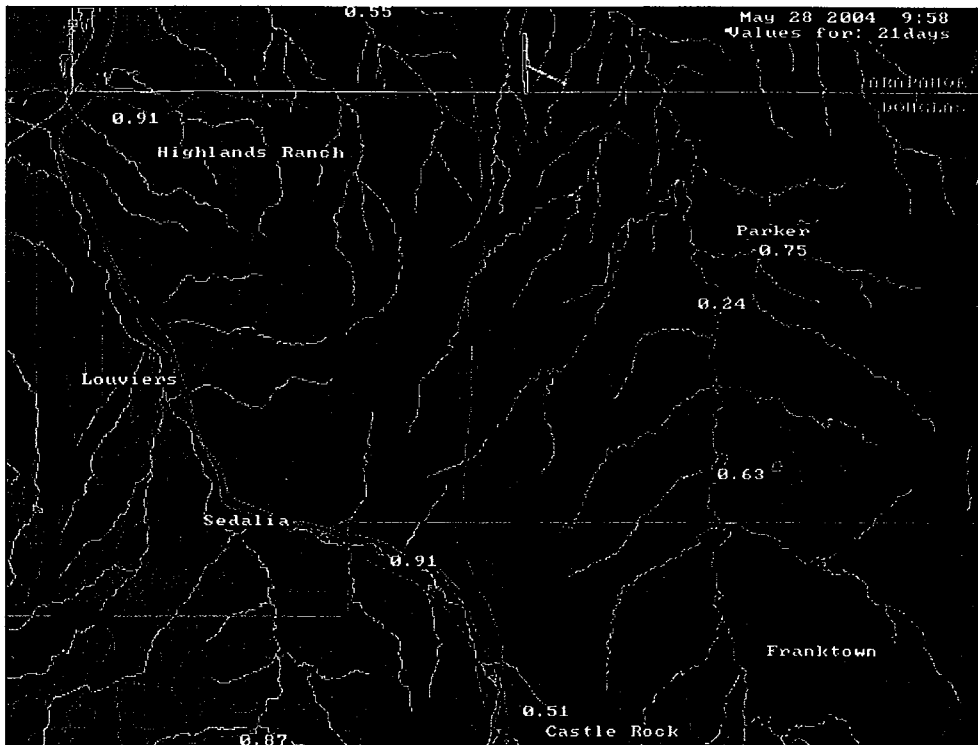


Figure 7: Urban Drainage and Flood Control District stream gage locations in Douglas County.

The rain gages are part of a large network of gages owned and maintained by the UDFCD that operate in the NWS ALERT format.

The gages transmit their information to a UDFCD base computer via VHF radio. The computer quickly compiles the information, displays the information and publishes the information to the Internet. The gages are powered by 12-volt batteries, which are recharged using small solar panels attached to the top or sides of the gages.

#### Castle Rock Parks and Recreation Department

The Castle Rock Parks and Recreation department owns and maintains five rain gages within the project area. The table below provides information on the gages.

Agency	Site Number	Site Name
Castle Rock P & R	N/A	Red Hawk Ridge Golf Course (weather station co-located)
Castle Rock P & R	N/A	Founders Park
Castle Rock P & R	N/A	Metzler Park
Castle Rock P & R	N/A	Butterfield Park
Castle Rock P & R	N/A	Centennial Park

Table 7: Castle Rock Parks and Recreation rain gages.



The gages transmit their information to a base computer via telephone line. The computer compiles and displays the information on the base computer located at the Castle Rock Parks and Recreation Department.

### Weather Stations

Information measured by the weather stations in the project area includes temperature, temperature dew point, humidity, wind direction and wind speed and precipitation depth.

### Urban Drainage and Flood Control District

The UDFCD owns and maintains three weather stations within the project area. The table and figure below provides information on the weather stations.

Agency	Site ID	Site Name
UDFCD	COKC2	Castle Rock
UDFCD	HIGC2	Highlands Ranch
UDFCD	SAPC2	Parker

Table 8: Urban Drainage and Flood Control District weather stations.

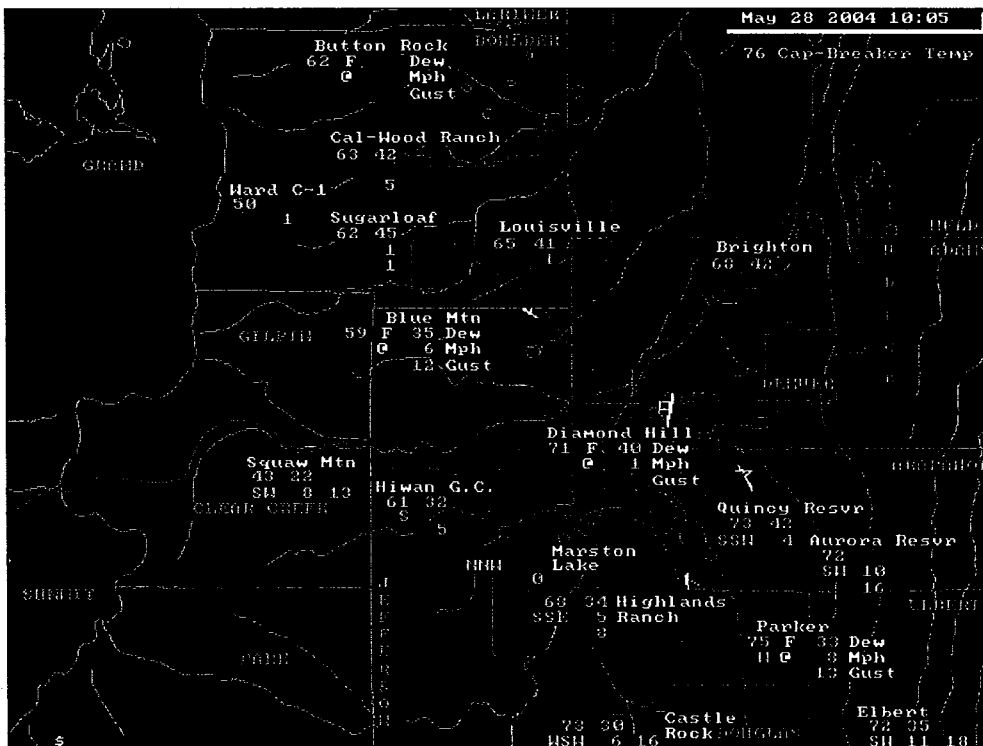


Figure 8: Urban Drainage and Flood Control District weather station network.

The weather stations are part of a large network of stations owned and maintained by the UDFCD that operate in the NWS ALERT format.

The weather stations transmit their information to a UDFCD base computer via VHF radio. The computer quickly compiles the information, displays the information and

publishes the information to the Internet. The gages are powered by 12-volt batteries, which are recharged using small solar panels attached to the top or sides of the gages.

### Colorado Department of Transportation

The Colorado Department of Transportation (CDOT) owns and maintains three weather stations within the project area. The table below provides information on the weather stations.

Agency	Site ID	Site Name
CDOT	CO001	Lone Tree (I-25)
CDOT	CO073	Surrey Ridge (I-25)
CDOT	CO075	Castle Pines (I-25)

Table 9: Colorado Department of Transportation weather stations.

The weather stations are part of a large network of stations owned and maintained by CDOT. The CDOT weather station network are composed of Roadway Information System (RWIS) stations that collect road weather information that is monitored and analyzed to detect and forecast environmental hazards such as icy road conditions, dense fog, and severe weather. This information is used to deploy road maintenance resources, issue general traveler advisories, and support location specific warnings to drivers using the CDOT website and variable message signs.

RWIS sites transmit information every 15 minutes using an open protocol architecture (TCP/IP) to a CDOT server that uploads the processed data for distribution on the Colorado State Traffic Operations Center (TOC) local area network. The information is displayed internally and published to the Internet.

### Citizens Weather Observer Program

The Citizen Weather Observer Program (CWOP) is a private-public partnership network of weather stations. There are two CWOP weather stations within the project area. The table below provides information on the weather stations.

Agency	Site ID	Site Name
CWOP	CW1793	Castle Rock (Skyview Weather)
CWOP	CW2023	Larkspur

Table 10: Citizen Weather Observer Program weather stations located in Douglas County.

The weather data gets is collected by a combination of the Internet and Internet-wireless combination. The data is distributed by the internet to a server which receives all the data and stores it in a centralized database. Every 15 minutes the server interrogates the database for data from the CWOP stations and publishes the information to the internet.

## Video Cameras

### Colorado Department of Transportation

CDOT owns and maintains a network of fixed position video cameras across the state of Colorado. The primary uses for the cameras are traffic surveillance, road conditions and weather detection. There are six video cameras located within Douglas County and are identified in the table below.

Agency	Site ID	Site Name
CDOT	CO757	Lone Tree (County Line & Quebec)
CDOT	CO761	Lone Tree (C470 & I 25)
CDOT	CO760	Parker (Lincoln Avenue & I 25)
CDOT	CO521008	Surrey Ridge
CDOT	CO759	Castle Rock
CDOT	CO9990	Monument Hill

Table 11: Colorado Department of Transportation video cameras located in Douglas County.

Panasonic's WV-CS854A cameras make up the CDOT network and offer such features as degree tilting, panning, and digital motion detection. Full motion video feeds are transferred by a combination of fiber optics, T1 telephone lines or by 10/100 BaseT Ethernet using TCP/IP to a CDOT server that processes and uploads data for distribution on the Colorado State TOC local area network. The information is displayed internally, published to the Internet and made available to local media. Currently only static images are available on the Internet.

### Weather Spotter Groups

#### Douglas County Amateur Radio Emergency Service

The Douglas County Amateur Radio Emergency Service (DCARES) is an organization of HAM radio operators who are trained in communications and the detection of severe weather and flooding events. Members of this group relay the observance of severe weather and flooding in Douglas County to Douglas County Sheriff Dispatch, Skyview Weather, and the NWS-BOU. This information is used by the NWS-BOU to prompt severe weather warnings and flood warnings.

### Weather Detection Resources - Recommendations

The following recommendations, if implemented should provide assistance with regard to meteorological, hydrological detection within Douglas County.

- 4-1 Re-evaluate the recommendations made in the 1993 document 'Flash Flood Warning Planning for Douglas County Meteorological and Hydrological Support' to expand the existing Douglas County FDN consisting of automated rain gages, stream gages, weather stations, and base stations to display the information. Prior

recommendations should be re-evaluated due to the implementation of some of the recommended gages, possible changes in watercourse and basin hydrological characteristics, and population growth.

- 4-2 Determine stream gage information that is consistent with NWS E-19 procedures for the stream gages owned and maintained by UDFCD (Table 3) and USGS (Table 5). The information should include elevations of critical points in the vicinity of the gage site, estimates of stage heights that could result in flood damage in vicinity of the gage site, and a determination of historical high water marks and other critical flood information.
- 4-3 Develop Flood Warning Templates (Figure 6) which are currently used by UDFCD to provide real-time assessment of streamflow, using the information obtained in recommendation 4-2.
- 4-4 Determine the feasibility and cost associated with incorporating the FDN (five rain gages and one weather station), maintained by the Castle Rock Parks and Recreation Department, into the UDFCD's real time FDN. Currently the Castle Rock FDN data is available in real-time through a dial-up connection, however only one location is accessible at a given time. The information is mainly used for post storm analysis, not real-time detection.
- 4-5 Develop Flood Threat Recognition (FTR) criteria (rain gage rainfall depth/time and stream gage criteria water discharge, water stage height), which if reached or exceeded would prompt information dissemination to key personnel.
- 4-6 Develop a methodology, through existing technology used by UDFCD, to disseminate information prompted by criteria developed in recommendation 4-5 to key Douglas County personnel.

## **5.0 Communication Resources**

Inter-department/agency communication, within the project area, is accomplished in a few different ways by utilizing the existing communication infrastructure. The main forms of communication include telephone, both landline and wireless (Nextel cell and two-way technology), and two-way radio (800 MHz and VHF). Communication to outside departments/agencies is carried out by various means and include telephone, both landline and wireless, both landline and wireless (Nextel cell and two-way technology), and two-way radio (800 MHz and VHF). The following are the communication resources within the three main population areas (unincorporated Douglas County, Castle Rock and Parker) located in the project area.

### **Douglas County**

Douglas County and local jurisdictions utilize the Cooperative Communications Network of Colorado (CCNC) 800 MHz radio system. This 800 MHz system incorporates digital trunking technology that permits a large number of users to share a relatively small number of communication paths. This sharing of communication paths are managed automatically by a computer. This system allows users immediate access to a channel

during emergencies to help ensure that calls get through and assists with department/agency and multi-jurisdictional coordination.

The Douglas DCSCC serves as the backbone for county emergency response agencies under the United Fire Dispatch Authority (UFDA). The DCSCC contains 31 dispatch positions and provides coverage for law, fire and medical within unincorporated Douglas County. The DCSCC also provides dispatch services to South Metro Fire Department, Castle Rock Fire and Rescue, Parker Fire Department, Jackson 105 Fire Department, Larkspur Fire Department, and West Douglas Fire Department. As a multi-jurisdictional agency, they also provide fire and medical services to other counties and law enforcement agencies.

All UFDA member stations are notified of their calls by a system called First In. When the DCSCC receives either an EMS or fire call, the fire station is alerted via computer, which sets off an audible tone in the station and then a voice alert which announces the type of call and the apparatus needed. This is followed by the dispatcher giving additional information. This system is designed to assist dispatchers and fire personnel by providing the most efficient service by cutting down response time.

The DCSCC uses the Zetron system, which is capable of paging individual units, and entire stations or departments. This helps in getting assistance to people quicker and more efficiently. Windows CAD (Computer Aided Dispatch) system is also utilized which allows tasks to be accomplished with much more ease than in the past. The CAD program can be switched from showing all types of calls, to specified areas such as Sheriff or fire department calls. There are five status screens that can be utilized for specific areas. They include unit status for all on-duty officers, status of active fire units, and the hospital status screen, which shows any divert status for the hospitals that are used by the fire departments for whom DCSCC dispatches for. The station status shows available fire units and to which station they are assigned. The on-call status shows all the on-call units for after hour access and the administrative unit status shows which administrative persons are on duty at the office and those who may be assigned to a major incident.

The DCSCC utilize many outside resources in order to provide the best service possible. Those resources are listed below:

- Colorado Crime Information Center (CCIC) computer and National Crime Information Center (NCIC) computer systems, which provides drivers license, license plate, criminal information, stolen vehicle/article information etc.
- EMSsystem computer is a system, which aids the fire departments in keeping up with current hospital statuses. Example: Sky Ridge Medical cannot accept patients with head injuries due to equipment failure.
- TREX computer is a computer that aids in "navigating" the current conditions of I-25, which can become a problem for an ambulance trying to get a critical patient to a hospital.
- Poison Control is used for assistance when toxic ingestion calls are received.

- AT&T Language Line is utilized so that proper information can be obtained and proper assistance can be provided to citizens that do not speak English.
- TDD/TTY telecommunications devices for the deaf so that communication can occur with the hearing impaired community.
- Emergency Preparedness Network (EPN) system, which allows the notification of a large group of citizens by landline telephone of a dangerous situation, including flooding.
- EAS to alert the public of severe weather and flooding.

All DCSCC dispatchers are trained, or are in the process of being trained, in Emergency Medical Dispatch (EMD). This is a state-recognized program that includes 24 hours of classroom training. This training and instruction teaches dispatchers to ask correct questions and to give pre-arrival instructions to the caller on scene. Pre-arrival instructions can be something as simple as what to do for a minor cut, to CPR instructions for a person who may be having a heart attack. As information is gathered, the responding fire/rescue units are updated with patient status and condition. The caller will be kept on the phone until rescuers arrive on scene.

The Douglas County Sheriff's Office owns and operates a Mobile Command Post (MCP). This vehicle is capable of performing limited dispatch functions and providing space and materials to the command structure. This vehicle is available for call-out anytime and may be requested by any emergency services agency in Douglas County. The MCP will be staffed with a dispatcher either upon arrival or shortly thereafter. The MCP is to be used to support the County ICS.

Douglas County has a technology called EPN in place which is a similar technology to reverse 911. EPN is a geographically-based telephone calling system that gives public safety agencies the ability to quickly communicate with specific groups of residents or residents within certain geographic areas. The system programs telephone numbers to be automatically called to deliver pre-recorded messages. The system can be remotely activated and can be used for notification of evacuations initiated by flooding events.

A Public Alert & Warning system that uses Comcast cable services, can provide an alert and warning in case of a disaster. The system offers specific messages of warning and protective actions that override programming to Comcast viewers in Douglas County. The system is regularly tested early in the morning on the first Thursday of each month.

Douglas County also participates in the nationwide EAS, which requires local radio and TV stations to broadcast emergency warnings.

All Douglas County facilities, deemed Critical facilities, have NOAA Weather Radios in place to receive National Weather Service Advisories, Watches, Warnings, and Forecasts.

## **Town of Castle Rock**

The Castle Rock Police Department operates a 24 hour communications center and serves as PSAP for the Town of Castle Rock. Communications modes relied upon include 800 MHz and VHF two-way radio communications, cellular phones (Nextel two-way), Motorola alphanumeric pagers, computer Records Management Systems (RMS), CAD response programming, and mobile data systems. Castle Rock fire and rescue department is dispatched by the DCSCC under the UFDA.

## **Town of Parker**

The Parker Police Department operates a 24 hour communications center and serves as the PSAP for Parker. Communication modes relied upon include 800 MHz and VHF two-way radio communications, cellular phones (Nextel Two-way), and Motorola alphanumeric pagers.

The Parker communications center utilizes enhanced 9-1-1 technology which enables a dispatcher to receive data showing both the phone number and a location of a person making a phone call by cell phone.

A Ford Excursion mobile communication command post is available to provide a fixed point of communication on the scene of an incident.

## **6.0 Incident Command Structure and Emergency Operation Center Operations**

Emergency Operation Centers (EOC) and the ICS utilized within the three main population areas (Unincorporated Douglas County, Castle Rock and Parker) located in the project area are described below.

### **Douglas County**

The Douglas County EOC is located in a secured facilities maintained by the Douglas County Sheriff's Office, located at the Robert A. Christensen Justice Center, 4000 Justice Way, Castle Rock, Colorado.

The EOC can be activated by authorized individuals within the County Emergency Services Division, Douglas County Sheriff's Office, and Douglas County Government Administration or based on recommendations by the Douglas County Multi-Agency Coordination (MAC) Group. The staffing of the EOC is dependent on magnitude and location of the event but will typically include MAC group members and the Douglas County Incident Management Team (IMT).

The Douglas County MAC group consists of principals from organizations and agencies with direct incident management responsibility. This group consists of the Sheriff, Douglas County Manager, Douglas County Commissioners, Douglas County Public

Works Operations Manager and Fire Department representatives located in Douglas County. The MAC group has the following roles and responsibilities:

1. Ensure that each agency involved in the incident management activities is provided appropriate resource status information.
2. Establish priorities between incidents and/or Area Commands in concert with the Incident Command.
3. Anticipate and identify future resource requirements.
4. Coordinate and resolve policy issues arising from the incident.
5. Provide strategic coordination as needed.

The Douglas County IMT has been established as an interagency cooperation group to provide a committed resource, and manage safe and efficient incident operation within Douglas County. The IMT provides incident management support to critical emergencies that are beyond the scope of a single agency. The IMT is composed of the

On-Call Emergency Manager and an Incident Commander (IC) that is assigned by On-Call Emergency Manager.

The EOC provides a physical location for collection and coordination of information and resources to support jurisdictional and multi-jurisdictional incident management activities as well as communications, resource dispatching and tracking. The communication infrastructure is currently in place that allows for an orderly jurisdictional and multi-jurisdictional communication flow. The EOC is clearly distinct from on-scene Incident Command Posts (ICP) where operational decisions are made.

Within the EOC the IMT has the following roles and responsibilities:

1. Gather incident information from various sources.
2. Develop an Incident Action Plan (IAP) that includes objectives, safety messages, organizational assignments and an Incident Radio Communications Plan (IRCP).
3. Organize information in the form of Situation Reports (SITREPs).

The following are activities and functions of the County EOC:

- Allow organization representatives to communicate and interact face-to-face.
- Contracts with or procures resources.
- Compiles information from all the different ICP's.
- Disseminates damage assessment information and reports to the State.
- Make executive policy decisions and enact special resolutions or ordinances.



- Appropriate and budget finances.
- Prepare reports, news releases, and maps.
- Complete paperwork for processing financial revenue and expenditure claims.
- Issues disaster declarations and provides information to the general public.

A communications link between the individual ICP's and the EOC will be established based on the situation and need. Each IC in the field should have a direct link to the County EOC.

The Logistics Section Chief is generally responsible for ensuring that an IRCP is completed. The communications plan is based on the needs of the incident and continually reviewed to be sure that all the needs are being met. The IRCP allocates radio frequencies to emergency responders in an attempt to address all the communication needs required. The following basic guidelines are adhered to in the IRCP:

- Set up a command channel for the IC and staff. No operational functions should take place on this channel.
- Operations should be conducted on it's own channel, free from interference from command, dispatch, and other non-essential functions.
- Law enforcement is to have its own coordination channel, especially if it is multi-jurisdictional. The National Law Enforcement Channel (NLEC) allows all the law enforcement representatives from the state, surrounding counties, and municipalities to communicate with each other for operational purposes at short range.
- Depending on the size of the ICS, Planning and Logistics may need their own frequencies to coordinate with each other.
- The EOC and ICP's will need a separate channel for each command post. This should not be the same channel that the command staff is utilizing.

### **Town of Castle Rock, Colorado**

The EOC is located at Castle Rock fire and rescue department headquarters at 300 North Perry Street. The EOC is the coordination center for all emergencies too large to be handled from the field, especially when more than one ICP is in operation. It allows emergencies to be better managed that require multi-agency response by providing interagency coordination and executive decision-making for managing disaster response and recovery. It is the place where elected leaders convene with staff to determine which path is most appropriate to guide the town's population through the crisis so as to reduce the personal and economic impact on the town.

Town emergency responders are the first to be notified and respond to an emergency. Emergency responders receive reports of damage or injury and respond with the appropriate resources. As resources begin to deplete and the situation is recognized to be one which will extend beyond the resources of on-site personnel, or an incident that will require the involvement of multiple town resources, the IC may declare a Situation Status 3 (SitStat 3). At this time, the Town Manager will be notified and all Department Directors involved in the incident complete situation reports and forward it to the Town Manager immediately. At this time, the Castle Rock police department and the Castle Rock fire and rescue department activate their respective Operations Control Dispatch (OCD) and all other Department Directors not currently involved are notified of the situation.

Within two hours of a SitStat 3 being declared, the Town Manager meets with the IC and the Chiefs of the Police and fire and rescue departments to determine the need to expand operations. At that time, should the decision be made to expand operations, the Emergency Executive Board confers and determines if the need exists for the Town

EOC to be activated or continue operations utilizing field command posts established by the IC under the ICS. The Emergency Executive Board consists of the Mayor, the Council person assigned to the Public Safety Commission, Town Manager, Town Attorney, Fire Chief, Police Chief, Town Clerk, Public Works Director, and Finance Director, or their appointed representatives. The Emergency Executive Board is the emergency policy and decision-making group responsible for representing Town Government, coordinating support for emergency response efforts, and overseeing emergency response and recovery efforts town-wide. This group is a support and coordination group and will not have any authority to override field operations or the decisions of the IC.

A number designation is used to convey the severity or magnitude of an event among Castle Rock emergency personnel.

The following Situation Status (SitStat) Designator (Modes), adopted by the Colorado Incident Command System Board and the Colorado State Fire Chiefs Association are used in Castle Rock:

SitStat	Incident magnitude
1	Single, routine incident that requires a normal response by Town emergency response agency.
2	Single incident requiring mutual aid from multiple local emergency response agencies and some Town resources.
3	Multiple incidents or a single catastrophic incident requiring mobilization of most Town resources and all emergency response agencies.
4	A disaster which exceeds Town and regional resources requiring considerable state and federal assistance.

Table 12: Castle Rock Situation Status Modes and associated incident magnitude.

The departments that make up Castle Rock government have been assigned to fill positions under the ICS. When the EOC is activated, personnel called to assist with an emergency should report to the appropriate section after check-in.

<b>Department/Division</b>	<b>Assignment</b>
Finance Department	Finance
Data Processing Division	Logistics
Planning and Code Enforcement Department	Planning Operations
Town Clerk/Personnel	Logistics
Douglas County Coroner's Office	Operations
Town Council	Emergency Executive Board
Town Manager's Office	Emergency Executive Board Logistics
Parks and Recreation Department	Logistics
Town Attorney	Emergency Executive Board Finance
Utilities Department	Operations
Citizen Outreach Coordinator	Public Information
Public Works/Engineering Department	Planning Operations
Fleet Maintenance Division	Logistics
Fire and Rescue Department	Emergency Executive Board Operations Planning (advisory only) Logistics (advisory only) Finance (advisory only)
Police Department	Emergency Executive Board Operations

Table 13: Castle Rock Emergency Operations Center staffing.

The Emergency Executive Board appoints an Emergency Management Coordinator (EMC) who will oversee the operations of the EOC. The specific roles and responsibilities of the EMC include:

1. Serve as advisor to the Emergency Executive Board on implementation of the Town EOP and ICS framework.
2. Activate the Town EOC at the discretion of the Emergency Executive Board and coordinate its operation.
3. Assist with the coordination between the EOC personnel and support agencies.
4. Keep the Douglas County Board of Commissioners apprised of the overall readiness of the Town to respond to all types of emergencies.

## **Town of Parker, Colorado**

The Parker EOC is located at a Parker Fire Protection District Facility. In the event the emergency exceeds the resources of the Parker Fire Department, and it lies mostly within Parker city limits, the Town of Parker EOC shall be activated. When the scope of the incident becomes county wide or larger, Town agencies may be requested to become part of the County MAC and request activation of the County EOC. The resources required and the activation of the Town EOC and/or County EOC will depend on the needs of the specific incident or incidents as determined by the IC.

The Parker Town Administrator and elected town government leaders are the primary decision-makers with regard to selecting the Lead Agency (LA) and activating the MAC group for emergencies that occur within the limits of the Town of Parker. The MAC consists of the Parker Police Chief, Parker Public Works Director, and the Parker Fire Chief.

The various modes that are used for determining the levels of flood related emergencies within the Town of Parker are included below.

- Mode 1. Less than 100-year storm with flooding of some streets requiring temporary closing and rerouting of traffic. Signals may be out and some limited electrical outages.
- Mode 2. Less than 100-year storm with flooding of some streets requiring temporary closing and rerouting of traffic. Sandbagging of some buildings and possible evacuation of people with impediments. Mudslides may close some roads and access to property.
- Mode 3. Greater than 100-year storm causing closure of major roads and rerouting or delaying of traffic. Mudslides will close some roads and access to property. Storm is of short duration.
- Mode 4. Same as "Mode 3" except duration of storm is of long duration affecting wide areas.

The departments that make up the Town of Parker government have been assigned to fill positions under the ICS. When the EOC is activated, personnel are called to the EOC by the Parker Fire Chief (EOC Manager) to assist with the emergency. The following are the main roles and responsibilities of the EOC staff:

- EOC Manager. In charge of overall operation and direction of the EOC including establishing the organizational framework needed to manage the emergency. Includes facility setup and ongoing command and general staff functions until and if positions are filled. Implement EOC Manager checklist.
- Operations Section Chief. The operations directed from the EOC include fire suppression field operations, emergency medical services treatment and transport, hazardous materials operations, warning support, search support,

damage assessment support, technical rescue operations. Implement EOC Operations Manager Chief checklist.

- **Planning Section Chief:** Responsible for producing and maintaining the IAP as well as ordering, assignment and accounting for all personnel status. Processes information on the current and projected situation. Maintains all the EOC/Incident related documentation. Implement EOC Planning Section Chief checklist.
- **Finance Section Chief:** Responsible for accounting for all EOC emergency incident costs and the administration of related outside procurement contracts. Implement EOC Finance Section Chief checklist.
- **Public Information Officer:** The central point for dissemination of information to the news media and other agencies and organizations. Implement EOC Public Information Officer checklist.
- **Communications Unit.** Responsible for communications links between affected organizations and communities as needed including the link between incident command posts and the operational group at the EOC. May also be required to set up area dispatch system from where local units would be dispatched. Implement EOC Communications Unit checklist.
- **Logistics Chief:** Responsible for providing for the needs of the responders to the incident and to the overhead support team including food, facilities, communications and ground transportation if needed. Implement EOC Logistics Chief checklist.

The following are the Parker MAC group functions and responsibilities:

- Decision-making, including establishing priorities for resource allocation and developing strategies for utilizing response resources from multiple agencies.
- Intergovernmental coordination and formal requests for State and Federal assistance.
- Disaster analysis, including policy formulation and the coordination of joint response efforts coordination of disaster recovery activities, including decisions about reentry into, disaster areas reconstruction of damaged services and facilities, and identification of long-term hazard mitigation issues and plans.

#### **Incident Command Structure and Emergency Operation Center Operations - Recommendations**

6-1 Develop levels or preparedness (Modes) based on potential flood depths and/or time until potential flooding using the information obtained in recommendations 3-5 and 4-5. Develop actions for departments/agencies to perform with regard to flood response for each level of preparedness. Incorporate this information into the Douglas County, Castle Rock and Parker EOP's.

## **7.0 Evacuation Procedures and Policies**

The Douglas County Sheriff's Department has the responsibility to coordinate the evacuation of the population at risk in Douglas County. Evacuation notification is accomplished through the media (EAS), EPN, door-to-door notification, and mobile public address systems.

The Douglas County Public Works Department coordinates evacuation related transportation issues through the Douglas County School District. The Douglas County School District provides buses and drivers for the transportation of evacuees, supplies, equipment and other resources.

The County EOC IMT will establish staging areas for evacuees waiting to be transported to shelters as well as transportation safe routes for the buses to utilize.

Shelter operations in Douglas County are provided and managed by the American Red Cross. The American Red Cross holds a legal contract with the Douglas County School District RE-1 to utilize their buildings as shelters. Any Douglas County School District school building in Douglas County has the potential to be utilized as a shelter. No other buildings in Douglas County have been legally designated as shelters.

### **Evacuation Procedures and Policies - Recommendations**

7-1 Develop evacuation procedures and policies based on the levels of preparedness developed in recommendation 6-1. Develop specific actions for departments/agencies to perform with regard to evacuations. Incorporate this information into the Douglas County, Castle Rock and Parker EOP's.

## **8.0 Flood Orientation**

HDR conducted a flood orientation for project area agencies and departments. Existing flood detection, flood prediction and flood warning resources applicable to Douglas County were showcased in the orientation. The NWSFO-BOU, Skyview Weather and the UDFCD F2P2 contractor provided the weather prediction and warning information. A representative from all three of these agencies were present to interpret the information and answer any questions that were posed. The flood orientation was based on a weather event that occurred on June 16, 1965 in Douglas County, which resulted in catastrophic flooding in Parker, Larkspur, Castle Rock, Sedalia, and Louviers.

The Flood Orientation agenda that was followed is depicted below:

### **Flood Warning Assessment for Cherry Creek and Plum Creek in Douglas County Colorado**

#### **Flood Orientation - Agenda**

Welcome: Garth Englund-Douglas County/Bryan Rappolt - HDR

Introductions by flood orientation attendees

Project overview and goals: Bryan Rappolt - HDR

Discussion by Jamie Moore, Douglas County Emergency Services Coordinator and Robert Glancy, NWSFO-BOU Warning Coordination Meteorologist. Overview of StormReady and the steps that were taken for Douglas County to be designated a StormReady County.

Overview of some historical flooding events that occurred along the Colorado Front Range: June 1935 and June 16, 1965: John Henz - HDR

Douglas County potential flood hazard areas: Bryan Rappolt - HDR

Overview by Kevin Stewart, Urban Drainage and Flood Control District Floodplain Manager, of the Urban Drainage and Flood Control District's services and responsibilities within Douglas County

Overview of forecast and detection information that could be utilized if a significant flooding and severe weather event; similar to what occurred on June 16, 1965 occurred today. Discussion and presentation of the prediction, detection and warning services currently provided by NWS-Boulder, Skyview Weather and Urban Drainage and Flood Control District (UDFCD).

### **Weather Scenario**

#### **1. Morning: 0600 to 1000**

**NWS Hazardous Weather Outlook (0600)**  
**Skyview Morning Weather Forecast (0730)**  
**UDFCD F2P2 Heavy Precipitation Outlook (0945)**

#### **2. Late Morning: 1000 to 1130**

**NWS Hazardous Weather Outlook (1010)**  
**UDFCD F2P2 Quantitative Precipitation Forecast (QPF) (1015)**  
**NWS Flash Flood Watch – Denver Metro Area, including Douglas County (1020)**  
**Skyview Request Douglas ARES ham radio spotter activation (1022)**  
**UDFCD F2P2 Message 2 (1025)**  
**Skyview Forecast Update (1030)**

**3. Mid Day: 1130 to 1300**

**Skyview Forecast Update (Verbal, Text Message) – Southwest Douglas County and Hayman area (1145)**

**NWS Flash Flood Warning – Hayman area (1245)**

**Skyview Forecast Update/NWS Flash Flood Warning (Verbal, Text Message) – Hayman area (1247)**

**UDFCD F2P2 StormTrak #1 (1300)**

**4. Early Afternoon: 1300 to 1430**

**Skyview Forecast Update (Verbal, Text Message) – Hayman area and Southwest Douglas County (1305)**

**UDFCD F2P2 Message 1 Red Flag – Northwest Douglas County (1310)**

**UDFCD F2P2 StormTrak # 2 (1400)**

**Skyview/NWS Douglas Ham Radio Spotters report developing wall cloud (1402)**

**NWS Severe Thunderstorm Warning – Northwest/Central Douglas County (1405)**

**UDFCD F2P2 Message Update (1405)**

**UDFCD F2P2 Message 1 Red Flag – Northern Douglas County (1412)**

**NWS Tornado Warning – Eastern Douglas County (1415)**

**Skyview/NWS Douglas Ham Radio Spotters report tornado (1418)**

**NWS Flash Flood Warning – Central Douglas County (1425)**

**Skyview Forecast Update/NWS Flash Flood Warning (Verbal, Text Message) (1427)**

**UDFCD F2P2 Message 3 (1427)**

**5. Mid to Late Afternoon: 1430 to 1530**

**NWS Tornado Warning Update (1435)**

**UDFCD StormTrak # 3 (1500)**

**Skyview/NWS Douglas Ham Radio Spotters report tornado has dissipated (1511)**

**NWS Flash Flood Warning – Northeast Douglas County (1515)**

**UDFCD F2P2 Message 3 (1518)**

**Skyview Forecast Update/NWS Flash Flood Warning (Verbal, Text Message) (1518)**

**NWS Flash Flood Statement – Northeast Douglas County (1530)**

Review of the services and information provided in the flood orientation.

Open Discussion



## **Flood Orientation - Recommendations**

8-1 Host a flood orientation on an annual basis to assist in flood awareness and make participants aware of any new flood detection, flood prediction and flood warning information that may be available in Douglas County.

## **9.0 Potential Flood Hazard Areas**

Potential flood hazard areas within the project area were identified using existing hydrological/hydraulic information that was provided by the Client that included the following:

- FEMA Flood Insurance Study – Douglas County Colorado – 1996.
- FEMA Flood Insurance Rate Maps – Cherry Creek, West Cherry Creek, Plum Creek, West Plum Creek and East Plum Creek Watersheds – 1996.
- URS/UDFCD Flood Hazard Area Delineation – Cherry Creek Corridor – Reservoir to Scott Road – 2003.
- WRC/UDFCD Plum Creek Watershed Outfall Systems Planning Preliminary Design Report – 2003.
- Douglas County Bridge Inspection Reports, Volumes I & II – 1998.
- Nolte Engineering/Henz Meteorological Services Flash Flood Warning Planning for Douglas County Meteorological and Hydrological Support – 1993.
- Castle Rock Colorado Storm Water Master Plan – 2004.
- Verbal Information from interviewed agencies/departments – 2004.

Potential flood hazard locations were identified using the information above and then site visits to these locations were performed by a HDR hydrologist/hydraulic engineer and a HDR meteorologist. These locations included bridges and culverts that pass flows on the watercourses identified above. Digital photographs were taken of the sites and visual hydrological and hydraulic observations were made and noted. Bridges owned and maintained by Douglas County were included in the Douglas County Bridge Inspection Reports. Contained within these inspection reports, produced by LONCO Inc, (LONCO) are channel cross section calculations at each bridge location. The cross sections yielded information such as observed high water levels, estimated manning water flow velocity (fps) at the high water level, travel surface level of the bridge, and potential scour depth for bridges that had piers associated with them.

Earthen dams located tributaries that flow into Cherry Creek may pose a potential flood hazard if the dams are overtopped or collapse due to high water flows. However assessments were not performed on the dams as it was not in the scope of the project.

Moving water, at differing depths, pose a threat to life and property. The charts below were developed by the United States Bureau of Reclamation (USBR) in a document titled 'Downstream Hazard Classification Guidelines'. The graphs depict danger levels to humans both as pedestrians and as an occupant in an automobile, due to differing depths and velocities of water.

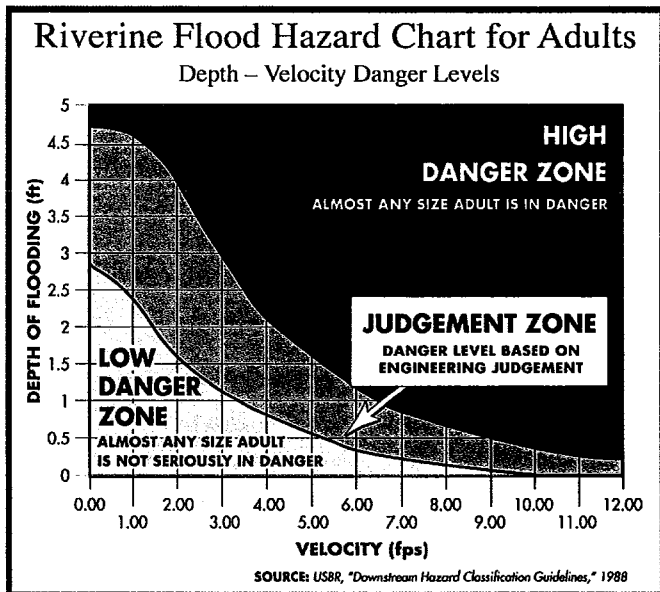


Figure 9: United States Bureau of Reclamation flood hazard chart for adults.

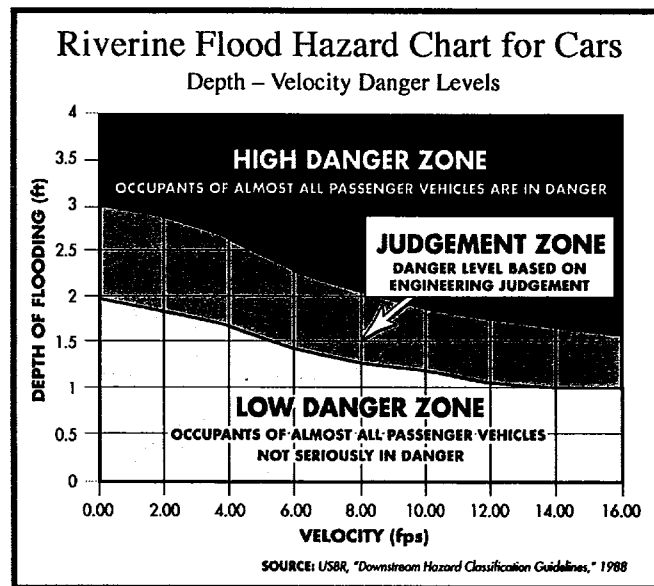


Figure 10: United States Bureau of Reclamation flood hazard chart for automobiles.

Flood Hazard Danger Index Value	Color Code	Pedestrians	Automobiles
High	Orange	Almost any size adult is in danger from flood water.	Occupants of any size passenger vehicle are in danger from flood water.
Moderate	Black	Danger level is based upon engineering judgment.	Danger level is based upon engineering judgment.
Possible	Black	Additional information needed to assess an FHDI value.	Additional information needed to assess an FHDI value.
Low or None	White	Almost any size adult is not seriously threatened by flood water.	Occupants of almost any size passenger vehicle are not seriously in danger from flood water.

Table 14: Flood Hazard Danger Index.

The information from the graphs and table above, was used in concert with the information obtained in the evaluations and site surveys to determine the Flood Hazard Danger Index (FHDI) for each location. Each location was assigned a value and a color from the FHDI found in table 14 due to the depth and velocity of moving water that overtops the bridge or culvert with a flow that has a 100-year or lower recurrence interval associated with it. There is no danger if overtopping does not occur with a flow with a

100-year recurrence interval. The colors depicted in Table 14 were used to identify the FHD value for each location, as apposed to the colors depicted in Figures 9 and 10, based on a request by the client. Judgement was replaced by moderate to reduce possible confusion.

Riverbed scour at bridges is a known widespread problem throughout the United States. Scour at bridges has caused bridges to fail suddenly without warning. Many bridge failures throughout the United States have been attributed to this scour problem. It has been determined by the Federal Highway Association (FHWA) that more bridges fail due to scour than by earthquakes, wind, structural, corrosive, accidental, and construction-related causes.

Inspections were performed in 1998 by LONCO on bridges owned and maintained by Douglas County. Potential scour depths (feet) were calculated in the inspection reports on some bridges. LONCO calculated potential scour depths using the methodology outlined in the FHWA Hydraulic Engineering Circular 18 (HEC 18), 'Evaluating Scour at Bridges'. The methodology that was used assumed a flow that overtops the bridge or a flow associated with a 100-year recurrence interval. If scour depths that were calculated reached or exceeded CDOT developed standards for scour depths, the bridge was identified as a Scour Critical. Scour Critical means that the bridge foundations will be unstable and may fail if the calculated scour were to occur. Figure 11 shows an example of scouring of a bridge due to high flows.

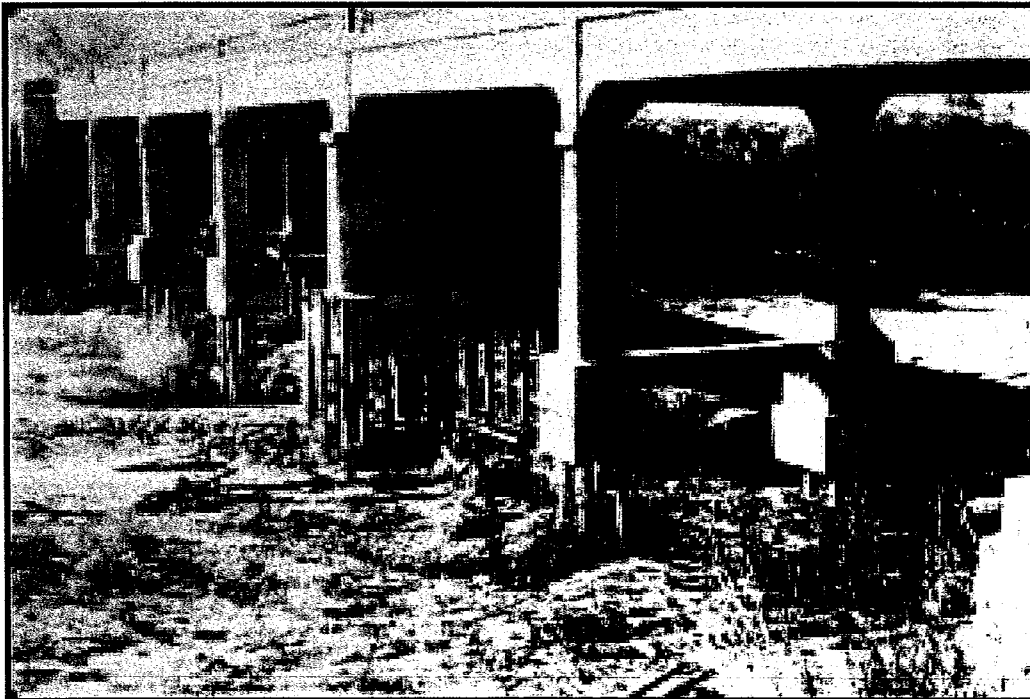


Figure 11: Bridge scouring due to high flows. Note: Bridge is not located in Douglas County.

The following are the locations that were evaluated and assessed a FHD value and identified as scour critical or non-scour critical:

Location	Structure Type	Flood Hazard Danger Index - Pedestrians	Flood Hazard Danger Index - Automobiles	Scour Critical
County Road 82 over West Cherry Creek	Bridge	Unknown	Unknown	Unknown
County Road 80 over West Cherry Creek	Bridge	Unknown	Unknown	Unknown
County Road 74 at West Cherry Creek	Culvert	Unknown	Unknown	Unknown
State Highway 83 over West Cherry Creek	Bridge	Unknown	Unknown	Unknown
State Highway 83 over Antelope Creek	Bridge	Unknown	Unknown	Unknown
State Highway 83 over Cherry Creek	Bridge	Unknown	Unknown	Unknown
State Highway 86 over Cherry Creek	Bridge	Unknown	Unknown	Unknown
Castle Oak Drive over Cherry Creek	Bridge	Unknown	Unknown	Unknown
County Road 39 (Scott Rd) over Cherry Creek	Bridge	Judgement	Unknown	Unknown
County Road 14 (Stroh Rd) over Cherry Creek	Bridge	Unknown	Unknown	Unknown
Mainstreet over Cherry Creek	Bridge	Unknown	Unknown	Unknown
Cottonwood Drive over Cherry Creek	Bridge	Unknown	Unknown	Unknown
County Road 105 over East Plum Creek	Bridge	Unknown	Unknown	Unknown
County Road 53 over East Plum Creek	Bridge	Unknown	Judgement	Unknown
County Road 56 over East Plum Creek	Bridge	Unknown	Judgement	Unknown
Red Rock Drive over West Plum Creek	Culvert	Unknown	Unknown	Unknown
County Road 58A over West Plum Creek	Bridge	Unknown	Unknown	Unknown
Perry Park Boulevard Over West Plum Creek	Bridge	Unknown	Unknown	Unknown
Dakan Road over West Plum Creek	Bridge	Unknown	Unknown	Unknown
Douglas Lane over East Plum Creek	Bridge	Unknown	Judgement	Unknown
Jackson Creek Road over West Plum Creek	Bridge	Unknown	Unknown	Unknown
Pine Cliff Road over Plum Creek	Bridge	Unknown	Unknown	Unknown
County Road 107 over Plum Creek	Bridge	Unknown	Unknown	Unknown
Rio Grande Ave over Plum Creek	Bridge (New)	Unknown	Unknown	Unknown

County Road 16 over Plum Creek	Bridge	
Main Street over Plum Creek	Bridge	
Titan Road over Plum Creek	Bridge	

Table 15: Flood Hazard Danger Index and potential scour for all the locations identified as potential flood hazard areas. All index values based on a flow with a 100-year or lower recurrence interval associated with it.

Some of the locations did not have sufficient existing hydraulic/hydrologic information to assign it a FHDI value and were assigned a value of Unknown. Most of these locations were outside of the FEMA detailed study areas and no other hydraulic/hydrologic studies have been performed for these areas, therefore no cross-sectional information was available to determine flow depths and flow velocities. Additional information will needed to determine a FHDI value for these locations, but are considered to be possible hazard locations due to visual inspection. A map (Insert 1 – Map) depicting the locations of the FHDI sites found in Table 15, can be found in the insert in the back of this report. The locations that were assessed a FHDI value of low (green) are not identified on the map. Only high (red), moderate (orange) and possible (black) hazard areas are identified on the map.

All the bridges that had potential scour depth calculations performed by LONCO were determined by them to be non-scour critical. It must be noted that these calculations were performed in 1998, approximately six years ago, and were very rough and did not include detailed information.

### Potential Flood Hazard Areas - Recommendations

- 9-1 Calculate potential bridge scour depths using an appropriate scour depth calculation methodology in concert with the information obtained in recommendation 3-4. Update the scour information in Table 15 based on a bridge being determined to be scour critical or non-scour critical.
- 9-2 Determine and update the FHDI for all the locations identified in Table 15 using information obtained in recommendations 3-4 and 9-1.
- 9-3 Determine flood risk and vulnerability to residents, business, county, local jurisdictional infrastructure and critical facilities in and around the East Plum Creek, Plum Creek, East Cherry Creek, West Cherry Creek and Cherry Creek watercourses. Utilize GIS data, such as census information and tax assessment information, along with information from recommendation 3-4 and Douglas County and Digital Flood Insurance Rate Maps (DIFIRMs) to determine the population at risk and potential dollar loss to structures. A format similar to what is produced using the National Oceanic and Atmospheric Administration (NOAA) and FEMA's Risk and Vulnerability Assessment Tool (RVAT) could be followed. Additional information on RVAT can be found in Section 3.0 in the Technical Addendum.
- 9-4 Implement video cameras (images transmitted by radio frequency) on bridges determined to have a high FHDI values obtained in recommendation 9-2.

9-5 Implement real-time bridge scour assessment and warning technology which is being used across portions of the United States, if any of the bridges in the project area are determined to be scour critical. Technology such as the Real-Time Bridge Scour Assessment and Warning Decision Support System (a white paper authored by Carlton Ho, 2001, on this technology can be found in Section 3.0 in the Technical Addendum) could be utilized.

## 10.0 Douglas County Weather Website

A website was produced by HDR that contains weather information that was determined to be relevant to Douglas County, Colorado. The website is called the Douglas County Weather Website. The purpose of the website is to have the ability to access weather information in a single location that is currently available from multiple websites. The first task included the production of a technical memorandum that contained Internet-based weather detection information, weather prediction information, weather warning information, and weather safety information that was evaluated and was determined to be relevant to Douglas County, Colorado.

The websites that were evaluated for content included the following:


1. National Weather Service Forecast Office in Boulder, Colorado
2. National Weather Service Forecast Office in Pueblo, Colorado
3. Skyview Weather and their sister company Anything Weather (AW).
4. Urban Drainage and Flood Control District (UDFCD)
5. United States Geological Survey (USGS)
6. Colorado Department of Transportation (CDOT)
7. MesoWest Cooperative National Meso-Weather Station Network.
8. United States Forest Service (USFS)
9. Automated Weather Source's School Weather Network (AWS)
10. Cooperative Program for Operational Meteorology Education and Training (COMET)

The type of weather information evaluated from the websites was associated with one of the four categories depicted below:

Weather Prediction Information  
Weather Advisory, Watch, and Warning Information  
Weather Detection Information  
Weather Safety and Preparedness information

A summary of the Internet-based information as it applies to these four categories can be found in Section 4.0 in the Technical Addendum. For each category there contains a depiction of the agency that produces the information, the Internet address (hyperlink) to the information and an example of the content.

The Internet based content in the Douglas County Weather Website is linked to other websites but is pulled into and is resident within a parent or orphan window associated with the Douglas County Weather Website. The main page of the web site (Figure 12) contains an interactive map of Douglas County that contains links to the detection information depicted in section 4.0 of this document. This map (Insert 2 – Map) can be found in the insert in the back of this report. The format of the website is shown in Figures 12, 13 and 14.


31 - [X]

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## Douglas County Colorado Weather Website

[Home](#)

Weather Prediction Information	Weather Detection Information	Weather Watches and Warnings	Weather Safety and Preparedness
Weather Prediction <input type="button" value="v"/>	Weather Detection <input type="button" value="v"/>	Weather Watches and Warnings <input type="button" value="v"/>	Weather Safety and Preparedness <input type="button" value="v"/>


Current Time: 12:05:58 PM Local

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### Douglas County Weather - Interactive Map

#### Douglas County Weather Detection Network






Dragging Your Mouse Over the Map will Display Available Information that is Viewable by a Left Mouse Click

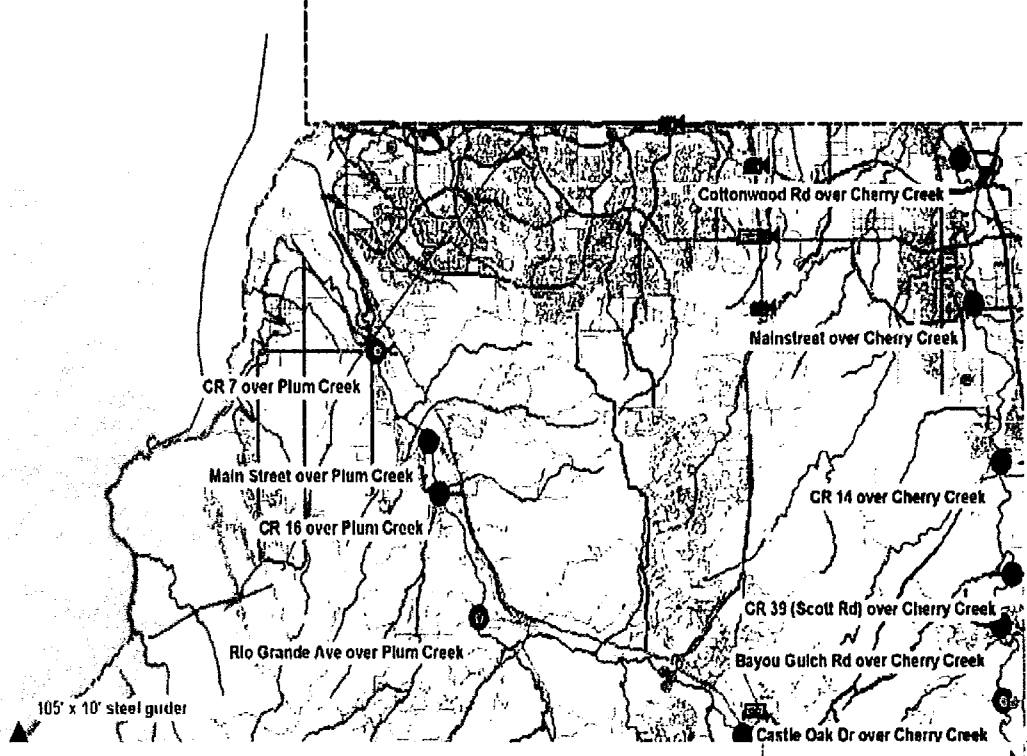


#### Legend

-  High Risk Structure
-  Bridge/Culvert
-  Stream
-  County

#### Road

-  Major Road
-  Interstate
-  Local Road
-  Highway
-  Trail



105' x 10' steel guider

Figure 12: Format of the Douglas County Weather Website main page (2 frames, banner and main).



## Douglas County Colorado Weather Website

Home

[Weather Prediction Information](#)  
Weather Prediction

[Weather Detection Information](#)  
Weather Detection

[Weather Watches and Warnings](#)  
Weather Watches and Warnings

[Weather Safety and Preparedness](#)  
Weather Safety and Preparedness

Current Time: 12:14:41 PM Local

Advisory, Watch, and Warning Information - National Weather Service Boulder (BOU) and Pueblo (PUB)

NWS Interactive Map - Watches, Warnings and Advisories

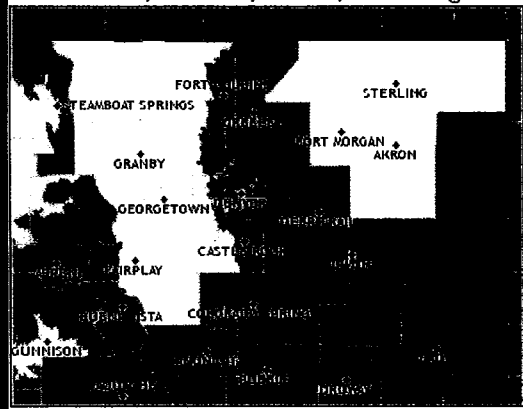
Text Based - Watches, Warnings and Advisories

Red Flag Warning/Fire Weather Watch (BOU)

Red Flag Warning/Fire Weather Watch (PUB)

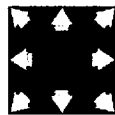
### Douglas County Weather - Advisory, Watch and Warning Information

Click on the map below, specifically Douglas County for the latest, Advisories, Watches, and Warnings



Current Advisories, Watches and Warnings Currently in affect.

Flash Flood Warning		Lake Wind Advisory	
Winter Storm Warning		Wind Advisory	
High Wind Warning		Urban And Small Stream Flood Advisory	
Flood Warning		Flood Statement	
Severe Thunderstorm Watch		Special Weather Statement	
Winter Storm Watch		Hazardous Weather Outlook	
Flood Watch		Gale Warning	
Snow Advisory		Small Craft Advisory	
Winter Weather Statement		Short Term Forecast	
Winter Weather Advisory			



Map and information courtesy of the National Weather Service.

Figure 13: Format of the remainder of the pages within the Douglas County Weather Website (3 frames, banner, column and main).

The website consists of multi-frame windows but does not exceed three frames in any window. JavaScript was used to display the detection information that is accessible on the interactive map, in orphan windows. An example of this technology is depicted in Figure 14 below.

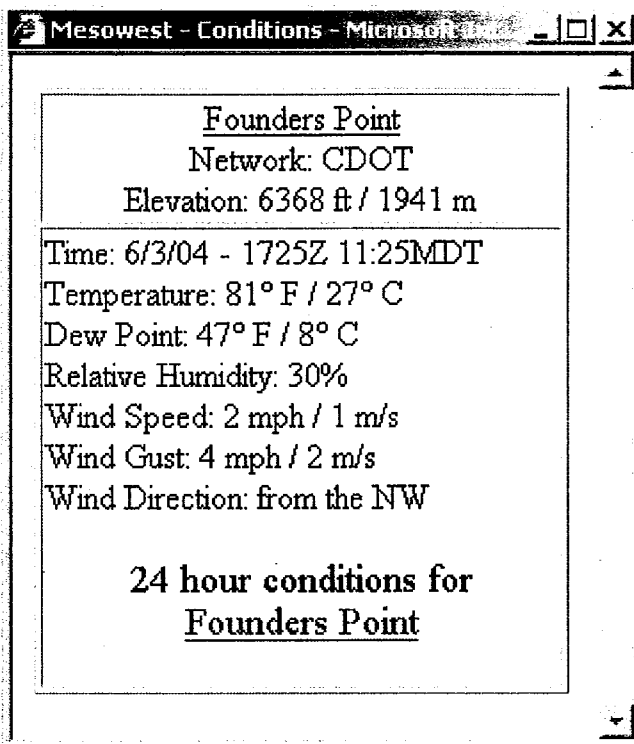


Figure 14: An example orphan window that contains detection information accessible on the interactive map on within the Douglas County Weather Website.

### **Douglas County Weather Website – Recommendations**

- 10-1 Implement content from the Douglas County Weather website into the Douglas County website <http://www.douglas.co.us> or have the web site hosted by a third party website hosting company, which would result in the web site having it's own domain name.
- 10-2 Review and update broken Internet links on a monthly basis.
- 10-3 Review agency websites depicted in Section 10.0 for updated or new information that is deemed applicable to Douglas County on a bi-monthly basis. Provide internet links to this information so it is made accessible by the Douglas County Weather website.

### **11.0 Summary**

HDR performed a flood warning assessment for Douglas County, Colorado with the main focus of the assessment being on the Cherry Creek and Plum Creek drainage basins including the population areas of Larkspur, Castle Rock, Sedalia, Louviers, Franktown and Parker.

Multiple tasks were performed in the assessment and are described in detail in this report and Technical Addendum that accompanies this report. The information that was gathered on the response agencies, flood detection resources, flood prediction resources, flood warning resources, communications resources, potential flood hazard areas, and hydrologic/hydraulic characteristics of the watercourses was reviewed and evaluated. Recommendations were made to enhance these components, if it was felt that if the recommended enhancement was implemented, the benefit would outweigh the cost associated with the implementation of the recommendation. One of these benefits would include a higher rating by FEMA Community Rating System (CRS) resulting in lower flood insurance rates for residents and business located within FEMA defined 100-year floodplains. Other benefits would include more accurate prediction of flooding events, increased lead time of flooding events, and pre-defined knowledge of areas at risk from flooding, possibly resulting in a reduced threat of loss of life.

Funding considerations, outside of funding from Douglas County, include alternative funding sources such as Castle Rock through their storm water utility fee, Parker through their storm water utility fee. UDFCD provides matching funds on capital, planning and maintenance projects and CWCB provides funding for planning, public awareness, and hydrological mapping projects.

The next section summarizes all the recommendations that were made in this report.

## **12.0 Summary of Recommendations**

Numerous recommendations were made throughout this report to enhance existing flood related components within the project area. These recommendations are summarized below.

### **Prediction/Hydrological Recommendations**

- 3-1 Determine basin average rainfall criteria, specific to individual major drainage basins for the 2-year, 5-year, 10-year, 25-year, 50-year, 100-year, and 500-year recurrence intervals for durations of 1-hour, 3-hours, 6-hours, 12-hours and 24-hours. Develop criteria through depth/duration/frequency (DDF) and intensity/depth/frequency (IDF) analysis using precipitation observation from UDFCD rain gages, NWS Cooperative Observer rainfall observations and Design Storm information.
- 3-2 Determine drainage basin hydrologic characteristics such as soil types, time of concentration, percent of imperviousness, area, and slope. Determine antecedent moisture affects on basin time of concentration.
- 3-3 Determine watercourse discharge, velocities, and depths based on all the basin average rainfall criteria information calculated in recommendation 3-1.
- 3-4 Develop GIS-based flood maps that depict water inundation and water depths associated with a 25-year, 50-year, 100-year, and 500-year recurrence intervals

on East Plum Creek, Plum Creek, East Cherry Creek, West Cherry Creek and Cherry Creek.

- 3-5 Determine depth and duration rainfall criteria utilizing the information calculated in recommendations 3-1 through 3-4, that if predicted would prompt flood advisories watches and warnings.

#### **Detection/Hydrological Recommendations**

- 4-1 Re-evaluate the recommendations made in the 1993 document 'Flash Flood Warning Planning for Douglas County Meteorological and Hydrological Support' to expand the existing Douglas County FDN consisting of automated rain gages, stream gages, weather stations, and base stations to display the information. Prior recommendations should be re-evaluated due to the implementation of some of the recommended gages, possible changes in watercourse and basin hydrological characteristics, and population growth.
- 4-2 Determine stream gage information that is consistent with NWS E-19 procedures for the stream gages owned and maintained by UDFCD (Table 3) and USGS (Table 5). The information should include elevations of critical points in the vicinity of the gage site, estimates of stage heights that could result in flood damage in vicinity of the gage site, and a determination of historical high water marks and other critical flood information.
- 4-3 Develop Flood Warning Templates (Figure 6) which are currently used by UDFCD to provide real-time assessment of streamflow, using the information obtained in recommendation 4-2.
- 4-4 Determine the feasibility and cost associated with incorporating the rain gage and weather station network, maintained by the Castle Rock Parks and Recreation Department, into the UDFCD's real time FDN. Currently the Castle Rock FDN data is available in real-time through a dial-up connection, however only one location is accessible at a given time. The information is mainly used for post storm analysis, not real-time detection.
- 4-5 Develop Flood Threat Recognition (FTR) criteria (rain gage rainfall depth/time and stream gage criteria water discharge, water stage height), which if reached or exceeded would prompt information dissemination to key personnel.
- 4-6 Develop a methodology, through existing technology used by UDFCD, to disseminate information prompted by criteria developed in recommendation 4-5 to key Douglas County personnel.

#### **Incident Command Structure Recommendation**

- 6-1 Develop levels or preparedness (Modes) based on potential flood depths and/or time until potential flooding using the information obtained in recommendations 3-5 and 4-5. Develop actions for departments/agencies to perform with regard to flood response for each level of preparedness. Incorporate this information into the Douglas County, Castle Rock and Parker EOP's.

## **Evacuation Resources Recommendation**

- 7-1 Develop evacuation procedures and policies based on the levels of preparedness developed in recommendation 6-1. Develop specific actions for departments/agencies to perform with regard to evacuations. Incorporate this information into the Douglas County, Castle Rock and Parker EOP's.

## **Flood Orientation Recommendation**

- 8-1 Host a flood orientation on an annual basis to assist in flood awareness and make participants aware of any new flood detection, flood prediction and flood warning information that may be available in Douglas County.

## **Potential Flood Hazard Area/Hydrological Recommendations**

- 9-1 Calculate potential bridge scour depths using the most appropriate scour depth calculation methodology in concert with the information obtained in recommendation 3-4. Update the scour information in Table 15 based on a bridge being determined to be scour critical or non-scour critical.
- 9-2 Determine and update the FHDI for all the locations identified in Table 15 using information obtained in recommendations 3-4 and 9-1.
- 9-3 Determine flood risk and vulnerability to residents, business, county, local jurisdictional infrastructure and critical facilities in and around the East Plum Creek, Plum Creek, East Cherry Creek, West Cherry Creek and Cherry Creek watercourses. Utilize GIS data, such as census information and tax assessment information, along with information from recommendation 3-4 and Douglas County and Digital Flood Insurance Rate Maps (DIFIRMs) to determine the population at risk and potential dollar loss to structures. A format similar to what is produced using the National Oceanic and Atmospheric Administration (NOAA) and FEMA's Risk and Vulnerability Assessment Tool (RVAT) could be followed. Additional information on RVAT can be found in Section 3.0 in the Technical Addendum.
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- 9-5 Implement real-time bridge scour assessment and warning technology which is being used across portions of the United States, if any of the bridges in the project area are determined to be scour critical. Technology such as the Real-Time Bridge Scour Assessment and Warning Decision Support System (a white paper authored by Carlton Ho, 2001, on this technology can be found in Section 3.0 in the Technical Addendum) could be utilized.

## **Douglas County Weather Website Recommendations**

- 10-1 Implement content from the Douglas County Weather website into the Douglas County website <http://www.douglas.co.us> or have the web site hosted by a third party website hosting company, which would result in the web site having it's own domain name.
- 10-2 Review and update broken Internet links on a monthly basis.
- 10-3 Review agency websites depicted in Section 10.0 for updated or new information that is deemed applicable to Douglas County on a bi-monthly basis. Provide internet links to this information so it is made accessible by the Douglas County Weather website.

# List of Acronyms

AHPS - Advanced Hydrologic Prediction Services

ALERT - Automated Local Evaluation in Real Time

ALS - Advanced Life Support

AW - Anything Weather

AWS - Automated Weather Source

CAD - Computer Aided Dispatch

CCIC - Colorado Crime Information Center

CCNC - Communications Network of Colorado

CDOT - Colorado Department of Transportation

COMET - Cooperative Program for Operational Meteorology Education and Training

CRS - Community Rating System

CWCB - Colorado Water Conservation Board

CWOP - Citizen Weather Observer Program

DCARES - Douglas County Amateur Radio Emergency Service

DCSDC - Douglas County Sheriff's office Dispatch Center

DDF - Depth/Duration/Frequency

DIFIRMs - Digital Flood Insurance Rate Maps

EAS - Emergency Alert System

EMC - Emergency Management Coordinator

EMD - Emergency Medical Dispatch

EMT - Emergency Medical Technicians

EMWIN - Emergency Managers Weather Information Network

EOC - Emergency Operations Center

EOP - Emergency Operation Plan

EPN - Emergency Preparedness Network

F2P2 - Flash Flood Prediction Program

FDFD - National Digital Forecast Database

FDN - Flood Detection Network

FEMA - Federal Emergency Management Agencies

FEMA - Federal Emergency Management Agency

FFG - Flash Flood Guidance

FFMP - Flash Flood Monitoring and Prediction

FHDI - Flood Hazard Danger Index

FHWA - Federal Highway Association

FTR - Flood Threat Recognition

FWT - Flood Warning Templates

HEC - Hydraulic Engineering Circular

HPO - Heavy Precipitation Outlook

HSPD-5 - Homeland Presidential Directive 5

IAP - Incident Action Plan

IC - Incident Commander

ICP - Incident Command Posts

ICS - Incident Command System

IDF - Intensity/Depth/Frequency

IMGS - Incident Management Guidelines & Standards

IMT - Incident Management Team

IRCP - Incident Radio Communications Plan

LA - Lead Agency



MAC - Multi-Agency Coordination

MCP - Mobile Command Post

MRBFC - Missouri River Basin Forecast Center

NGVD - National Geodetic Vertical Datum

NIMS - National Incident Management System

NLEC - National Law Enforcement Channel

NOAA - National Oceanic and Atmospheric Administration

NWAS - METS -Metropolitan Telephone System

NWR - NOAA Weather Radio

NWS - National Weather Service

NWSFO-BOU - National Weather Service Forecast Office - Boulder, Colorado

OCD - Operations Control Dispatch

PSAP - Public Safety Answering Point

QPF - Quantitative Precipitation Forecasts

RMS - Records Management Systems

RVAT - Risk and Vulnerability Assessment Tool

RWIS - Roadway Information System

SITREPs - Situation Reports

SitStat - Situation Status

SOP - Standard Operating Procedure

ST - StormTrak

TOC - Traffic Operations Center

UDFCD - Urban Drainage and Flood Control District

UFDA - United Fire Dispatch Authority

USBR - United States Bureau of Reclamation

USFS - United States Forest Service

USGS - United States Geological Survey

WFO - Weather Forecast Office

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