LEFT HAND CREEK WATERSHED MASTER PLAN

December 9, 2014

amec

CDR ASSOCIATES
COLLABORATIVE DECISION RESOURCES

Walsh
an ecology and environment company

Coalition Letter of Support for Left Hand Creek Master Plan

In June 2014 a diverse group of 22 stakeholders formed a coalition to develop a master plan that provides the foundation for the long-term restoration of Left Hand Creek and its tributaries following the devastating flood of September 2013. The purpose of the master plan is to identify actions that, if implemented, will lead to a more resilient creek corridor. The master plan focused on flood risk, ecological enhancements, and community values using best available science, professional expertise and agency, public and stakeholder input.

The Left Hand Creek Master Plan Coalition included representatives of water users; ditch companies; community-based watershed organizations; cities and towns; County, State, and Federal agencies; potable drinking water suppliers and a Conservancy District. One of the early actions of the Coalition was to advise Boulder County on the selection of a team of consultants to take on the heavy task of developing the master plan within a short 5-month time frame. The selected consultant team of AMEC, Walsh Environmental, and CDR Associates performed their duties as assigned, and presented the draft master plan for public review in November 2014.

Throughout the planning process, the AMEC team kept the Coalition and the public informed and engaged through a comprehensive set of Coalition and community meetings and by facilitating communications. With the finalization of the plan, stakeholders interested in the future of the Left Hand Creek Watershed have a valuable statement of the status of the creek, and a road map for selecting, funding, and implementing long-term restoration projects. The project recommendations, in concept, support the master plan purpose of restoring geomorphic function, improving flood resiliency, and reducing flood risks along the creek corridor.

The Coalition would like to take this opportunity to express its acceptance and appreciation for this master plan. Members fully recognize that in order to transition the master plan to implementation, additional analysis of proposed projects and funding will be necessary, as well as continued public engagement and communications.

While acceptance of this master plan does not waive any requirements for future projects to comply with federal, state and local policies, plans, rules and regulations, the Coalition is hopeful that this plan will launch a coordinated and systematic repair and restoration of Left Hand Creek.

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List of Abbreviations and Acronyms

ac: Acre
af: Acre Foot
AWA: Applied Weather Associates
BFE: Base Flood Elevation
CDBG: Community Development Block Grant
CDBG-DR: Community Development Block Grant – Disaster Recovery
CDOT: Colorado Department of Transportation
CDPHE: Colorado Department of Public Health and Environment
CFR: Code of Federal Regulations
cfs: Cubic Feet per Second
CLOMR: Conditional Letter of Map Revision
CWA: Colorado Watershed Assembly
CWCB: Colorado Water Conservation Board
DEM: Digital Elevation Model
DFIRM: Digital Flood Insurance Rate Map
DHSEM: Colorado Division of Homeland Security and Emergency Management
DOLA: Colorado Department of Local Affairs
DRCOG: Denver Regional Council of Governments
ELJ: Engineered Log Jam
EPA: Environmental Protection Agency
EWP: Emergency Watershed Protection
FEMA: Federal Emergency Management Agency
FHWA: Federal Highway Administration
FIRM: Flood Insurance Rate Map
FIS: Flood Insurance Study
GIS: Geographic Information Systems
HEC: Hydrologic Engineering Center
HEC-HMS: Hydrologic Engineering Center – Hydrologic Modeling System
HMGP: Hazard Mitigation Grant Program
HUD: U.S. Department of Housing and Urban Development
JCWI: James Creek Watershed Initiative
LEFCRECO: Left Hand Creek Near Boulder County station (Colorado Division of Water Resources Gage)
LHCC: Left Hand Creek Coalition
LHCWMP: Left Hand Creek watershed Master Plan
LHDC: Left Hand Ditch Company
LiDAR: Light Detection and Ranging
LOMA: Letter of Map Amendment
LOMC: Letter of Map Change
LOMR: Letter of Map Revision
LWD: Large Woody Debris
LWOG: Lefthand Watershed Oversight Group
NFIP: National Flood Insurance Program
NOAA: National Oceanic and Atmospheric Administration
NRCS: Natural Resources Conservation Service
OSMP: City of Boulder Open Space and Mountain Parks
PMR: Physical Map Revision
SCS: Soil Conservation Service (now NRCS)
SFHA: Special Flood Hazard Area
SVAP2: Stream Visual Assessment Protocol Version 2
SVLHWCD: St. Vrain and Left Hand Water Conservancy District
SWMM: Storm Water Management Model
SWPP: Source Water Protection Plan
TMDL: Total Maximum Daily Loads
USACE: U.S. Army Corps of Engineers
USFS: U.S. Forest Service
USGS U.S. Geological Survey
WQCD: Water Quality Control Division
WRC: U.S. Water Resources Council

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EXECUTIVE SUMMARY

Background

In September 2013, Left Hand Creek experienced a flood event that destroyed large sections of local roads and public, residential, and commercial properties within the Left Hand Creek watershed. The high peak flow, combined with the extended duration of the event and the large amount of sediment/debris inputs from landslides/debris flows, exacerbated the damage in the creek corridor. The Town of Jamestown experienced devastating damage, as did areas in the City of Longmont and in unincorporated Boulder County along the upper, middle, and lower sections of the watershed. Extensive sections of roadways were damaged limiting the ability of many residents to evacuate during the flood. Culverts and crossings throughout the system plugged with debris causing the stream to jump course, damaging adjacent lands.

Left Hand Creek watershed Master Plan

The Left Hand Creek Watershed Master Plan (LHCWMP) was written to address and coordinate the response to key restoration issues in the planning area in the aftermath of the September 2013 floods along the Colorado Front Range. The LHCWMP was developed between June and November 2014 by the Left Hand Creek Coalition (hereafter referred to as the LHCC or the Coalition) with assistance from AMEC Environment and Infrastructure, Walsh Environmental, and CDR Associates.

The goal of the Plan was to create an open, collaborative, and voluntary approach to long-term planning and management of the Left Hand Creek watershed. The LHCWMP is the first step in that process, with the following objectives:
Plan Objectives:

- Reduce the risk of future flood and debris flow damage to public and private infrastructure along Left Hand, James, and Little James Creeks (Left Hand Creek watershed);
- Define the approximate post-flood 100-year floodplain, including surface water elevations, to prepare for future Federal Emergency Management Agency (FEMA) floodplain mapping submittals;
- Enhance understanding of how physical infrastructure in the creek corridor affects flows;
- Identify, evaluate, and prioritize opportunities to manage flood risk while restoring, enhancing, and preserving the ecological functions, values, and characteristics of streams in the watershed, including aquatic and riparian communities;
- Recognize the importance of ditch infrastructure so that the plan is pragmatic, balanced, and compatible with Colorado water law and existing property rights;
- Create a plan that is consistent with existing local policies and plans and helps facilitate recovery from the September 2013 flood;
- Protect and enhance water quality, specifically addressing the impacts to the source water for Jamestown and Left Hand Water District's potable water systems;
- Evaluate how transbasin diversions into the watershed affect flow and flood hydrology along streams in the Left Hand Creek watershed; and
- Ensure property owner engagement in the planning process, including those property owners along the creeks and property owners with interest in the creek corridor.

The Left Hand Creek Coalition that developed this LHCWMP includes representatives from local, state, and federal government; non-profit watershed organizations; water districts; ditch companies; and land owners. Public input was also solicited and included in the LHCWMP.

Risk Assessment

For this project, the risk assessment was divided into three separate analyses; flood, geomorphic, and ecosystem. The risk model common to all three analyses examined both the probability and the consequences of the hazard. In an attempt to utilize existing resources, past reports, existing plans, and previously collected flood data were incorporated to the furthest extents possible. While the utility of many past reports was decreased as a result of the magnitude of the September floods, those reports were still able to provide historical context within which to view flood risk in the watershed. Spatial data was brought into a GIS and used as the foundation to organize data for, and complete, each of the risk assessments.

Flood Risk

FEMA floodplain mapping is used for regulatory purposes and is the primary tool floodplain managers use to determine flood risk. A complete re-mapping of the watershed was beyond the scope of this project. Instead, the flood risk component made determinations regarding the utility of the existing Flood Insurance Study (FIS) and Interim mapping efforts.

An analysis was performed by AMEC to compare the currently published regulatory Special Flood Hazard Area (SFHA) limits to the post flood observations and modeling noted above. SFHA zones were overlain with Boulder County parcel data and tabulated by use and FIRM Panel. This analysis was used to determine whether the pre-flood data was still accurate. In many cases, the September 2013 flood changed the stream channel and floodplain so substantially that the existing studies are no longer accurate. Recommendations for revising these studies and regulations include updating the datasets required for flood hazard mapping and prioritizing portions of the watershed.

Geomorphic Risk

The geomorphic risk assessment is based on a rapid geomorphic assessment utilizing a stream classification methodology known as River Styles. The goal of this method identifies the conditions that determine how the stream channel and floodplain behave; how confined the stream is (e.g., is it confined in a steep valley or is it unconfined in an open plain); whether a particular location is prone to storing sediment and debris, what the dimensions of the floodplain in that location are; how steep the gradient is, etc. In general, the application of the River Styles framework to this project involved a desktop analysis of best available GIS data, fieldwork, and a determination of reach trajectories, or behavior that can be expected of the stream given the current state.

Six River Styles were identified for the Left Hand Creek watershed:

1. Headwater
2. Confined Valley, Limited Floodplain
3. Confined Valley with Bedrock-Controlled Floodplain Pockets
4. Partly Confined, Wandering
5. Unconfined, Continuous Floodplain
6. Entrenched, Residential

Typical properties of each reach were defined and used to develop simple ratings of geomorphic condition. In general, reaches with good condition have functioning floodplains, complex channels, and intact riparian corridors consisting of native vegetation complexes. Reaches receiving a fair rating have local disturbances to several properties, an overall degraded condition, and are able to withstand disturbance events without fundamentally changing their river style. Reaches with a poor rating have systemic degradation and lack functioning riparian vegetation. These reaches have changed their behavior in response to disturbance and will require restoration assistance to stabilize.

With the development of the River Styles and the determination of the geomorphologic condition, the downstream pattern of change, or trajectory, can be examined. In this manner, the stream is examined holistically – each reach is examined in the context of the surrounding reaches and larger system. Given the geomorphic condition, the downstream pattern of change, or trajectory, for each reach can be determined in the context of those reaches above and below it. These trajectories, in conjunction with the vulnerabilities (e.g., infrastructure, homes, diversion structures, business, etc.) in that reach, then define the geomorphic risk for that reach. Reaches receiving a risk rating of 'High' are generally in poor condition, have considerable vulnerabilities, and/or the potential to impact downstream reaches.

In general, reaches located high in the watershed were in better condition, were less affected by the flood, and received lower risk ratings. Many of the remaining reaches received a poor condition rating, as they were affected by the flood, but risk ratings depended on vulnerabilities present.

Ecosystem

As part of the Left Hand Creek Corridor Master Planning effort, a rapid ecologic stream assessment of Left Hand Creek was completed. The Stream Visual Assessment Protocol (SVAP2), developed by the U.S. Natural Resources Conservation Service (NRCS, 2009) was used for this assessment. The SVAP2 is a national protocol that provides an initial evaluation of the overall condition of streams, their riparian zones, and their in-stream habitats. It is often used as a tool for conservation planning, identifying restoration goals and objectives, and assessing trends in stream and riparian conditions through time. For the purposes of this analysis the results were used to identify critical riparian ecosystem elements that are damaged or absent from the river system, as well as to identify highly degraded areas. The evaluations are intended to supplement an overall understanding of the vulnerabilities that certain key species may have in Left Hand Creek and assist with focusing appropriate restoration strategies.

The application of the SVAP2 protocol includes the evaluation of stream system features that affect overall stream conditions and generally encompass the following categories:

1. Channel stability (channel condition, bank condition)
2. Water quantity (hydrologic alteration)
3. Water quality (nutrient enrichment and manure/human waste)
4. Vegetation (riparian area quantity/quality and canopy cover)
5. Instream habitat (pools, habitat complexity, embeddedness)

These elements (e.g., channel condition, bank condition) were evaluated and scored from 1 to 10, with a score of 1 indicating a severely degraded ecological condition and a score of 10 indicating an excellent ecological condition. Based on these scores, habitat enhancement recommendations to improve the ecological conditions in each reach were developed.

Recommendations

The recommendations presented in this plan are the result of a combination of technical analyses and stakeholders' input, and include both reach specific and system-wide strategies. Reach specific strategies are detailed in the mapbook while system-wide recommendations are described in section 5.2 of the report. The strategies generated for this plan are diverse and reflect the physical constraints and community values present in each reach. In general, stream restoration recommendations are focused on restoring river function (as identified in the geomorphic risk analysis) and addressing flood safety concerns. Flood risk recommendations are focused on updating the regulatory flood hazard mapping. Ecosystem recommendations focus on enhancing habitat and work in tandem with the restoration strategies.

The process of developing the recommendations involved the following elements. Stakeholder input provided insight used by the consultant team to focus on specific areas of concern and to also identify opportunities to stabilize the channel. Community members were able to provide input during neighborhood and public meetings, and through comments submitted to the consultant team through the project website and/or email address. Coalition and community members provided watershed recovery and restoration input that helped to draw attention to areas with existing needs. Field investigations and desktop analyses were used to identify problem areas and to record and brainstorm potential restoration strategies. The risk assessments helped to frame site specific issues in the context of stream processes at work at the local and system-wide scales. All of these information sources were then compiled in a GIS to lay out a framework for identifying the most appropriate treatments for each reach in the study area.

Individual treatments were then grouped into projects based on spatial extent, property lines (where appropriate) and dependencies (i.e., individual treatments that need to be completed in tandem with adjacent treatments). In total, nearly 50 individual projects are recommended within the LHCWMP and depicted in the plan mapbook. In general, most of the recommended projects are located near infrastructure (e.g., bridges, culverts, roads) and provide a balance between protecting the infrastructure and improving the ecology of the stream. In many locations where infrastructure is not present, no projects are proposed because the channel is likely to recover through natural processes without additional human input.

The treatment and project recommendations are based on realistic goals and consider the trajectories for each stream type and reach. The consultant team developed drawings to show the unique restoration strategies for each different River Style. The drawings include standard plans, profiles, and cross sections and they depict general recommended restoration techniques for each stream reach. This guidance will improve the likelihood that their projects match the system and reach behavior, and thus may last longer and perform better. Standard plans for each river style are detailed in the attached mapbook (Sheets T-1 through T-6).

In addition to the projects depicted in the mapbook, system-wide recommendations were developed that should be applied to the entire watershed. Examples include strategies for dealing with sediment and debris at crossings and diversion structures and approaches for restoring each River Style.

Finally, projects were ranked on a number of criteria, including how they address identified flood, geomorphic, and ecosystem risks, as well as how they address community values as communicated at the public meetings. Five projects, selected for their expected impact on stabilizing the watershed and increasing safety, are detailed and a table of rankings for all of the identified projects included.

Next Steps

The LHCC will need to determine its organizational capacity, and members will need to affirm their commitment to collaboration on pursuing funding and promoting projects in the watershed. One of its primary responsibilities moving forward will be to pursue funds to begin implementing the projects identified in the LHCWMP. There are several grant and loan programs that fund watershed restoration and flood mitigation projects, and the deadlines for these are varied and in some cases very near. This document will be a useful evaluation tool for both the applicants and granting agencies.

1 INTRODUCTION

1.1 Authorization

The LHCWMP was authorized by Boulder County and the LHCC under a contract with AMEC Environment and Infrastructure, Inc. (AMEC). CDR Associates and Walsh Environmental were subcontracted by AMEC to assist with the public outreach strategy and the ecological risk assessment, respectively. The study area for this plan, which includes Left Hand Creek and all drainages flowing into it, including James Creek and Little James Creek, is depicted in **Figure 1**.

1.2 Purpose and Scope

A major flood event occurred in the Left Hand Creek watershed during September, 2013, which destroyed large sections of local roads and public, residential, and commercial properties. The damage was a result of high peak flows, the extended duration of the event, and sediment/debris inputs from landslides/debris flows, and resulted in dramatic changes in the creek corridor. In various locations the stream migrated laterally, experienced significant deposition and erosion in-stream and off-channel, cut new overbank channels, lost a significant amount of its riparian vegetation, and migrated or scoured to the point of destroying or significantly damaging numerous waterlines, roads, embankments, bridges, and other infrastructure. The Town of Jamestown experienced devastating damage, as did areas in the City of Longmont and in unincorporated Boulder County along the upper, middle, and lower sections of the watershed. The flood also caused damage to mine tailing sites that were previously mitigated, and resulted in new soils or mineral loadings in the source water for the Town of Jamestown and Left Hand Water District's water treatment plants.

The flood's impact on the main creek corridor and tributaries in the drainage varied from the mountains to the plains. In the mountain areas, many of the upper tributary drainages experienced debris flows, which is when a mix of water-laden soil, vegetation, and other debris rushes down mountainsides and into streams to form a powerful and erosive torrent that cause massive destruction. The debris flows lose energy as they progress downstream and then deposit the rocks, cobble, sand, trees, and household materials that were entrained in the debris flow throughout the stream corridor below. The impact in the plains was generally in the main stream corridor, with a less drastic effect in the tributary drainages at lower elevations. As the floodwaters reached the plains at the mouth of the canyon, water spread out across the wider, unconfined valley bottom and deposited large quantities of materials that were transported during the height of the flood.

In the aftermath of the flood, ditch companies, land owners, land management and transportation agencies, and communities within the Left Hand Creek watershed took actions to address their immediate needs and minimize risk of additional damage. Many of the actions had a short-term, temporary, and site-specific focus in order to address the most urgent needs caused by the flood damage. Efforts of this nature included such actions as constructing emergency access and temporary roads, installing temporary berms, re-establishing channel conveyance, and stabilizing stream channels. Site-specific efforts continued to take place along different reaches of Left Hand, James, and Little James Creeks, again oriented toward meeting immediate needs or mitigating the potential threats posed by the upcoming spring run-off.

Jamestown completed several planning documents after the floods: the Town of Jamestown Stream Corridor Master Plan Technical Memorandum, including a provisional floodplain map; a Programmatic Environmental Assessment; and an Emergency Watershed Protection Plan primarily addressing debris removal and restoration of water conveyance. Projects deriving from these plans are in various stages of design and implementation.

Property owners, watershed restoration groups, local government, and other stakeholders recognized the need to conduct long-term planning for Left Hand Creek at a watershed scale to augment the short term solutions that were already being implemented. Planning at the watershed scale for the Left Hand Creek corridor was necessary in order to incorporate local needs (residents of the Town of Jamestown, City of Longmont, and Boulder County; ditch companies; and property owners) and broader stakeholder interests (recreation, habitat preservation, water quality, etc.) into a unified approach to land and water management, public policies, and other strategies for flood control and stream restoration.

For these reasons, various entities within the Left Hand Creek watershed formed the LHCC. The Coalition initiated the planning process for the LHCWMP, which was partially funded by the Colorado Water Conservation Board (CWCB) through the Colorado Watershed Restoration Program. The purpose of the LHCWMP was to collect, generate, and share information with the public, property owners, stakeholders, and local decision makers about the current condition of the Left Hand Creek watershed and to collaboratively identify, prioritize, and select policies, programs, and projects that reduce flood and debris flow risk to public and private infrastructure, while preserving, enhancing, or restoring the creek's natural environment. These projects are currently not funded. The LHCWMP is designed to help the Coalition and its members and constituents apply for funding to implement the projects recommended in this document. It may also be used by the granting agencies in their decision-making process.

The LHCWMP is not a regulatory document. This plan presents a conceptual vision for the recovery and restoration of the watershed and guides future planning activity by recommending projects and treatments that align with diverse community and public priorities. All recommended restoration and recovery activities in this plan will still need to be designed by licensed professionals and comply with all federal, state, and local requirements prior to implementation. The required prerequisites likely include but are not limited to additional environmental and engineering studies, detailed engineering designs, agency permits and approvals, compliance with local land use and zoning designations, land ownership or landowner permissions, and local public engagement requirements.

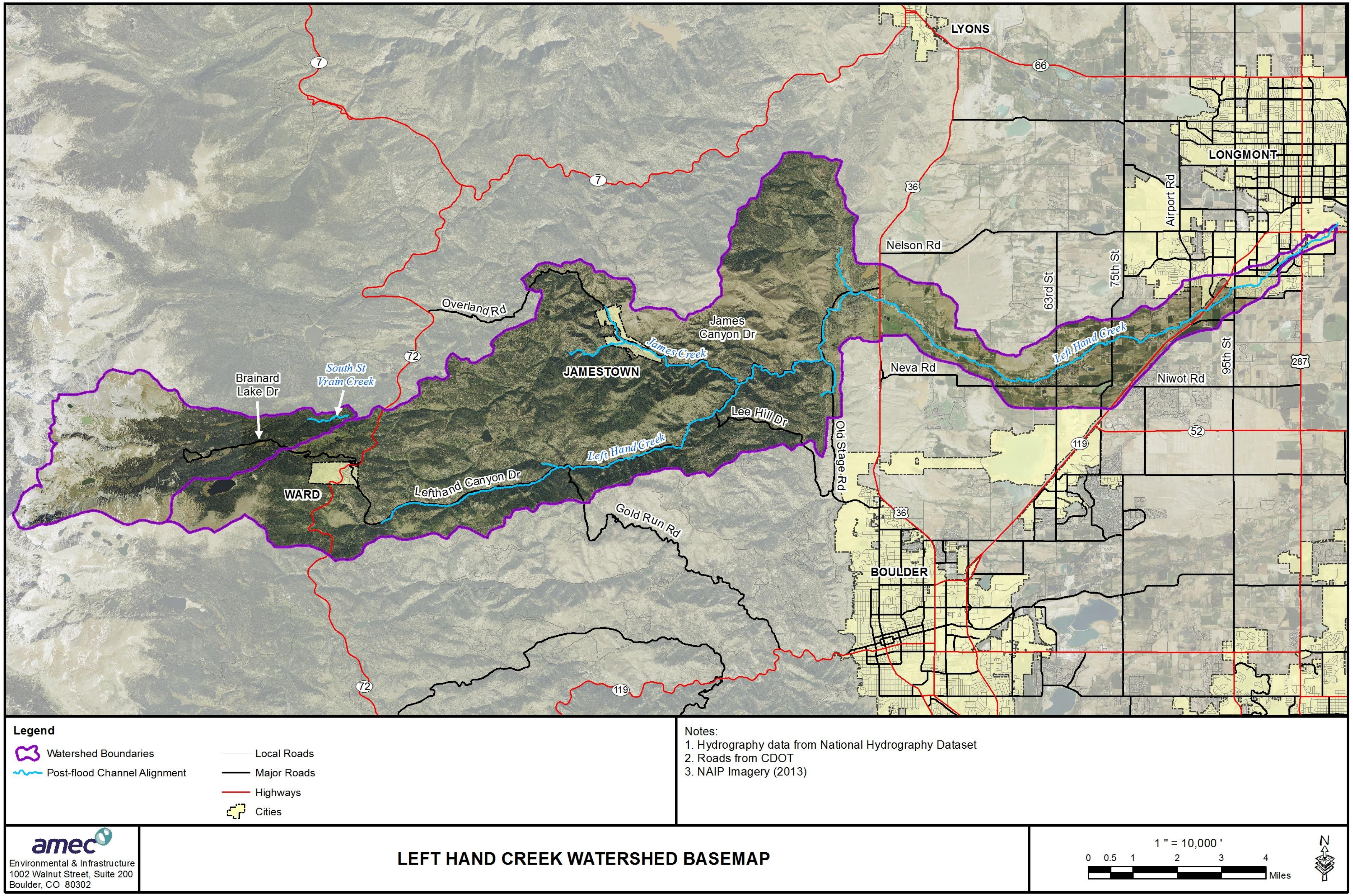


Figure 1. Left Hand Creek Watershed Study Area

2 Planning Process

This Plan resulted from a coordinated effort and ongoing commitment to address long-term recovery and mitigation issues in the Left Hand Creek watershed caused by the September 2013 floods. The LHCC was formed to guide the development of the LHCWMP. The LHCC hired AMEC Environment and Infrastructure, CDR Associates, and Walsh Environmental (hereafter referred to as "the AMEC team") to assist with the development of the planning process for the LHCWMP. Key components of the planning process included public/stakeholder engagement, technical risk assessment, project identification, and planning for long-term Coalition engagement. The long-term Coalition engagement includes identifying funding sources for implementing the recommended projects, which are currently not funded. Cost estimates were provided with the project recommendations to help the Coalition identify and apply for funding.

2.1 Goals and Objectives

The goals of the LHCWMP, which worked to create an open, collaborative, and voluntary approach to long-term planning and management of the Left Hand Creek watershed, were to:

- Reduce the risk of future flood and debris flow damage to public and private infrastructure along Left Hand, James, and Little James Creeks (Left Hand Creek watershed);
- Enhance understanding of how physical infrastructure in the creek corridor affects flows;
- Identify, evaluate, and prioritize opportunities to manage flood risk while restoring, enhancing, and preserving the ecological functions, values, and characteristics of streams in the Left Hand Creek watershed, including aquatic and riparian communities;
- Recognize the importance of ditch infrastructure so that the plan is pragmatic, balanced, and compatible with Colorado water law and existing property rights;
- Create a plan that is consistent with existing local policies and plans and helps facilitate recovery from the September 2013 flood;
- Protect and enhance water quality, specifically addressing the impacts to the source water for Jamestown and Left Hand Water District's potable water systems;
- Evaluate how transbasin diversions into the watershed affect flow and flood hydrology along streams in the Left Hand Creek watershed; and
- Encourage property owner engagement in the planning process, including those property owners along the creeks and property owners with interest in the creek corridor.

These goals for the LHCWMP were confirmed during the planning process. In order to achieve these goals, it was vital to engage those affected by the 2013 flood including agencies, property owners, ditch companies, other members of the public, and other stakeholders. The methods for engaging these stakeholders are discussed in the following sections.

2.2 Left Hand Creek Coalition

2.2.1 Coalition Formation and Member Entities

The Left Hand Creek watershed is very diverse, with rural mountain communities in the Upper Watershed, agricultural communities in the Lower Watershed, and incorporated towns and cities. The Left Hand Creek watershed has several other pre-existing watershed interest groups, such as the Lefthand Watershed Oversight Group (LWOG) and the James Creek Watershed Initiative (JCWI). A Coalition formed in recognition of the importance of bringing these diverse stakeholders together to develop a plan for the long-term recovery of the Left Hand Creek watershed. The LHCC served as the steering committee for the development of the LHCWMP; coordinated activities with other agencies, stakeholders, and the public. Boulder County served as the Contracting Agency and acted as the primary point of contact for the AMEC team. The Coalition will lead and oversee plan implementation efforts once the final plan is approved and funding is available.

The LHCC consisted of representatives from:

- Boulder County
- City of Boulder Open Space and Mountain Parks (OSMP)
- City of Longmont
- Colorado Division of Homeland Security and Emergency Management (DHSEM)
- Colorado Parks and Wildlife
- Colorado Department of Public Health and Environment (CDPHE)
- Colorado Department of Transportation (CDOT)
- Colorado Division of Reclamation and Mine Safety
- CWCB
- JCWI
- Keep it Clean Partnership
- Left Hand Ditch Company (LHDC)
- Left Hand Water District
- LWOG
- Longmont and Boulder Valley Conservation Districts
- Natural Resources Conservation Service (NRCS)
- St. Vrain and Left Hand Water Conservancy District (SVLHWCD)
- Town of Jamestown
- U.S. Forest Service, Arapaho/Roosevelt National Forest
- FEMA Region VIII
- Environmental Protection Agency (EPA), Region 8

The JCWI is an important local partner within the Coalition that has several years of experience in watershed restoration grant writing, grant administration, and project implementation. JCWI is a grass roots community based organization located in Jamestown, Colorado. JCWI's mission is to *"engage the community in protecting the waters of James Creek and the forest ecosystem surrounding it"*. The organization was founded in 1997 as a Masters Degree project at the University of Denver. Start-up funding was provided by an EPA Regional Geographic Initiative grant, under the umbrella of the Town of Jamestown. In 2000, the Initiative received its 501 (c) (3) status as a non-profit organization. JCWI has been the project lead and grant writer for many restoration projects within the Left Hand Creek watershed.

PHOTO: COLLEEN WILLIAMS

JCWI organized the Mulch the Gulch Project to prevent further mudslides throughout the Town after the Overland Fire.

Since its formation, JCWI has provided a holistic approach to environmental protection by sponsoring public education and outreach activities, organizing volunteer groups for stream clean-ups and restoration, organizing the community around forest management and water quality issues and building partnerships with stakeholders. JCWI has successfully established partners with several organizations and governmental agencies.

LWOG is another important local partner and member of the Coalition with a proven track record of successfully implementing watershed restoration projects. According to LWOG's website, "the mission of the Lefthand Watershed Oversight Group is to assess, protect, and restore the quality of the Left Hand Creek watershed, and to serve as a hub of communication about watershed issues through the fostering of stakeholder collaboration" (http://www.lwog.org/org/orgindex.html). LWOG's activities include monitoring water quality at various locations in the watershed, identifying and facilitating clean-up projects to improve water quality, increasing public awareness about issues in the watershed, and securing funding for projects.

A complete list of Coalition members is provided in **Appendix C**.

2.2.2 Input

The Coalition primarily provided input to the AMEC team via phone, email, and Coalition meetings. Summaries of each meeting were shared with the Coalition to inform members who could not attend meetings about what was discussed. Coalition members could also edit the meeting summaries to correct any misinformation or add other important details. The Coalition reviewed and refined the materials shared with the public and other stakeholders to ensure that everyone received a consistent message.

2.2.3 Meetings

The LHCC held eight meetings between June 27, 2014 and November 10, 2014. At these meetings the Coalition discussed progress on LHCWMP development efforts, what information should be contained in the LHCWMP, public engagement and outreach, long-term Coalition building, and funding source identification. The summaries of the Coalition meetings and surveys and summaries from the public meetings are available in **Appendix D**.

2.2.4 Review of Draft Documents

The first draft of the LHCWMP was provided to the Coalition for a high-level review on October 15, 2014. The Coalition reviewed the document for major flaws or missing information, and provided comments and edits to AMEC by October 20th so that the draft could be revised in advance of the public review draft. The public was also given a chance to review the document and provide edits, as discussed in Section **2.3.3**.

The Coalition reviewed the public review draft plan between October 27th and November 3rd. Comments on this draft were discussed at the final Coalition meeting held on November 10th, 2014 and incorporated into the Final Plan.

2.3 Public Engagement Process

2.3.1 Public Meetings

The first round of public meetings was held on July 31, 2014 at the Altona Grange and August 6th, 2014 at the Greenbriar Inn. The purpose of the LHCWMP kick-off community meetings was to announce the beginning of the master planning process, to inform the public on what flood recovery issues will be addressed by the LHCWMP and to let the public know how they can provide input. Fifty-two community members attended the Lower Watershed meeting at the Altona Grange, in addition to ten members of the LHCC. Fifty-eight community members attended the Upper Watershed meeting at the Greenbriar Inn, in addition to nine members of the LHCC.

The Lower Watershed meeting split into four facilitated groups, while the Upper Watershed meeting attendees split into three groups. The opening remarks at each meeting helped set the stage for the large groups and small group discussions. People provided feedback that they appreciated the facilitated groups and the focus on the whole watershed.

The second set of public meetings was held on October 22nd at the Jamestown Town Hall and October 23rd at the Boulder County Parks and Open Space Building Prairie Room. The purpose of these meetings was to share the AMEC team's risk assessment and high-level project recommendations for each reach. Thirty community members attended the Upper Watershed meeting on October 22nd. The project team delivered a PowerPoint presentation to the group to explain how projects were developed and how to use the LHCWMP. At the end of the presentation, the project team organized two breakout groups based on the attendees' locations in the watershed and gave a hands-on demonstration of how to interpret the maps and conceptual drawings in the LHCWMP. Five members of the public attended the Lower Watershed meeting on October 23rd. Due to the smaller number of people at this meeting, the project team spoke with the attendees in one group for the entirety of the meeting rather than using breakout groups.

The public provided feedback by marking up maps and making notes on comment cards. Comments included project recommendations at specific sites, such as installing a sediment retention basin, installing a culvert, and removing debris to mitigate flooding and protect infrastructure.

2.3.2 Online Survey

Twenty-two residents also filled out survey forms to answer the same questions used in the public meeting comment forms. The results of the comment forms and the online survey were posted on the project website.

2.3.3 Public Review of Draft Plan

The public review draft was posted to the project website on October 27th, 2014. The public and the Coalition had until November 3rd to provide feedback, which AMEC incorporated into the final LHCWMP.

2.3.4 Project Website

A project website was established at lefthandcreekmasterplan.com. The website served as the primary method of interaction with the community. It was periodically updated with relevant information and materials, including photos and maps. The draft plan was posted to the website on October 27th for Coalition and public review during the public review period. Press releases for related plans and projects were posted to the website as well. Twitter was also used to communicate project updates.

3 Watershed Background and Description

The LHCWMP addressed the stream reaches of the Left Hand Creek watershed that were significantly impacted by the September 2013 flood. In order to do so, hydrological processes and land use activities in the Upper Watershed were evaluated to determine their ability to convey water and sediment to the Lower Watershed. For this reason, the LHCWMP established a Planning Area, as depicted in the proceeding map.

The Planning Area for the LHCWMP was the geographic area for data collection, analysis, and all other planning activities. The Planning Area was defined in the following manner:

- Left Hand Creek from its headwaters near the base of Niwot Ridge, to its confluence with James Creek;

- James Creek from its headwaters near the Town of Ward (including Little James Creek east of the Sky Ranch Estates subdivision), to above the confluence with Left Hand Creek;
- The main stem of Left Hand Creek below the James Creek confluence, to its confluence with St. Vrain Creek in the City of Longmont; and
- That portion of the South St. Vrain Creek Watershed above the trans-basin diversion in R73W T2N Sec 36.

On the plains, neither the Dry Creek north of Left Hand Creek, nor the Dry Creek south of Left Hand Creek were included in the Planning Area.

3.1 Location

The Left Hand Creek drainage basin is located on the eastern slope of the northern Front Range of the Rocky Mountains. The incorporated Town of Jamestown is at the confluence of James and Little James Creeks, at an elevation of 7,000 feet. James Creek then joins Left Hand Creek at the junction of James Canyon Drive and Lefthand Canyon Drive. Left Hand Creek then flows eastward from the mountains onto the plains. The transition of the creek from mountain to plains occurs as it crosses U.S. Highway 36 or the Foothills Highway. Just east of the City of Longmont, Left Hand Creek joins St. Vrain Creek, which flows to the South Platte River.

Upstream of US 36, the creeks are more natural than the lower reaches and are confined by the existing steep canyon topography, as well as by roadways. Much of the area is U.S. Forest Service land with some pockets of residential development and local Open Space in unincorporated Boulder County. On the plains, the creek gradient decreases and it is more heavily managed with several irrigation head gates and evidence of current and past land uses (gravel pits, roadways, rural subdivisions and urban development).

Elevation in the approximately 72-square-mile natural watershed of Left Hand Creek ranges from 11,600 feet on Niwot Ridge to 4,920 feet at the confluence of Left Hand Creek and St. Vrain Creek in the City of Longmont. The topography changes from forested mountain terrain on the west to rolling pasture and cultivated plains on the east. The Left Hand Ditch diversion from South St. Vrain Creek to the headwaters of James Creek above the Town of Ward adds another 13.6 square miles of South St. Vrain drainage to the watershed, with elevations ranging up to 13,400 feet on the Continental Divide. The mean average annual precipitation in the mountains of the western watershed averages approximately 25 inches per year (Jamestown Source Water Protection Plan, pg. 9). The average annual temperature is approximately 40 degrees Fahrenheit with cold winters and hot summers.

3.2 Setting

3.2.1 Geology

The division of Left Hand Creek into an Upper and Lower Watershed falls very closely along the boundary between two significantly different physiographic regions: the Southern Rocky Mountain province and the Colorado Piedmont section of the Great Plains province (Worcester, 1920). The Upper and Lower divisions are separated by the transition from foothills to plains (see **Figure 3**).

The canyons in the Upper Watershed have a V-shaped morphology, formed by water flow rather than glacial ice though there are a few places where glacial deposits are present. Stream erosion and deposition, wind erosion, and atmospheric weathering formed and continue to alter the watershed topography. The watershed features gentle slopes concentrated near the top of the Upper Watershed and steep canyons near the transition from the Upper to Lower Watershed. The mountainous portion of the Upper Watershed is comprised of Pre-Cambrian metamorphic and granitic rocks including intrusive stocks and dikes. Crystalline rocks within the watershed contain gold, fluorite, lead, silver, uranium, tungsten, and copper in extractable quantities. These minerals were deposited with intrusions of molten igneous rocks during periods of mountain uplift. Soils in the Upper Watershed are fairly thin and are identified by the Cryboralfs-Rock outcrop.

The Lower Watershed morphology is primarily an alluvial floodplain. The transition between the Upper and Lower Watershed is abrupt, where the creek flows through several uplifted sandstone layers. These layers include Fountain formation sandstone, the Dakota group, Lyons sandstone, and the Niobrara formation. In reaches located in the lower plain, the floodplain geology is dominated by alluvium. Areas not immediately in the floodplain are windblown clay, silt and loess. Flood events and wind transport are the primary processes that dominate geologic changes in the Lower Watershed.

3.2.2 Hydrography

As part of the St. Vrain Creek basin (HUC 10190005), the Left Hand Creek watershed lies northwest of Boulder, Colorado on the eastern slope of the Rocky Mountain Front Range (Wood et al., 2005). The primary streams in the watershed are James Creek, Little James Creek, and Left Hand Creek (see **Figure 4**). The watershed area is approximately 85 sq. miles (54,400 ac) at the confluence with the St. Vrain Creek near Longmont, Colorado, and ranges in elevation from 13,800 ft near the continental divide to 4,900 ft. on the eastern plains (Wood et al. 2005). Left Hand Creek has an average annual discharge of 29,000 af (40 cfs) (Wood et al. 2005), and serves as the primary water source for over 14,000 residents (EPA 2003). Monthly average flows for Left Hand Creek near the canyon mouth are presented in **Figure 2**.

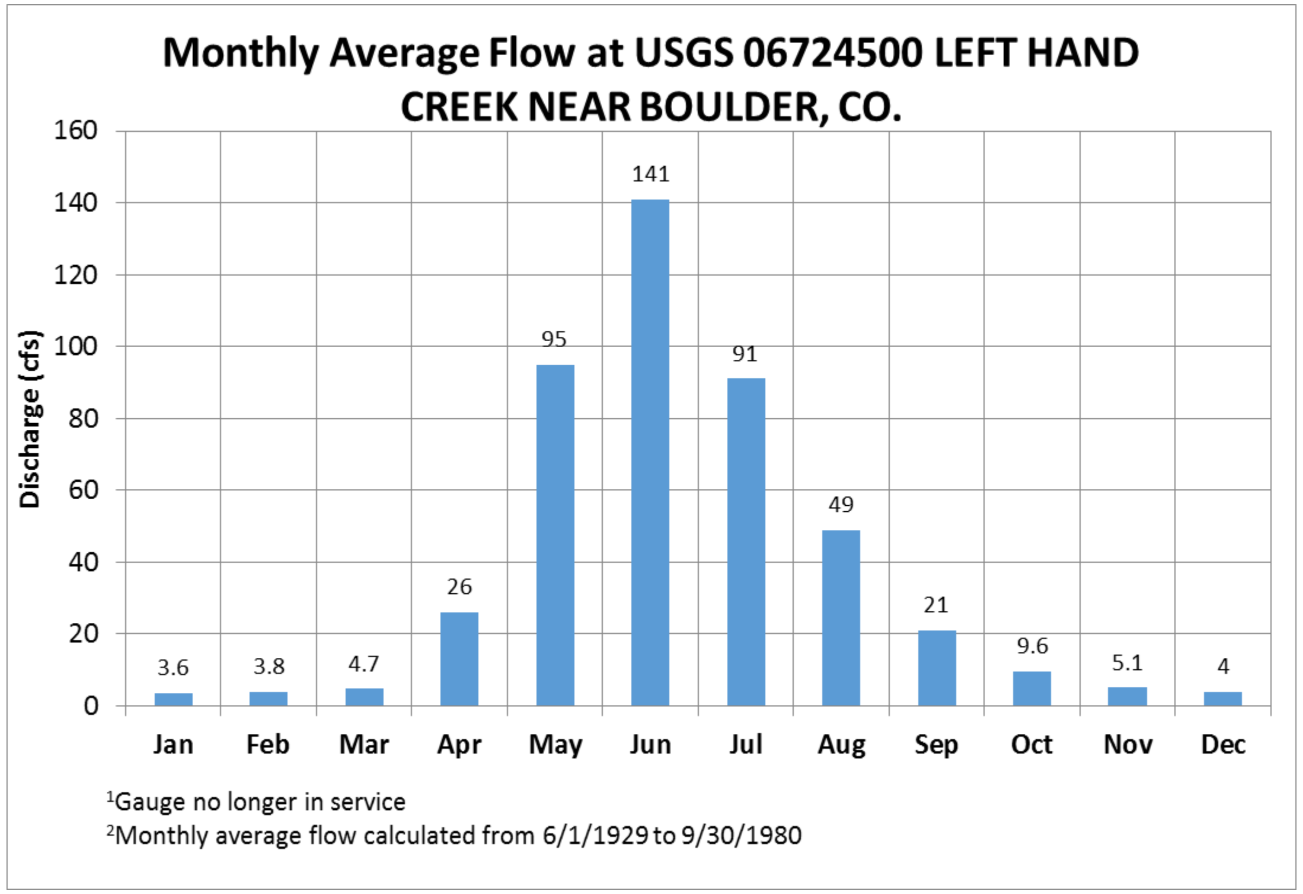


Figure 2. Left Hand Creek Hydrograph

The largest tributary to Left Hand Creek is James Creek, which drains 18.5 sq miles of subalpine and alpine forest (Wood et al. 2005). A diversion of flow from South St. Vrain Creek to James Creek contributes nearly all of the flow in James Creek during the summer months (Wood et al. 2005, CDWR 2002, Colorado River Watch, 2004). The headwaters of the South St. Vrain Creek are made of up glacial-melt fed lakes near the continental divide, and snow melt in the South St. Vrain creates unnaturally high flows in James Creek due to the diversion. A tributary to James Creek, Little James Creek meets James Creek at a confluence in Jamestown, Colorado. Little James Creek drains approximately 5.8 sq. miles of alpine and subalpine land cover (Wood et al. 2005).

3.2.3 Debris Flows

The Upper Left Hand Creek watershed (i.e., above the intersection with Highway 36) is flanked by steep slopes that are prone to landslide processes, including deep failure of slopes, rockfall, and mud and debris flows. All deliver significant and occasionally (during and immediately after large storms) massive amounts of sediment to Left Hand Creek. Some landslides within the canyon move slowly and cause damage gradually, whereas others move so rapidly that they can destroy property and take lives suddenly and unexpectedly. For example, the Howlett's Gulch debris flow in Jamestown claimed one life during the September 2013 flood event.

Gravity is the primary driving force for these landslides to occur, but there are other contributing factors affecting the original slope stability. Pre-conditional factors build up specific sub-surface conditions that make a hillslope prone to failure, whereas the actual landslide often requires a trigger before being released. For example, human activities such as deforestation or natural processes such as the 2003 Overland wildfire may destabilize an already vulnerable slope by removal of deep-rooted vegetation that binds colluvium to bedrock and by damaging soil structure. Consistent rainfall before a big storm will saturate soils and create groundwater conditions whereby pore water pressures act to destabilize the slope. A large rainfall event such as the September 2013 storm may then cause a slope stability threshold to be crossed, this being the trigger to release a landslide or debris flow. In the September 2013 floods, antecedent rainfall conditions were almost certainly a factor in the widespread release of numerous debris and mudflows from hillslopes in the Left Hand Creek watershed.

Mudflows are composed mostly of grains smaller than sand. Geomorphic evidence in the watershed indicates these are far less common than debris flows. Debris flows have volumetric sediment concentrations exceeding approximately 40%, with the remainder of the flow's volume consisting of water. Debris includes sediment grains with assorted shapes and sizes, commonly ranging from clay (i.e. very fine) particles to massive boulders. In a debris flow this mixture rushes down slope into stream channels, entraining objects in their paths, and forming thick, muddy deposits on valley floors. Debris flows in Left Hand and James Canyons generally have bulk densities comparable to those of rock avalanches and other types of landslides (approximately 125 pounds/cubic foot), but owing to widespread sediment liquefaction caused by high pore-fluid pressures, they can flow almost as fluidly as water making them very erosive and dangerous. Debris flows in forested areas of the watershed often contain large quantities of woody debris such as logs and tree stumps. Debris flows descending steep channels commonly attain speeds that surpass 30 feet per second (more than 20 miles per hour). As a result of their high sediment concentrations and mobility, debris flows in the Left Hand Creek watershed can be very destructive.

Debris flows usually start on steep hillsides as shallow landslides that liquefy and accelerate. Debris flows from many different sources can combine in channels, and their destructive power may be greatly increased. They continue flowing down hills and through channels, growing in volume with the addition of water, sand, mud, boulders, trees, and other materials. They can carry very large objects such as cars. Once in the creek channel, a debris flow triggered by a flood inducing rainfall event will typically become diluted by sediment-rich water floods with solid concentrations ranging from about 10 to 40%. These flows will behave somewhat differently from a pure debris flow and are known as hyper-concentrated flows. While less so than debris flows, these flows are still highly erosive. Geomorphic evidence such as distinct debris flow berms alongside long reaches (>100 foot) of creek channel indicated that so much sediment was delivered to the creek at various times during the Left Hand Creek watershed flood event that there were periods where full debris flow conditions existed in various reaches of the channel.

In the September 2013 event, sediment inputs from landslides and debris flows contributed greatly to the dramatic changes and damage in the creek corridor. In various locations the stream migrated laterally, experienced significant in-stream and off-channel deposition and erosion, cut new overbank channels, lost a significant amount of its riparian vegetation, and migrated or scoured to the point of destroying or significantly damaging numerous houses, diversion structures, roads, embankments, bridges, waterlines, and other infrastructure.

3.2.4 Land Cover and Land Use

Dominant land cover in the Left Hand Creek watershed generally follows the topography and underlying geology of the region, rapidly transitioning from the foothills in the west to the plains in the eastern watershed. As depicted in **Figure 5**, the predominant land cover in the Upper Watershed is Evergreen Forest and Shrub/Scrub. Together with Perennial Ice/Snow, these three land cover groups make up 85% of the land area.

More suitable for a wide variety of land uses, the land cover on the Lower Watershed is split between grasslands, pastures, and cultivated croplands. These three land covers make up 65% of the eastern plains, as shown below in **Table 1** (USGS 2011).

Table 1. Left Hand Creek watershed Land Cover (in percent)

Name	Upper	Lower	Total
Open Water	1%	1%	1%
Perennial Ice/Snow	5%	0%	4%
Developed-Open Space	1%	10%	3%
Developed-Low Intensity	0%	5%	1%
Developed-Medium Intensity	0%	3%	0%
Developed-High Intensity	0%	1%	0%
Barren Land	4%	0%	3%
Deciduous Forest	2%	1%	2%
Evergreen Forest	65%	1%	55%
Mixed Forest	0%	0%	0%
Shrub/Scrub	14%	2%	12%
Grassland/Herbaceous	7%	16%	8%
Pasture/Hay	0%	19%	3%
Cultivated Cropland	0%	30%	5%
Woody Wetlands	1%	9%	2%
Herbaceous Wetlands	0%	3%	0%

Land use in the watershed parallels land cover and topography between the Upper and Lower Watershed. The Upper Watershed is dominated by forest land and the lower by agricultural lands. The total acreage of land use is given below in **Table 2** and shown in **Figure 6** (Boulder County 2014). The largest category is "Exempt" which is defined as exempt from development or zoning by the County. Generally this is lands within the boundary of the Roosevelt National Forest.

Table 2. Boulder County Land Use

Land Use Category	Area (acres)	Percentage
Affordable Residential	1.6	0.00%
Agricultural, Mixed	904.1	1.76%
Agricultural	5490	10.66%
Apartment	0.3	0.00%
Commercial	211.5	0.41%
Exempt	34736.7	67.46%
Imp Only	0	0.00%
Industrial	18.1	0.04%
Minor Structure	20.1	0.04%
Mixed Use	117.5	0.23%
Natural Resources	1229	2.39%
Part Exempt	10.8	0.02%
Poss Interest	572.4	1.11%
Resident Land	324.6	0.63%
Residential	6523.2	12.67%
State Assessed	40.3	0.08%
Vacant Land	1295.3	2.52%
Grand Total	51495.5	

3.2.5 Fire History

Several fires of significance have burned portions of the Left Hand Creek watershed, affecting runoff, water quality and flooding. In September of 1988 two human-caused fires occurred above Buckingham Park, including the Lefthand Fire. Houses were threatened, but not lost (Boulder County 2013).

On October 29th, 2003, the Overland fire occurred northwest of Jamestown. It is believed to have started when a tree was sheared off by 60 mph winds and fell onto a power line near the Burlington Mine cleanup site. High winds and dry weather conditions existed. 3,500 acres were burned; 12 residences and several outbuildings were destroyed. Property damage was estimated in excess of $8 million but no infrastructure damage was reported. The town was evacuated and roads and schools were closed for 24 hours (Boulder County 2013).

In September of 2010, the Fourmile Canyon fire, the largest in Boulder County's history, burned a significant portion of the neighboring Fourmile watershed, but in large part stopped at the divide between the watersheds. A very small portion of the Left Hand Creek watershed was burned at the most northern extent of the fire, just over the divide between the watersheds.

A map of significant fires in the Left Hand Creek watershed is shown below in **Figure 7**.

3.2.6 Water Quality

3.2.6.1 Water Quality Setting

Water quality can be used as a measurement of a water body's ability to meet the requirements of human and aquatic need or purpose. Most of the stream segments in the Left Hand Creek watershed have designated uses for aquatic life, recreation, water supply, and agriculture. CDPHE sets quantitative standards for acceptable levels of pollutants and contaminants in water. These levels are monitored as described in Section **3.2.6.3**. In 1998 some segments of Left Hand Creek and Little James Creek were placed on Colorado's list of impaired waters for failing to meet water quality standards for supporting aquatic life (Left Hand Water District Source Water Protection Plan, pg. 20).

3.2.6.2 Contaminant Sources

The Left Hand Creek watershed was once a very active mining area, especially in the 19th century. Mining occurred in the watersheds for Left Hand Creek, James Creek and Little James Creek (Wood et al. 2005). The 2003 Colorado Source Water Assessment identified 344 mines within the Left Hand Water District source water protection area (Left Hand Water District SWPP, pg. 33). Most of the mines were abandoned. There are still thirteen inactive, permitted mines in the watershed, as well as three active, permitted mines. Left Hand Creek flows through the Ward mining district, including the Captain Jack Mine and Mill superfund site. Over 100 years of mining activity have resulted in heavy metal and other mining-related contamination in the Left Hand Creek watershed (EPA 2003). Left Hand Creek was unable to support life by the 1930s, and was considered a dead creek until the 1950s (EPA 2003). James Creek drains the Jamestown and Golden Age mining districts, and Little James Creek drains many areas of former hard rock mining and processing activities. Little James Creek was listed on the State of Colorado's 303(d) list of impaired streams in 1998 with a high ranking (Wood et al. 2005). The Water Quality Control Division of the State CDPHE developed Total Maximum Daily Loads (TMDL) for cadmium, zinc, iron, manganese and pH (WQCD, 2002, Wood et al., 2005).

CDPHE compiled a contaminant source inventory in 2001-2002. The inventory identified discrete contaminant sources in Left Hand Water District including above, underground and leaking storage tanks; existing/abandoned mine sites; EPA hazardous waste generators; and standard industrial facilities. The Town of Jamestown Inventory included above, underground and leaking storage tanks; existing/abandoned mine sites; and hazardous waste generators. The inventory also identified dispersed potential sources of contamination including agricultural, forests, septic systems, commercial/industrial/transportation, low intensity residential, urban recreational grasses, and roads. These sources can cause acute and chronic health concerns.

After identifying the contaminant sources, CDPHE rated the total susceptibility to water source contamination in the Left Hand Water District and the Town of Jamestown. The rating was based on the physical setting vulnerability of the water source and the contaminant threat. Left Hand Water District received a high overall susceptibility rating. Discrete contaminant sources were all ranked as high threats to the District. Jamestown's overall susceptibility rating was moderately high, although hazardous waste generators and storage tanks were removed from Jamestown's discrete source inventory.

Wildfires can also contribute to contamination by increasing sediment loads in streams. Post-wildfire areas have less vegetation to anchor the soil, and burned soils can be hydrophobic. This can lead to sedimentation in streams, erosion, mudslides, and debris flows.

Stormwater runoff is another potential contaminant source. According to the Left Hand Water District SWPP, "stormwater runoff also increases turbidity, causing water treatment concerns described above (Boulder, 2005)" (pg. 49). Turbidity is the measure of clarity of a liquid. Stormwater runoff can increase sedimentation in water which makes it appear cloudy (i.e., sedimentation caused by stormwater runoff increases turbidity). Stormwater can also carry pollutants from roadways and more developed areas where household, automobile, and agricultural chemicals may be present.

3.2.6.3 Water Quality Monitoring

When considering implementation of projects within the scope of this plan, it is important to consider other water quality programs and efforts underway in Boulder County. Examples include the watershed monitoring plans that the Keep It Clean Partnership is coordinating. These plans provide a sound scientific understanding of baseline water quality conditions, identify reaches of streams in need of water quality and aquatic life improvements, and to support prioritization of improvements expected to improve water quality and aquatic life. Boulder County departments engaged in similar efforts include Transportation, Public Health, and Parks and Open Space. Additionally, LWOG and JCWI volunteer as stream monitors for the River Watch program. JCWI monitors "sites along James Creek above and in the Town of Jamestown, and LWOG has been monitoring sites along Little James Creek, and one station on Left Hand Creek (Patterson, 2010)" (Left Hand Water District SWPP, pg. 22).

The Town of Jamestown established a Watershed District in 1991. In 2001 the boundaries of this district were modified to begin five miles above the Town's water treatment plant with a 1,000-foot radius along either side of James Creek (measured from the center of the creek). The Town of Ward completed a Wellhead Protection Plan in 1995 to "protect public groundwater supplies from contamination" (Left Hand Water District SWPP, 2010, pg. 13).

3.2.6.4 Further Reading

A number of documents and studies examine water quality issues in the watershed, including the impacts of local mining operations. These documents make recommendations for mine cleanup to improve water quality that the Coalition may wish to revisit. These studies include:

- Town of Jamestown Source Water Protection Plan
- Section 319 Nonpoint Source Pollution Control Program Watershed Project Final Report: James Creek Watershed Restoration Project
- Abandoned Mine Lands Case Study: Left Hand Creek watershed – Use of NPL as Catalyst for Abandoned Mine Cleanup. November 3, 2003, EPA
- Lefthand Watershed Task Force Report to Boulder County Board of Health
- Left Hand Water District Source Water Protection Plan

3.2.7 Diversions

The LHDC is the primary water rights diverter, owning the first 31 priorities in the Left Hand Creek watershed (Wood and Russell 2005). LHDC diverts water from South St. Vrain Creek, Left Hand Creek and James Creek. The LHDC owns Lake Isabelle, Left Hand Park Reservoir, diversion rights from the South St. Vrain River, Gold Lake, and the flows in the Little James, James Creek, and Left Hand Creek (Wood and Russell 2005). The LHDC is a consolidated ditch company serving agricultural, domestic, and municipal shareholders located in the foothills and plains east of the Lefthand Canyon. The largest single shareholders are the Left Hand Water District, whose use is primarily for domestic water for approximately 7,000 active taps in Boulder, Weld, and Broomfield counties (Wood and Russell 2005).

There are four diversions in the James Creek watershed (Williams 2000). At the headwaters of James Creek, water is diverted from South St. Vrain Creek into James Creek. The Gold Lake Fill Ditch diverts a small amount of water from James Creek into Gold Lake, which lies on the divide between James Creek and Left Hand Creek (Williams 2000). This water is used as a winter supply for residents in the Left Hand Creek watershed.
Jamestown had the ability to divert water for irrigation from James Creek into a ditch that skirted the town and returned back into James Creek downstream of town. The 2013 flood damaged the head gate of this ditch, rendering it inoperable. The town's diversion from James Creek to its municipal treatment plant was also destroyed in 2013; however, this diversion has been restored.

An abandoned diversion exists from James Creek to the Bueno Mill. It is possible that the mill could reopen, and water diverted once again.

Table 3. James Creek Shares

Agency/Jurisdiction	Share
Left Hand Ditch Company	685 cfs (1885)
Gold Lake	Unconditional adjudicated 1907, in use
John Jay Mine	Abandoned, never used
Wano-Calvin (Bueno-Mill)	0.432 cfs (unused, 1980)
Jamestown	24 shares of Left Hand Ditch (1982)

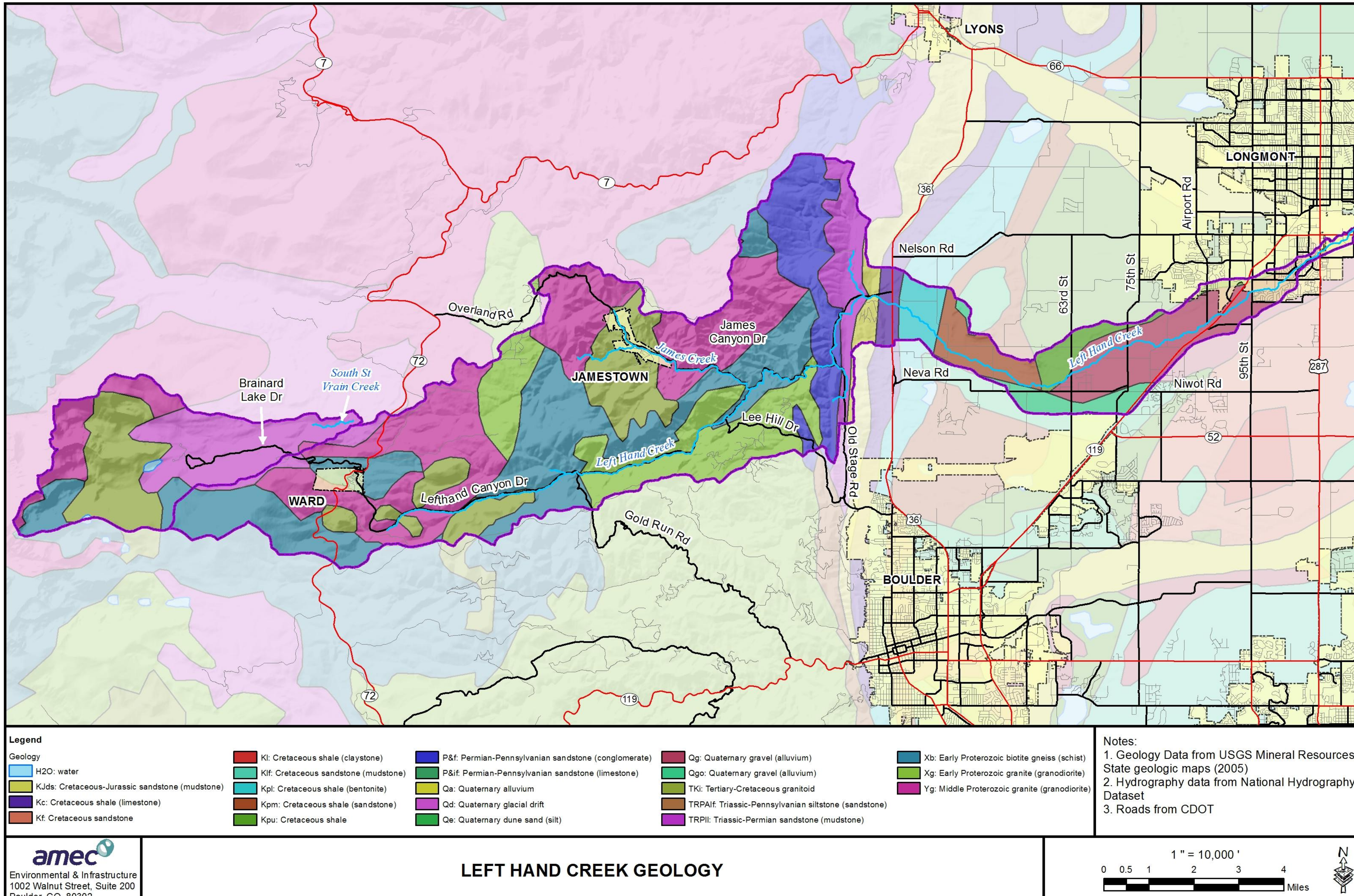


Figure 3. Left Hand Creek Watershed Geology

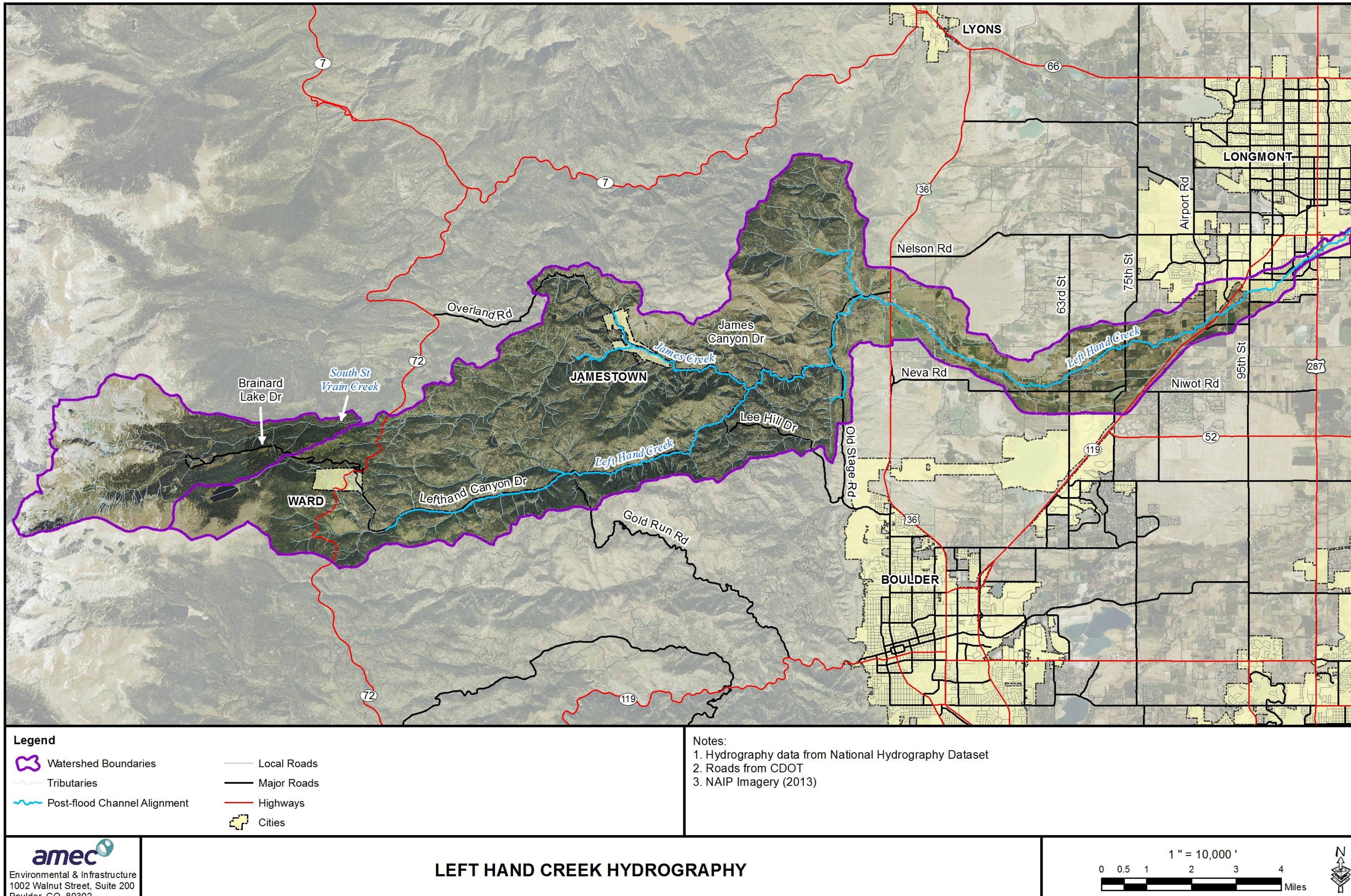


Figure 4. Left Hand Creek Watershed Hydrography

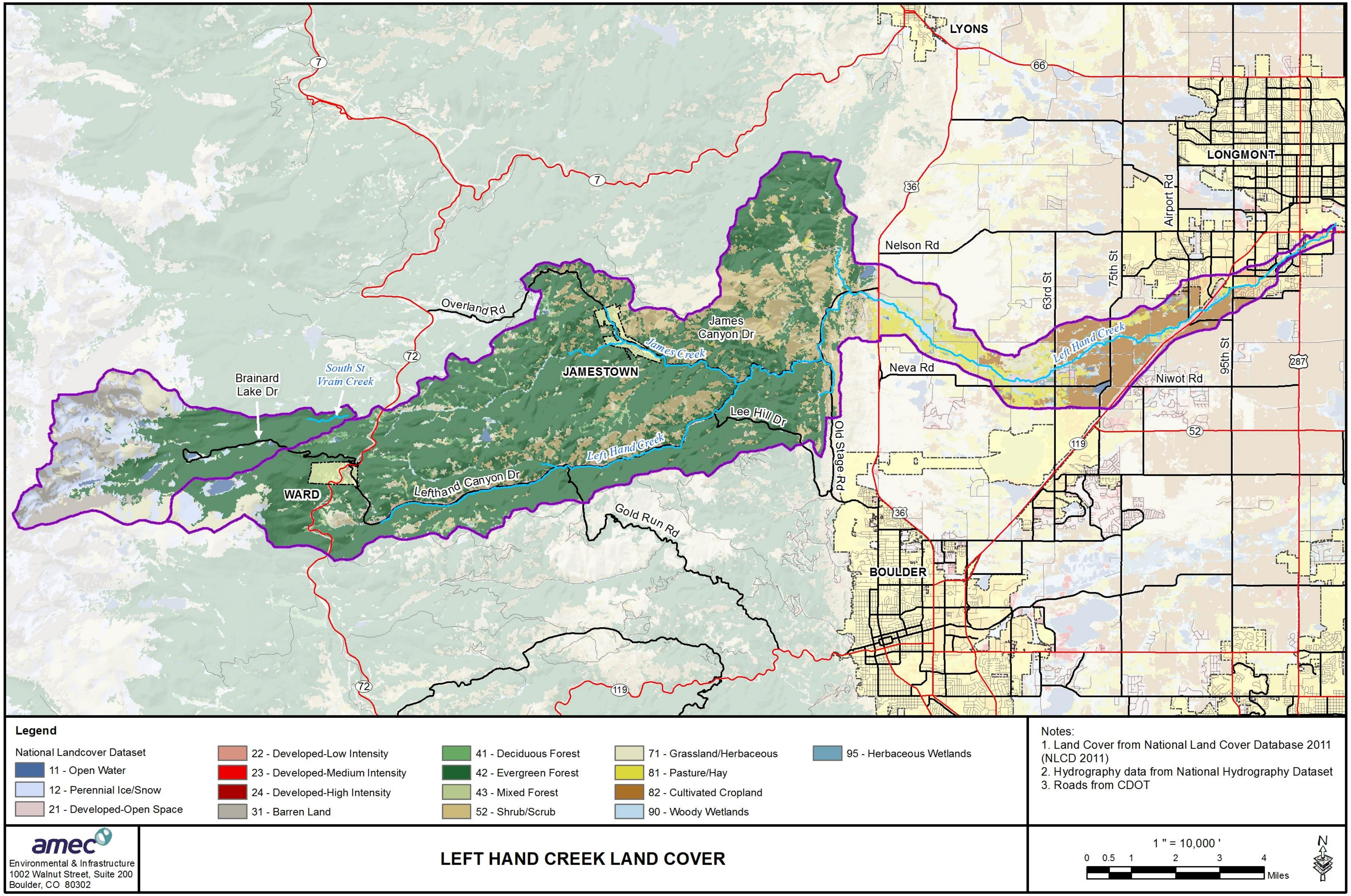


Figure 5. Left Hand Creek Watershed Land Cover

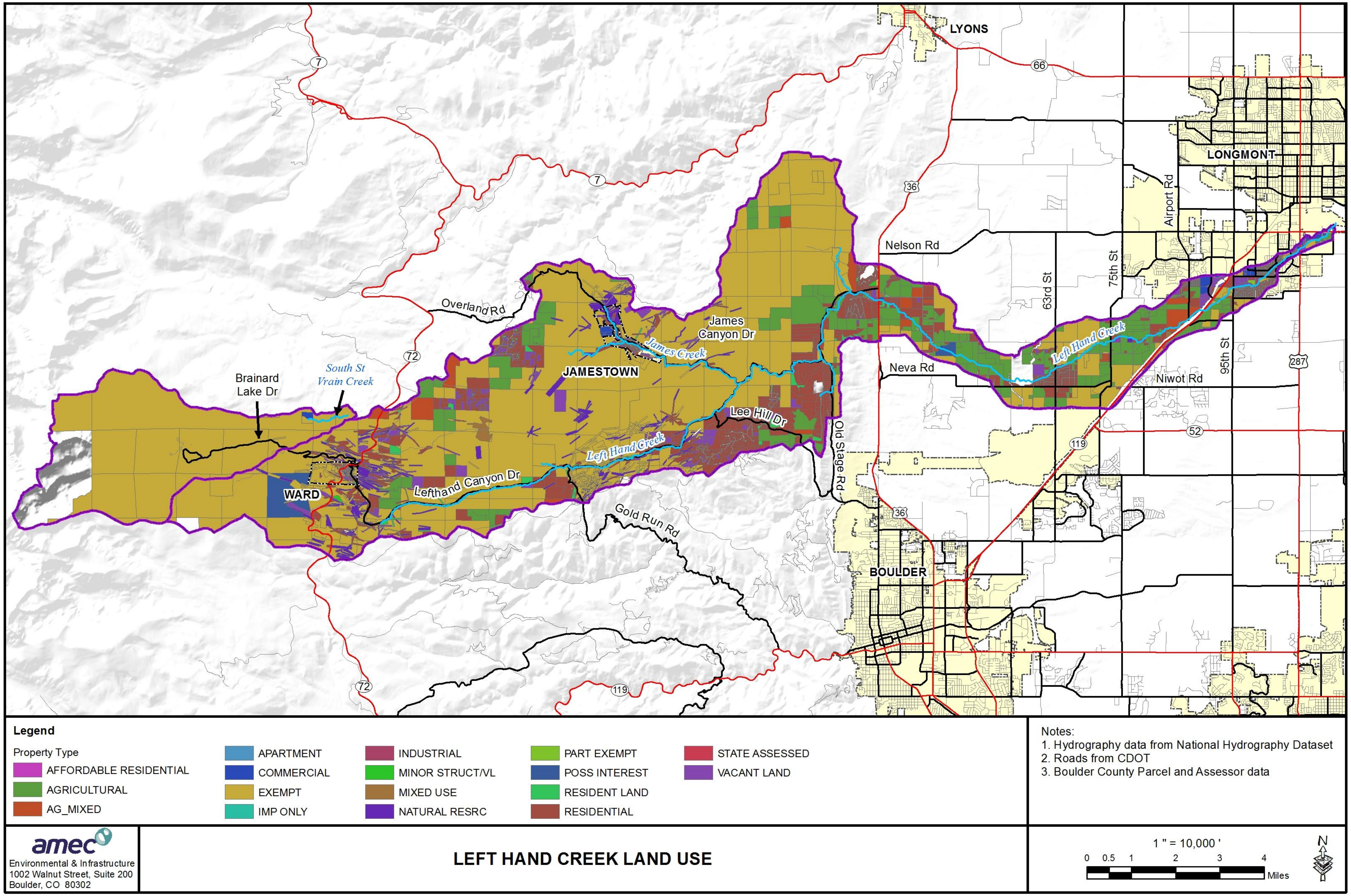


Figure 6. Left Hand Creek Watershed Land Use

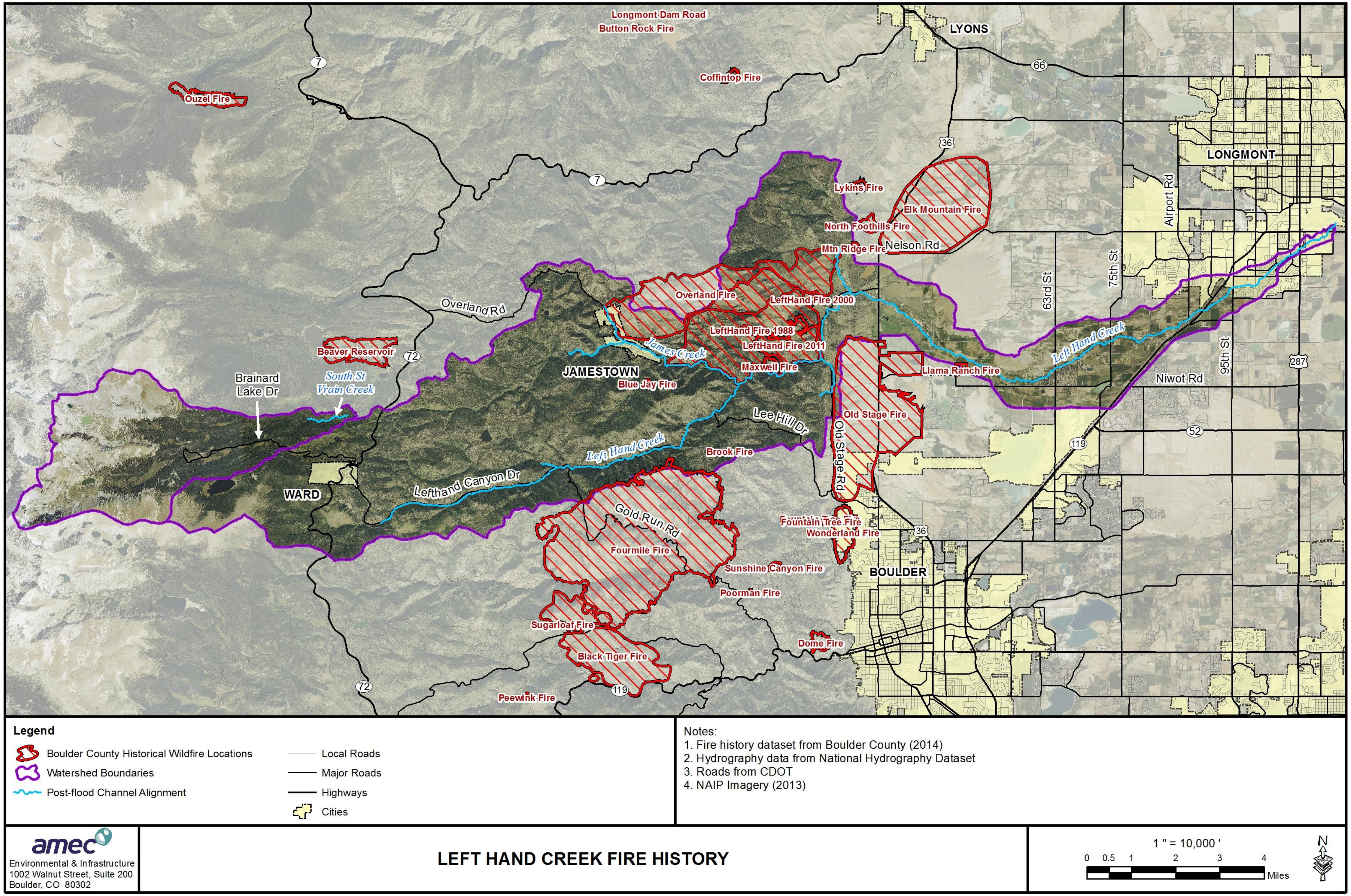


Figure 7. Left Hand Creek Watershed Fire History

3.3 Jurisdictions, Population, and Economy

The planning area primarily lies within unincorporated Boulder County. It also includes the Town of Jamestown and a portion of the City of Longmont. The total population of Boulder County in 2013 was 310,048. Jamestown had a population of nearly 300 people prior to the September 2013 flooding. Most residents are still displaced as of October 2014. Longmont's population in 2013 was estimated at 89,919. The Town of Ward lies within the watershed but was not a formally participating jurisdiction in the LHCWMP.

Jamestown is a small mountain community located in the central northwest section of Boulder County, approximately 10 miles northwest of the City of Boulder. The town lies at an elevation of 6,920 feet above sea level. The terrain is mountainous with steep slopes. Longmont is located in Boulder and Weld counties, roughly 33 miles north-northwest of Denver. The elevation at the Longmont Town Hall is 4,978 feet above sea level. The elevation change between Jamestown and the Longmont Town Hall is 1,942 feet. The terrain in the Upper Watershed is similar to that of Jamestown, and the terrain in the Lower Watershed is similar to Longmont.

The economy in the planning area is fairly diverse. Jamestown was historically a mining town and is now a residential community, with most people commuting out of town for work. The economy in the Lower Watershed was historically agricultural. Longmont bloomed as an agricultural center in the late 19th century after the railroads were built in the area. Longmont and the surrounding area still retain their agricultural character with a number of farms and ranches in the Lower Watershed. Many people who live in the Left Hand Creek watershed commute to Boulder, Denver, or Longmont for work. The 2013 American Community Survey found that 23% of the employed population in Boulder County works in education services, and health care and social assistance; 20.6% works in professional, scientific, and management, and administrative and waste management services; 11.3% works in manufacturing; 10.6% works in arts, entertainment, and recreation, and accommodation and food services; and 10.2% works in retail trade. Only 0.6% of Boulder County's working population works in agriculture, forestry, fishing, hunting, and mining; however, agriculture is an important part of the character of the Lower Left Hand Creek watershed.

3.4 Flood History

Major historical floods in Boulder County are due mainly to snowmelt combined with heavy rainfall, although heavy rainfall, especially in the form of cloudbursts, is also capable of causing flooding (U.S. Water Resources Council 1976). This risk is especially high during the summer monsoons.

The steep slopes and canyons in the Upper Watershed create swift flood waters that scour streambanks and exacerbate damages. Debris carried by the fast-moving water not only threatens bridges and culverts, but batters houses and other structures on the floodplain. Large debris such as boulders and trees can be too large to pass through bridges and culverts. Erosion and debris undercut streambanks and destroy structures that would otherwise receive little damage from inundation. Large quantities of rock are often deposited in portions of the channel, leaving little capacity for future floods. Undersized bridges and culverts can also cause flooding in the Lower Watershed. These structures become clogged with debris and sediment from upstream. Debris, mud, and sedimentation may cause more damage to homes and other buildings than floodwaters.

Due to sparse settlement and the lack of continuously operated gages in the upper reaches of the watershed, only anecdotal information is known about the flooding above Foothills highway, other than areas of extreme velocity have caused damage to roadways and private crossings. A gage (USGS station 06724500) was operated sporadically about 2.5 miles west of Foothills in the 1930's, 40's and 50's, and the U.S. Army Corps of Engineers (USACE) Floodplain Information Report for Left Hand Creek (USACE 1969) provided some historic peaks. Since 1980 USGS Station 06724500 has been operated by Left Hand Water District with assistance from the Colorado Division of Water Resources. The gage is now known as LEFCRECO. Left Hand Water District has records for the gage, and One Rain, Inc. in Longmont has archived data for the station. More is known about Plains Region flooding, especially near Longmont. The flood of record occurred in June of 1949, although a large flood occurred in May of 1969, which destroyed the South Pratt Parkway Bridge. Damage caused by debris washed down the channel is routinely cited as a major problem with bridges and highways. The 1981 FIR for lower Left Hand Creek recounts detailed descriptions of major events.

According to Boulder County's 2012 FIS, "flooding occurred in the Left Hand Creek watershed in 1864, 1876, 1894, 1921, 1938, 1949, and 1951" (pg. 18). Other floods of significance occurred in 1913, 1965, and 1969. The most damaging events along Left Hand Creek described in the Boulder County Multi-Hazard Mitigation Plan (2013) occurred in the summer months. These events were caused by a mix of snowmelt runoff and heavy rains, or just heavy rains alone. Several of the events washed out bridges, roads, and culverts and also damaged houses. Farmlands, crops, and irrigation headworks were also damaged by a couple of the events. Wildfires in the County have increased flood and debris flow risk.

Jamestown has also had several damaging floods. In June 1894, a flood roared down James Creek and washed away much of the low-lying area of the town. Heavy rains accompanied by heavy spring runoff caused the flood. Most of the houses on the north side of Main Street were ruined or washed away, as was much of the road. A similar flood occurred in August 1913, damaging or destroying almost every house along James Creek. All wagon bridges and footbridges were destroyed, and it took two weeks to open the road to traffic. In August 1955, a brief cloudburst, lasting approximately 30 minutes, damaged four bridge and culvert crossings and deposited several inches of mud in local residences. The town was also flooded in 1965, and again in May 1969, following three days of heavy snow and rain. The floodwaters left the normal channel, destroying a number of buildings and the town water supply. In 1969, readings by members of the University Institute of Arctic and Alpine Research showed snow content or rainfalls of 6.56 inches at 10,000 feet, 9.10 inches at 8,500 feet, and 8.90 inches at 7,200 feet (USACE 1980). Flood damage estimates in a 9-county area were $7,000,000, including $700,000 for roads and bridges in Boulder County alone. The photos in **Figure 8** show the similar nature of the 1969 and 2013 floods in Jamestown. In both floods, structures along the creek were washed away and the road was eroded. The damage from the September 2013 flooding, described in Section **1.2**, was estimated to be even greater than that of the 1969 flood. Public and private roads were hit especially hard, including many of the creek crossings. **Figure 9** and **Figure 10** show road structure damage.

Figure 8. Flood Damage in Jamestown in 1969 (left) and 2013 (right)
(source: University of Colorado 2014 and New York Times 2013, respectively)

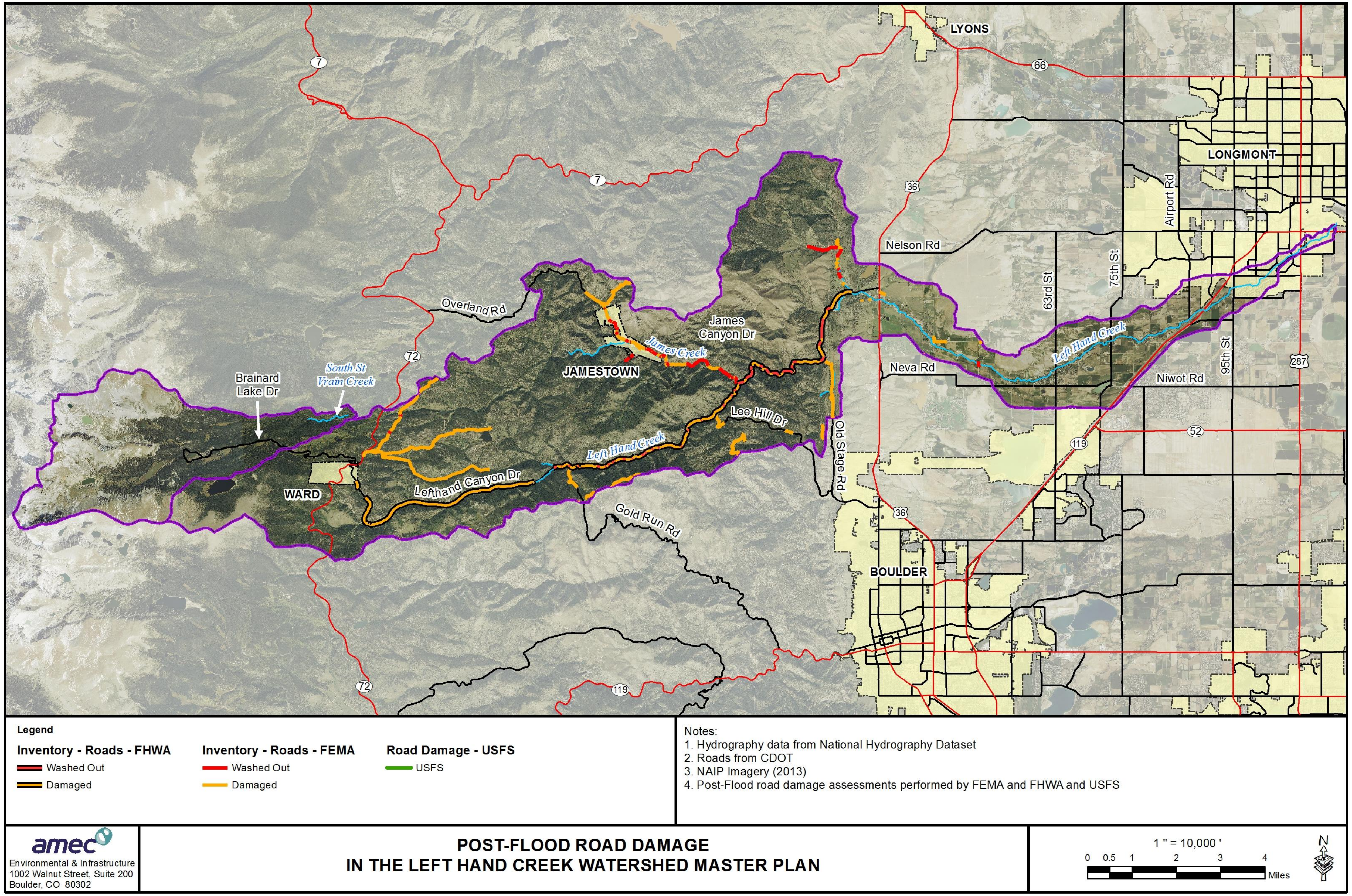


Figure 9. Post-Flood Road Damage in Left Hand Creek Watershed

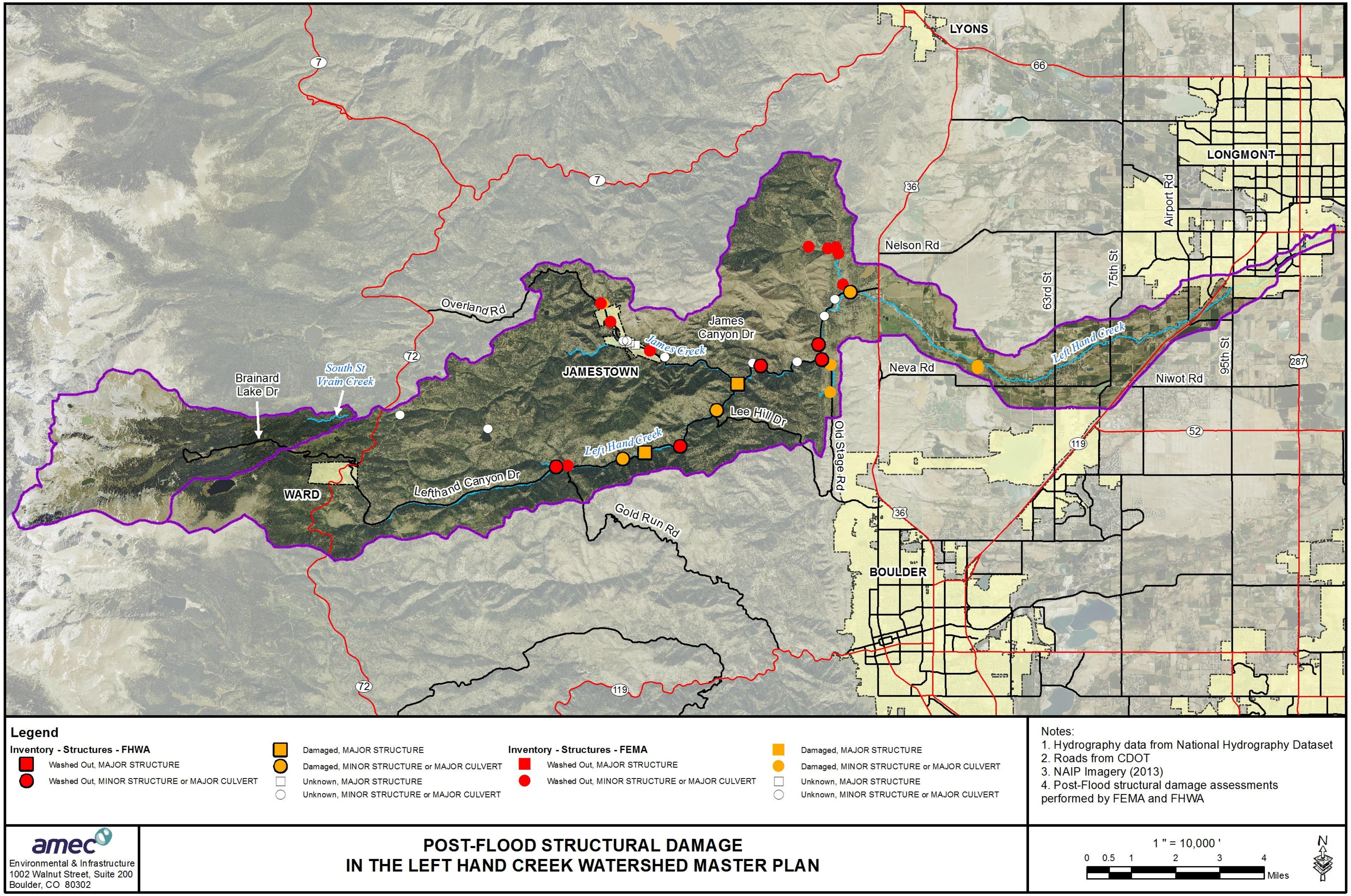


Figure 10. Post-Flood Public Structure Damage in Left Hand Creek Watershed

3.5 Related Plans and Documents

The LHCWMP built upon flood recovery and mitigation policies and projects developed through other planning efforts and documents. Related documents include:

- Boulder County Natural Hazard Mitigation Plan (2013)
- Boulder County Comprehensive Plan (in development)
- Boulder County Emergency Operations Plan
- Boulder County Land Use Code, Article 4 and Article 7
- Boulder County Flood Insurance Study (2012)
- Riparian Inventory and Assessment, Boulder County Parks and Open Space
- St. Vrain Creek Watershed Master Plan
- Coal Creek Watershed Master Plans (Upper and Lower Reaches)
- Boulder Creek Watershed Master Plan (Lower Reaches)
- Fourmile Creek Watershed Master Plan
- Little Thompson River Master Plan
- South Boulder Creek Flood Mitigation Planning Study
- Town of Jamestown Stream Corridor Master Plan Technical Memorandum
- Watershed Management Plan for the Upper Lefthand Creek Watershed, Boulder County, Colorado
- Exceedance of Probability Analysis for the Colorado Flood Event, September 9-16, 2013
- CDOT/CWCB Hydrology Investigation Phase One – 2013 Flood Peak Flow Determinations
- Draft Hydrologic Evaluation of the Lefthand Creek Watershed Post September 2013 Flood Event
- Endangered Species Act Compliance on Flood-Related Projects and Platte River Depletions Following the September 2013 Flood Event
- Longmont Phase 2 Project Description
- South Platte Basin Implementation Plan (in development)
- Landslides in the Northern Colorado Front Range Caused by Rainfall, September 11-13, 2013, USGS

The Coalition should refer to these documents when monitoring progress on project implementation. It may be advantageous to link the goals, objectives, recommendations, and projects in this plan to those of other plans and documents when pursuing funding. Full references to these documents are provided in the *References* section.

4 Risk Assessment

4.1 Overview

Risk assessments help to understand what assets are present in the watershed, determine their exposure to damage, and to weigh the consequences of future flooding. Conventional risk models equate risk to the product of hazard and vulnerability or probability and consequence. For this project, the risk assessment was divided into three separate analyses; flood, geomorphic, and ecosystem. The common element to all three analyses is that the risk model used is meant to examine both the probability and the consequences of the hazard.

Despite not accounting for the consequence component of risk, FEMA floodplain mapping is used for regulatory purposes and is the primary tool floodplain managers use to determine flood risk. A complete re-mapping of the watershed is beyond the scope of this project. Instead, the flood risk component made determinations regarding the utility of the existing FIS and provided a course of action to address flood hazard mapping updates. Geomorphic risk mapping made use of the River Styles framework to define reach trajectories, which will then be linked to infrastructure and property to assess risk. Ecosystem risk will be assessed utilizing the NRCS SVAP2 assessment methodology.

In an attempt to utilize existing resources, past reports, existing plans, and previously collected flood data were incorporated to the furthest extents possible. While the utility of many past reports was decreased as a result of the magnitude of the September floods, those reports were still able to provide historical context within which to view the recent events. Spatial data was brought into a GIS and served as a basis for each of the risk assessments.

4.2 Floodplain Regulation

Floodplain regulation in the Left Hand Creek watershed has expanded over the years as safety hazards and damage to infrastructure have increased due to rapid growth of affected communities. Much of the floodplain is used for agriculture; however, major transportation corridor crossings and residential development continue to encroach on the flood fringe.

The current regulatory framework as authorized by the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973 consists of Flood Insurance Rate Maps (FIRMs) depicting Special Flood Hazard Zones (SFHAs). This mapping is developed and updated through a Flood Insurance Study (FIS), which combines technical documentation of the hydrologic and hydraulic studies (FIRs) used to create flood profiles establishing the Base Flood Elevation (BFE) from various flooding sources. The base flood has been established as the design event which has a one percent chance of being exceeded or equaled in any one year, and is sometimes called the 100-year or Intermediate Regional Flood.

Minimum floodplain management requirements for participation in the National Flood Insurance Program (NFIP) are set forth in the Code of Federal Regulations at 44 CFR, 60.3. The FIS develops flood risk data which is used to establish actuarial flood insurance rates in order to compensate land owners for damages due to flooding and to provide land use planners and community officials with a regulatory instrument for sound land use management and infrastructure policy decisions. The communities within the Left Hand Creek watershed which participate in the NFIP are listed in **Table 4** and shown in **Figure 11**.

Table 4. NFIP Participation in the Left Hand Creek Watershed

Community	Region	Panel
Jamestown	Mountain	219J, 0357J
Ward	Mountain	334J
Boulder County	Mountain	240J, 245J, 342J, 355J, 360J, 365J, 376J, 377J, 378J, 379J, 385J
Longmont	Plains	268J, 269J, 288J
Boulder County	Plains	245J, 289J, 385J, 401J, 402J, 407J, 410J

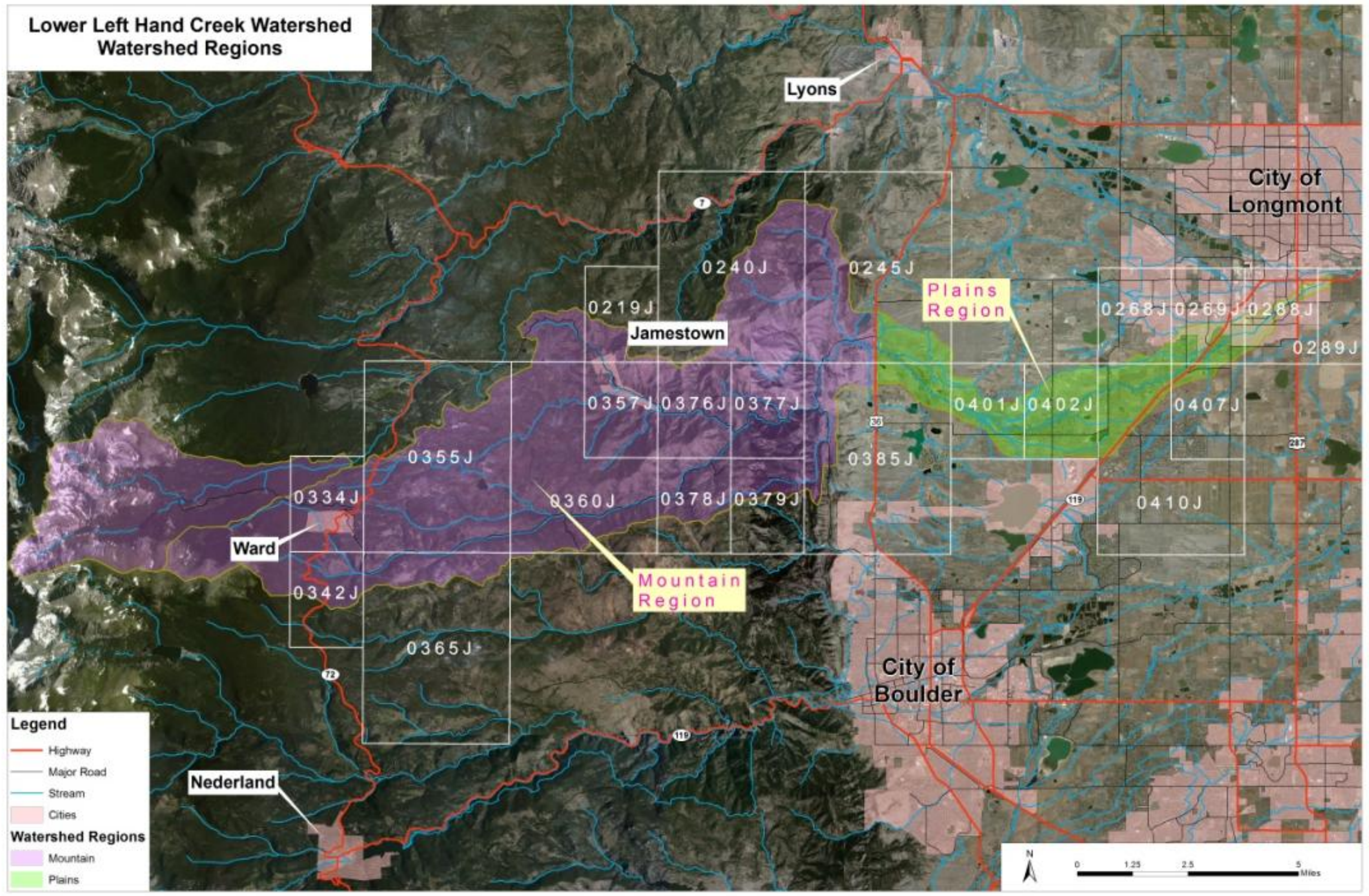


Figure 11. Watershed Regions

4.2.1 *Previous studies*

Damages due to flooding have long been an issue in the James Creek watershed. The USGS published a report in 1962 (Jenkins 1962) which estimated flood depths and profiles for St. Vrain and Left Hand creeks for the 25 and 50-year events based on a regression analysis of gaging stations along the front range and a backwater analysis using approximated section geometry. The study also noted potential damages to bridges due to erosion from high water velocities.

In 1969, the Denver Regional Council of Governments (DRCOG) published a report prepared by the USACE (USACE 1969) which computed backwater profiles for the Intermediate Regional, or 100-year and Standard Project Flood defined as “from 40 to 50 percent of the Probable Maximum Flood”. This study established the original hydrology for the watershed utilizing a log-Pearson Type II analysis of peak runoff data recorded at gages on St. Vrain Creek near Lyons and Platteville in accordance with U.S. Water Resources Council (WRC) Bulletin 15. The study area extended from Hwy 287 in Longmont to upstream of Hwy 36, and noted overtopping of several bridges. In conjunction with DRCOG, population and land use statistics were compiled along with base flood elevations for this FIR which provided the first basis for land use management in the floodplain.

4.2.1.1 Flood Insurance Studies

In 1972, the Soil Conservation Service (SCS, now the NRCS) completed the first FIS for Boulder County (SCS 1972), Longmont in 1973 (HUD 1973) and Jamestown in 1975 (HUD 1975). These led to initial FIRMs being published in 1979, 1977 and 1983, respectively.

In 1980, the USACE completed a detailed study of the St. Vrain Watershed, including Left Hand Creek and James Creek using hydrology developed with EPA’s SWMM model (USACE 1980), and developed backwater profiles for James Creek with HEC-2. In 1981, Gingery Associates (Gingery Associates 1981) prepared a study of Left Hand Creek for Boulder County and Longmont from the confluence with St. Vrain Creek to approximately 0.5 miles above Foothills Highway (Hwy 36) utilizing the same methodology, and in 1983, Simons and Li extended the study area through Ward on Left Hand Creek (Simons and Li 1983). **Table 5** lists parameters of interest for the study areas.

Table 5. Study Parameters

Reach	Physiography		Hydrology						Hydraulics				Study	
	Reach Length (Miles)	Slope (Ft/Mile)	Method	Duration (Hr)	Infiltration (Inches)	Storage (Inches)	Min Q (cfs)	Max Q (cfs)	Method	Mannings N Channel	Mannings N Overbank	Bridge	Date	Reference
James Creek			SWMM (WRC-17b)	1	1.0	0.5	1,160	4,810	HEC-2	0 075	0.08	Un-obstructed	1980	6
Left Hand Creek – Plains	13.7	8.5 - 136	SWMM (WRC-17b)	6	1.0	0.3	4,610	6,700	HEC-2	0.040 – 0.045	0.050 – 0.100	Un-obstructed	1981	7
Left Hand Creek - Mountains			SWMM (WRC-17b)	1 - 6	1.0	0.3 – 0.5	3,180	6,700	HEC-2	0.06 – 0.120	0.08	Obstructed	1983	8

4.2.1.2 FIRM Revisions

Map revisions generally take place through a Letter of Map Change (LOMC) which is then processed and approved through FEMA. Structures located in the floodplain may be removed or added through the Letter of Map Amendment (LOMA) process by issuing an Elevation Certificate, while physical revisions are handled through Letters of Map Revision (LOMR's). The LOMR process entails defining a study area, matching any existing detailed study analysis (effective model), updating any changes in stream geometry or datum (corrected effective model) and adding any manmade structures which have been installed (existing conditions model), and documenting any changes to Base Flood Elevations.

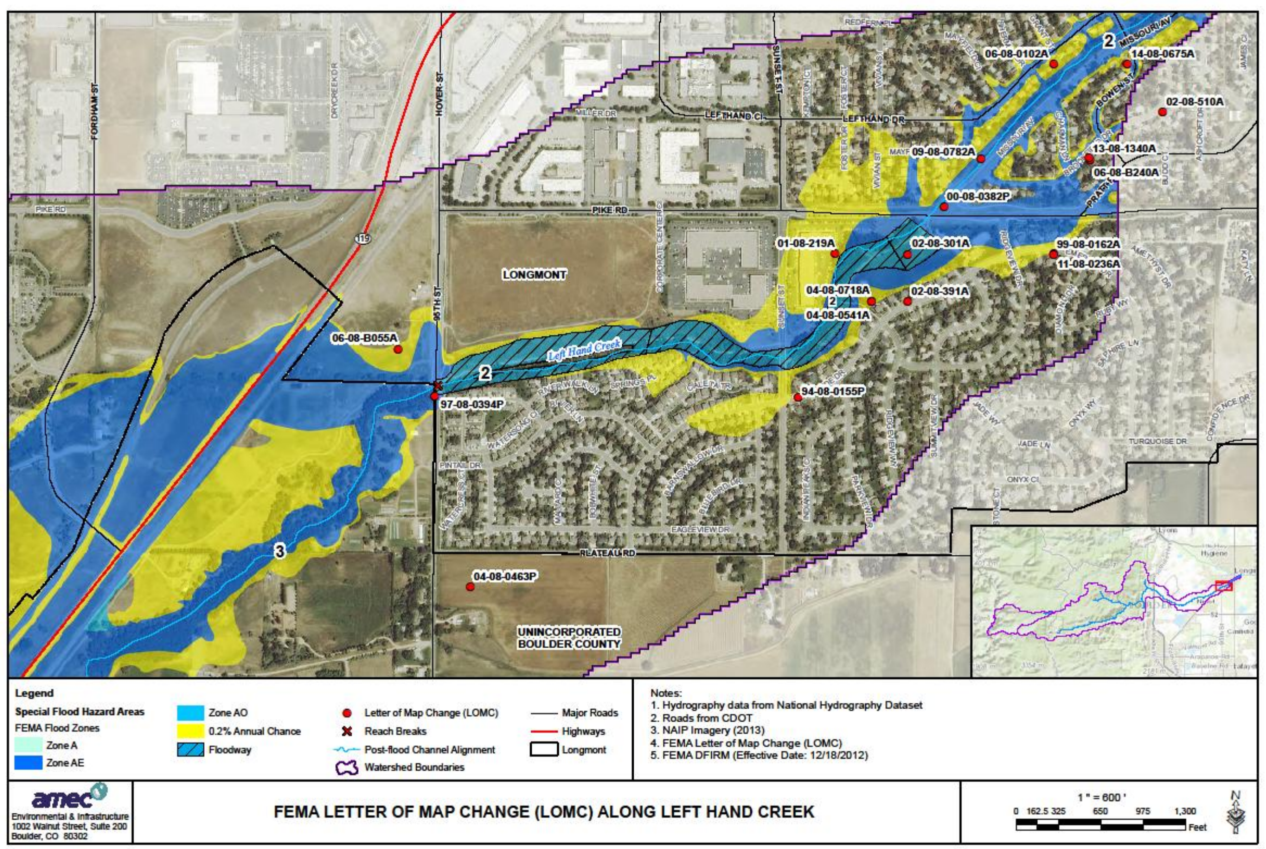


Figure 12. LOMCs along Left Hand Creek

Proposed changes are modeled through the design process and a request is made for a Conditional Letter of Map Revision (CLOMR). Periodically, complete sets of community panels are updated with all past LOMC's, however if changes are made to a substantial reach involving multiple panels, a Physical Map Revision (PMR) is requested with supporting technical documentation.

The FIRMs for Longmont were revised in 1987 and Boulder County in 1988, and all of Boulder County was revised in 2012 to reflect LOMC's published at that time. The FIRM for Jamestown has not been revised since its first publication in 1983. **Table 15** in **Appendix B** lists 65 LOMC's which have been processed or are still open in the Left Hand Creek watershed. Of these, 26 have occurred after the last community FIRM update (J suffix), although many have now been updated in the electronic DFIRM database. There are currently several projects underway which have or will produce CLOMR's, particularly in the City of Longmont. Additional information on these projects may be useful in the future evaluation of mapping needs. **Table 6** lists current LOMC's by panel.

Table 6. Current LOMC by Panel

Panel Number	LOMCs
288J	6
402J	19
410J	1

4.2.1.3 Post Flood Studies

The flooding of 2013 provided a stark reminder of the need for floodplain regulation in the Left Hand Creek watershed. Damage to infrastructure and drastic changes to the fluvial system have reinforced the need for a better understanding of the methodologies used to model and delineate flood hazards.

Hydrology
Peak flow discharges in the riverine system are modeled and are combined with models of the watercourses and floodplain to map the physical limits of the floodplain in terms of depth, width and velocity for floods with varying magnitudes, based upon the likelihood of them happening in a particular year. The original hydrologic study was performed over 35 years ago. While land use in the Upper Watershed has not changed drastically, we have gained a better understanding of its response to rainfall, and have a greater and more accurate record of streamflows from which to draw statistical insight.

In August of 2014, CDOT published a hydrologic evaluation of the Left Hand Creek watershed in the Mountain Region (Jacobs Engineering 2014). The study utilized the USACE Hydrologic Engineering Center's Hydrologic Modeling System (HEC-HMS) to calculate peak runoff from physical parameters derived from GIS data and NOAA design rainfall events. The model was calibrated using meteorological data from the September 2013 storm event and peak discharge estimates from field investigations. Rainfall data and corresponding flow data were developed by Bob Jarrett, USGS retired, of Applied Weather Associates (AWA) utilizing methods he developed over his years at the USGS. These observations are tabulated in a letter to CDOT by Kevin Houck of the CWCB which is located as Appendix B of the referenced CDOT report (Table 1 – Summary of Observed Discharges and Frequency Estimates). It is of note that the discharge calculated by Mr. Jarrett for Left Hand Creek above Hwy 36 (3,520 cfs) was estimated to be representative of the 1%-2% exceedance probability. In other words, the 2013 flood on Left Hand Creek was between the 100 and 50-Year event as computed by the 1972 SCS study, but was noted as the 50-Year event in recommendations to CDOT by Kevin Houck of the CWCB in a memorandum dated July 16, 2014. While this study provides a great foundation to use as a basis for the mountain portion of the watershed, it does not cover the area of the watershed below US 36.

The SCS Curve Number method was used for the CDOT study to simulate infiltration losses, calculated from an aggregation of cover and soil type among 18 sub-basins. The Snyder Unit Hydrograph method was selected to transform the runoff response and Muskingum-Cunge for channel routing. A reasonably good fit was obtained for the calibrated model to the field-estimated discharge levels of the September 2013 flood, however there are significant differences between the simulated peak discharge rates from synthetic design storms (10 – 500-year) compared to the published FIS flows computed in 1974. Flood discharge rates are rarely changed with good reason as this affects every regulatory profile associated with them. Phase II of this study, currently underway, will enlarge the scope to include the entire watershed to the mouth of Left Hand Creek at St. Vrain Creek. Until the revised hydrologic analysis has been completed, reviewed and either adopted or discarded, any new hydraulic modeling or mapping should be based on effective FIS flood discharges.

Hydraulics

In addition to the recent hydrologic modeling performed for the watershed, an inundation area for the 2013 event (Boulder County Land Use 2014) was recorded by the National Geospatial Agency and supplemented with observations made by Boulder County Land Use and Parks and Open Space using imagery from the Digital Globe First Look product. This coverage is currently available from the Boulder County data repository and has limitations in that it contains inaccuracies and errors.

In addition, LiDAR imagery that was obtained shortly after the floods was used for input to an automated hydraulic modeling algorithm performed by Atkins Global, Inc. for CWCB. The model was adjusted manually in some areas but depended largely on the density of cross section sampling available by the methodology. According to information presented to the CWCB Board in July of 2014 (Resolution 14-650, Atkins Global 2014), “This study uses USGS regression equations for hydrologic information, and hydraulic information was derived using automated methods associated with post-flood LIDAR mapping that was flown following the 2013 flood. The model and the results were published as an interim mapping product on the Boulder County data repository (Houck 2014). Staff findings are as follows:

> *“CWCB staff has determined that the subject 100-year approximate floodplain information for the studied stream reaches is in conformance with the CWCB’s rules and regulations for floodplain designation and approval. CWCB staff therefore endorses this study as containing the most current floodplain mapping available and encourages the affected communities to consider adopting said study for land use regulation purposes pursuant to statutory authority. This information is considered provisional and temporary, and is not intended to rescind any previous designations for the subject streams. It is left to the discretion of the community to determine if this study represents better available information for the purposes of administering the local floodplain ordinance during the flood recovery and redevelopment process.”*

While this effort is certainly helpful, it is not without issue. The LiDAR flown after the event represents the conditions at that time. Many areas of the channel have been reworked by restoration and infrastructure projects, emergency protection work, and spring runoff. Therefore the geometry used may not represent the current channel and floodplain configuration. The stream channel above US 36 will be re-surveyed as part of the Boulder County Roads project. Hydraulics models are also scheduled to be updated as part of that project. However, the area below US 36 to Longmont is not included in the project and will need to be studied and modeled.

4.2.2 Flood Risk Analysis

In order to gain a better understanding of how this information can be used to prioritize flood hazard mapping updates, an analysis was performed by AMEC to compare the currently published regulatory SFHA limits to the post flood observations and modeling noted above.

The current DFIRM data for the county was processed for the combined Left Hand and St. Vrain watersheds to analyze the combined flood zones. This coverage was then combined with the 2013 flood inundation area and interim flood hazard coverage. This combined coverage was then intersected with the county’s parcel boundary coverage to produce a database containing areas common to each of these coverages. The database was then processed to produce the statistics cited below. The economic valuation was performed by calculating the percentage of each parcel in the subject zone, applying that percentage to both the land value and the building value, and totaling each by category. The totals are representative of damage potential from an area perspective only, and do not include a full risk assessment by depth of flooding. Dollar amounts are estimates only based on current land assessment and percentage of parcel area located within a regulatory flood zone and should only be used for broad scale comparison and planning purposes.

4.2.3 Results

The plains region constitutes approximately 12.4 square miles of the watershed (**Figure 13**). This region, which was first brought into the NFIP in 1979, currently has approximately 900 acres (ac) designated as zone AE with 560 ac in the 500 year designation. Traditionally, the plains region has been predominantly agricultural, however as the City of Longmont grows, this area is becoming increasingly urbanized. As agricultural parcels are subdivided into residential and commercial lots with higher market value the damage potential increases. According to data found in the county parcel database, the land currently mapped within the AE zone within the plains region (base flood zone including floodway) is valued at about $56,400,000 while land in the 500-year floodplain is valued at $104,800,000, for a total of about $161,200,000.

During the September flooding, the configuration of the floodplain shifted as a result of flood processes (e.g., avulsion, channel expansion, aggradation, etc.). This fluvial change was recorded with the inundation area coverage described above. While there are mistakes and issues with the inundation area dataset, it does provide a general indicator of locations where the floodplain was likely reconfigured. For example, areas that have a large areal discrepancy between the SFHA and inundated area are likely areas that have been re-worked, geomorphically. **Figure 14** shows an area where the 2013 flood inundated a parcel valued at $273,000 by the Boulder county tax assessor. This parcel was not included in the 100-year SFHA and was therefore not eligible for federally subsidized flood insurance. Extending this analysis across the entire plains region, approximately $35,000,000 worth of property that was located in the SFHA was inundated, while approximately $7,200,000 worth of property was inundated by this event but is not presently included in the SFHA.

In the Mountain Region (**Figure 15**), the area of the SFHA comprises a much smaller area due to the lower discharge and the narrow valley sections. For Upper Left Hand Creek, there is only about 342 ac of AE zone and 103 acres in the 500-year zone totaling about $6.7 million dollars in land and structure value combined. As noted previously, the "Interim" flood zone area, which is based on unverified post 2013 flood topography, has been recommended for use by communities as a provisional flood hazard delineation for recovery purposes. However, these provisional floodplain limits are much smaller than the current regulated floodplain limits in the Mountain Region (**Figure 16**). Considering only those areas located in the interim flood zone, the total property value drops to less than $3 million dollars.

These results highlight potential discrepancies that exist between the information used to define regulated and un-regulated areas of the floodplain. Due to the extensive re-working of the channel by the flood and the amount of work performed on the channel since, the geometry used to determine the regulatory SFHA is not representative of the existing floodplain configuration.

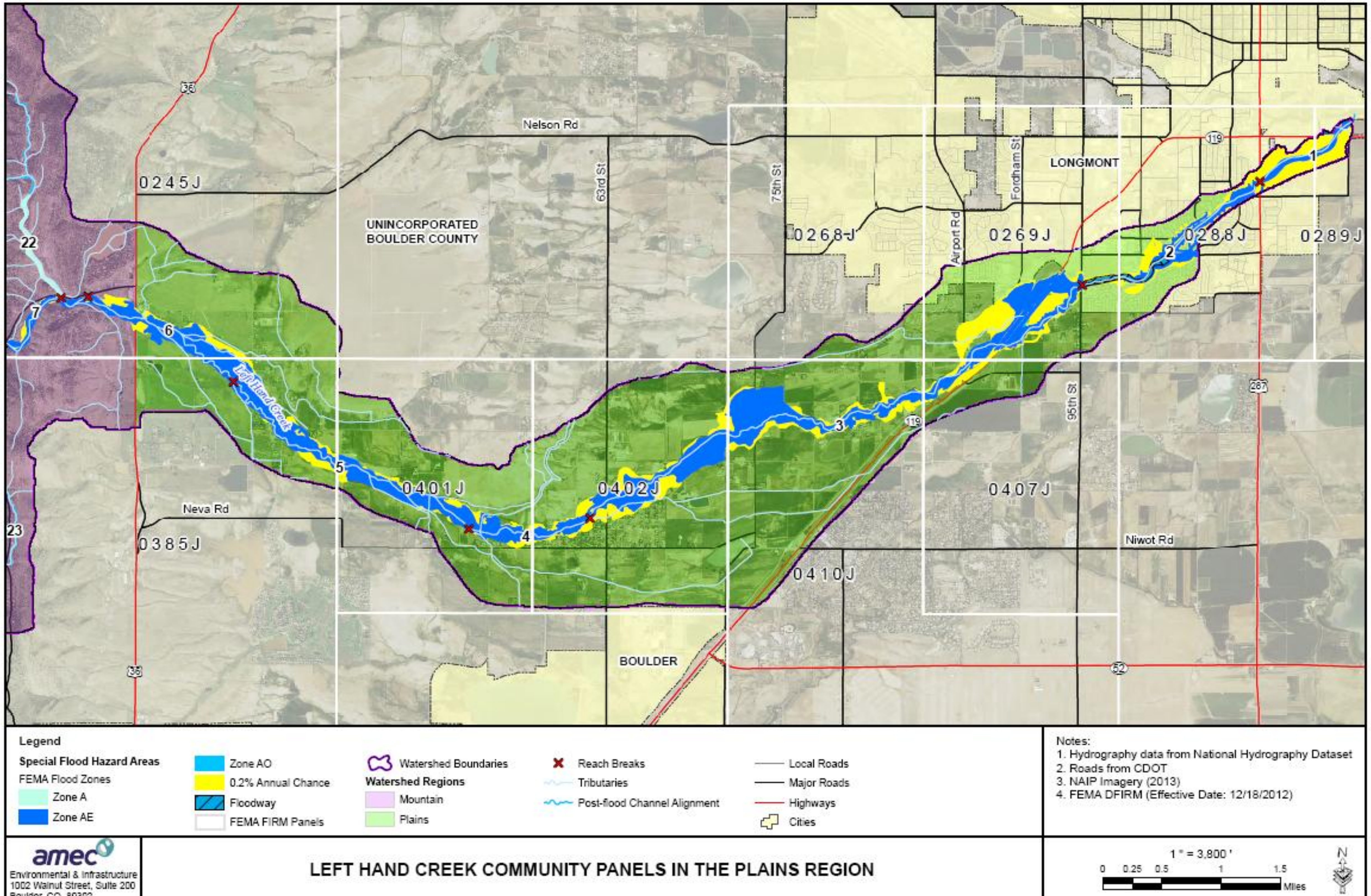


Figure 13. Community Panels in the Plains Region

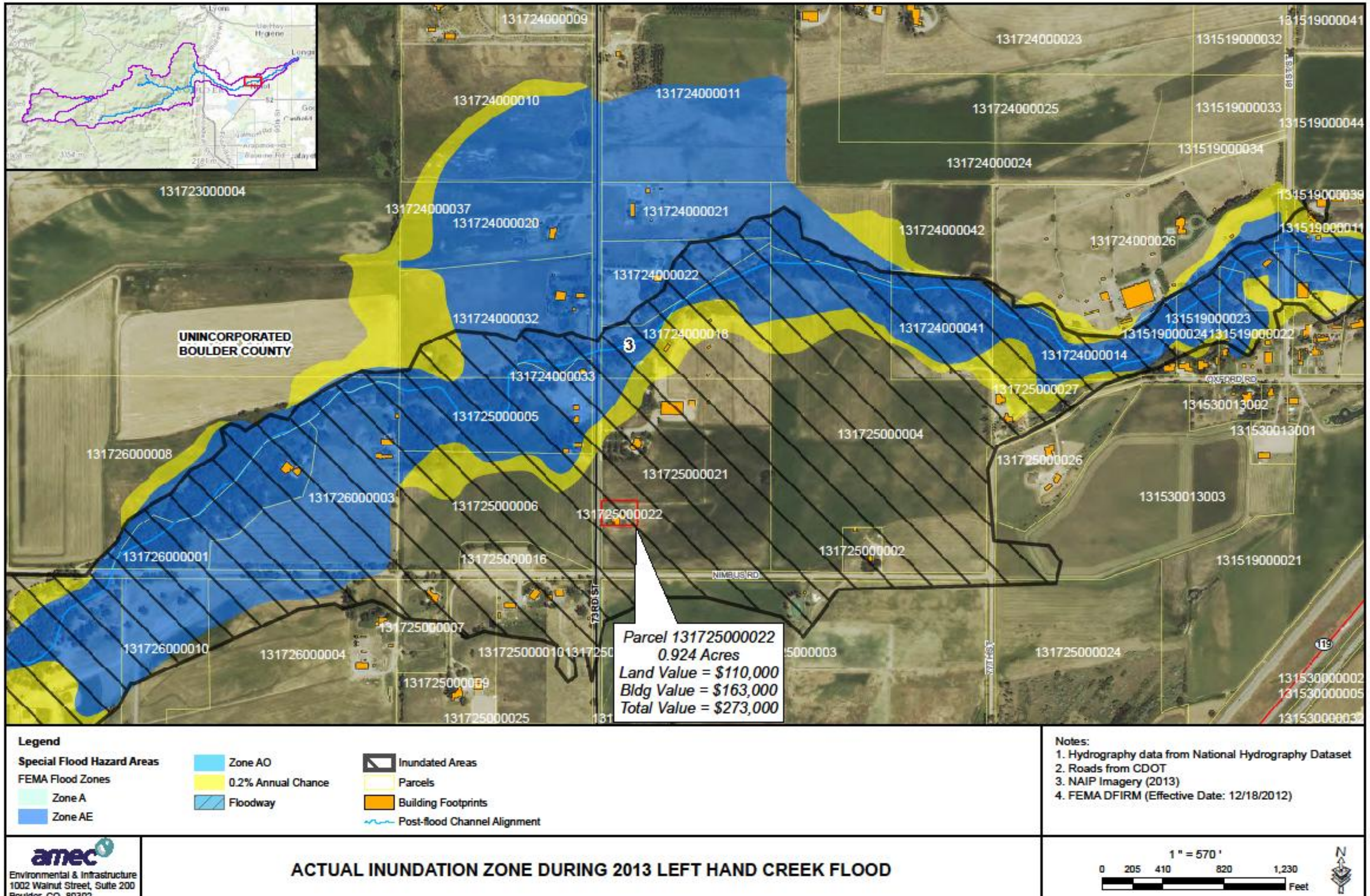


Figure 14. Actual Inundation Zone During 2013 Flood

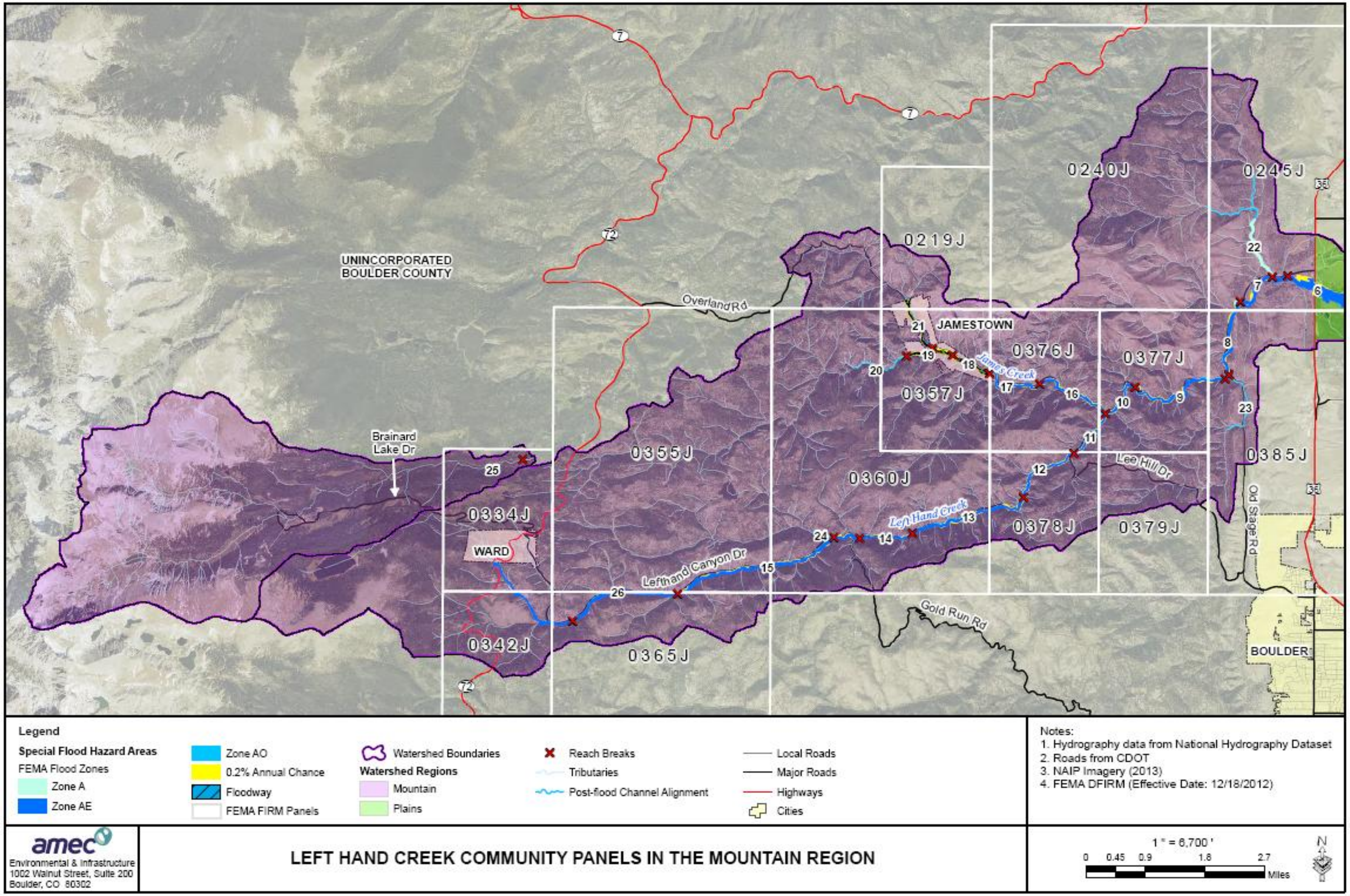


Figure 15. Community Panels in the Mountain Region

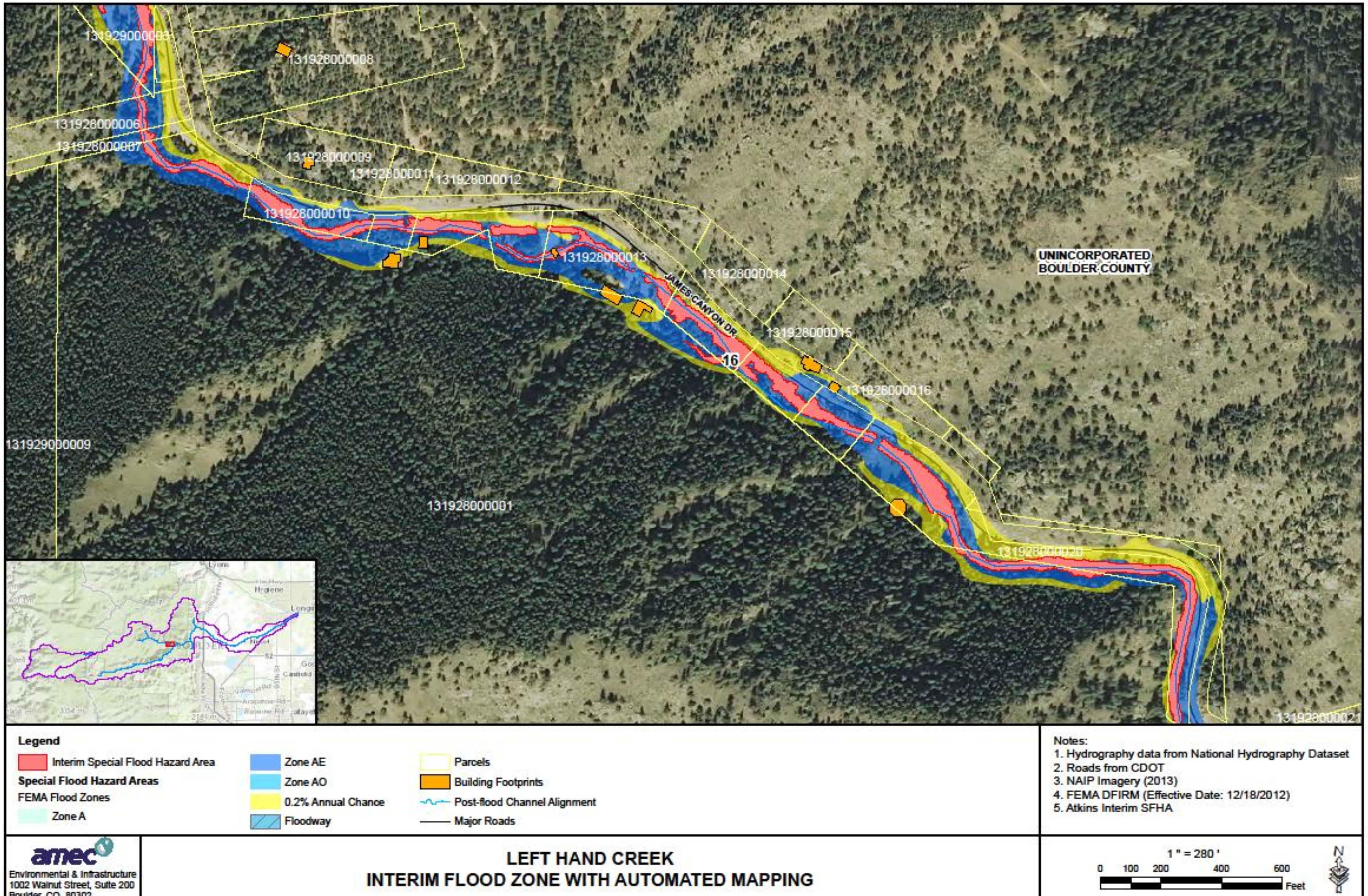


Figure 16. Interim Flood Zone with Automated Mapping

4.3 Geomorphic Risk

The geomorphic risk assessment is based on a rapid geomorphic assessment utilizing the River Styles stream classification methodology. The goal of the method is to identify the spatial extent of dominant controls on the downstream behavior of the stream channel and floodplain. In general, the application of the River Styles framework to this project involved a desktop analysis of available GIS data, identification of River Styles, summary and mapping of the field data, and some basic stream power calculations. These tasks are elaborated upon below.

4.3.1 Methods

4.3.1.1 Desktop Analysis

The desktop analysis of the GIS data for the geomorphic risk assessment was focused on mapping the current channel alignment, calculating channel slopes, assessing valley and channel confinement, breaking the study area into reaches, and determining the position of the reach within the watershed. In all, the study identified 26 reaches to be handled individually in the analysis.

Reach breaks were identified using the DEM of Difference calculation (i.e., difference between the pre-flood terrain and post-flood terrain) to identify flood response and an assessment of valley confinement (**Figure 17**). The junctions of major tributaries and prominent infrastructure were also used. For example, the diversion structure at the boundary of reaches 5 and 6 diverts nearly all of the water in the channel during the irrigation season so this feature was chosen as a reach break. **Figure 18** shows the LiDAR terrain surface and DEM of difference for Reach 6, located near US 36.

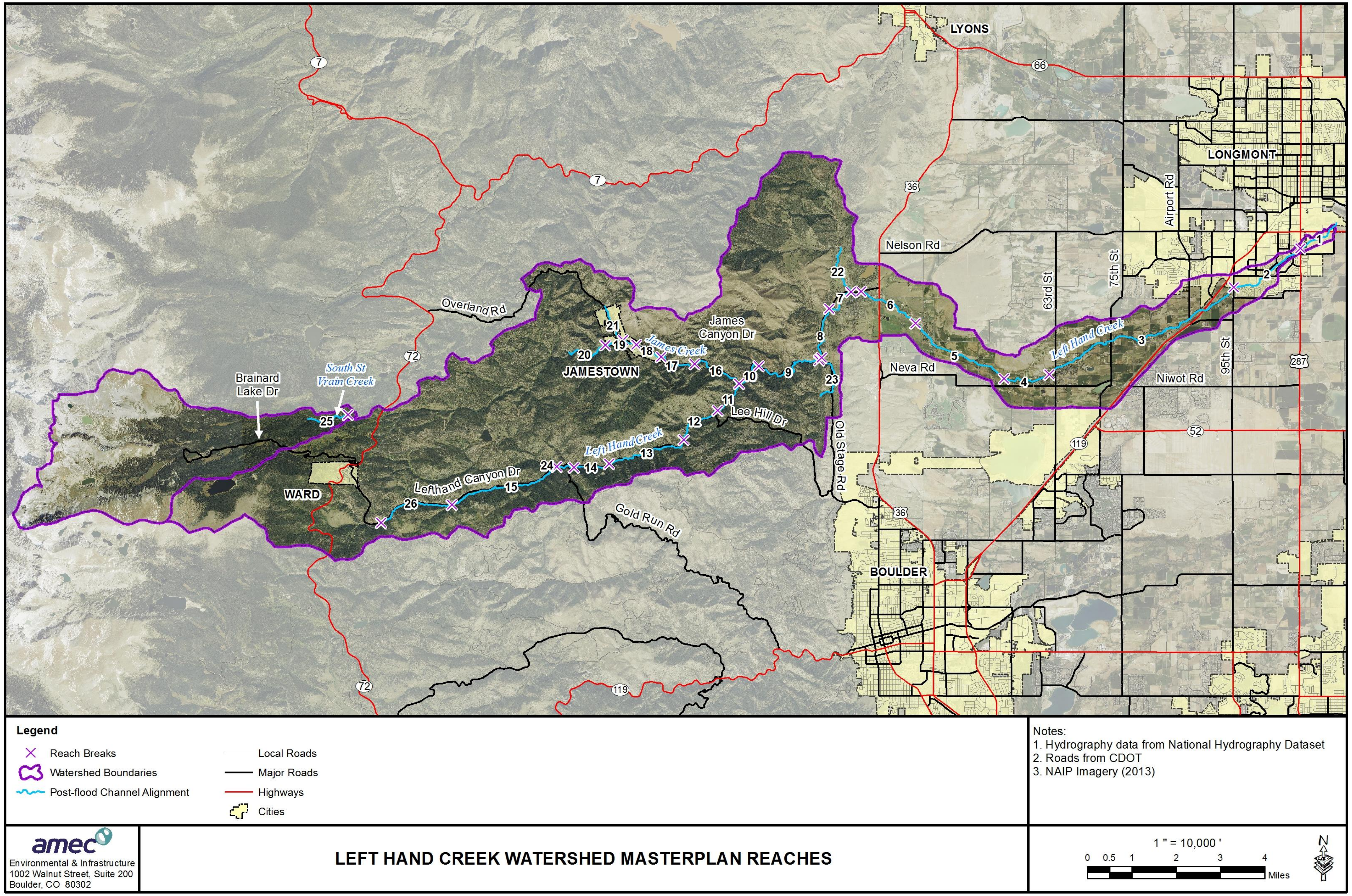


Figure 17. Left Hand Creek Watershed Reaches

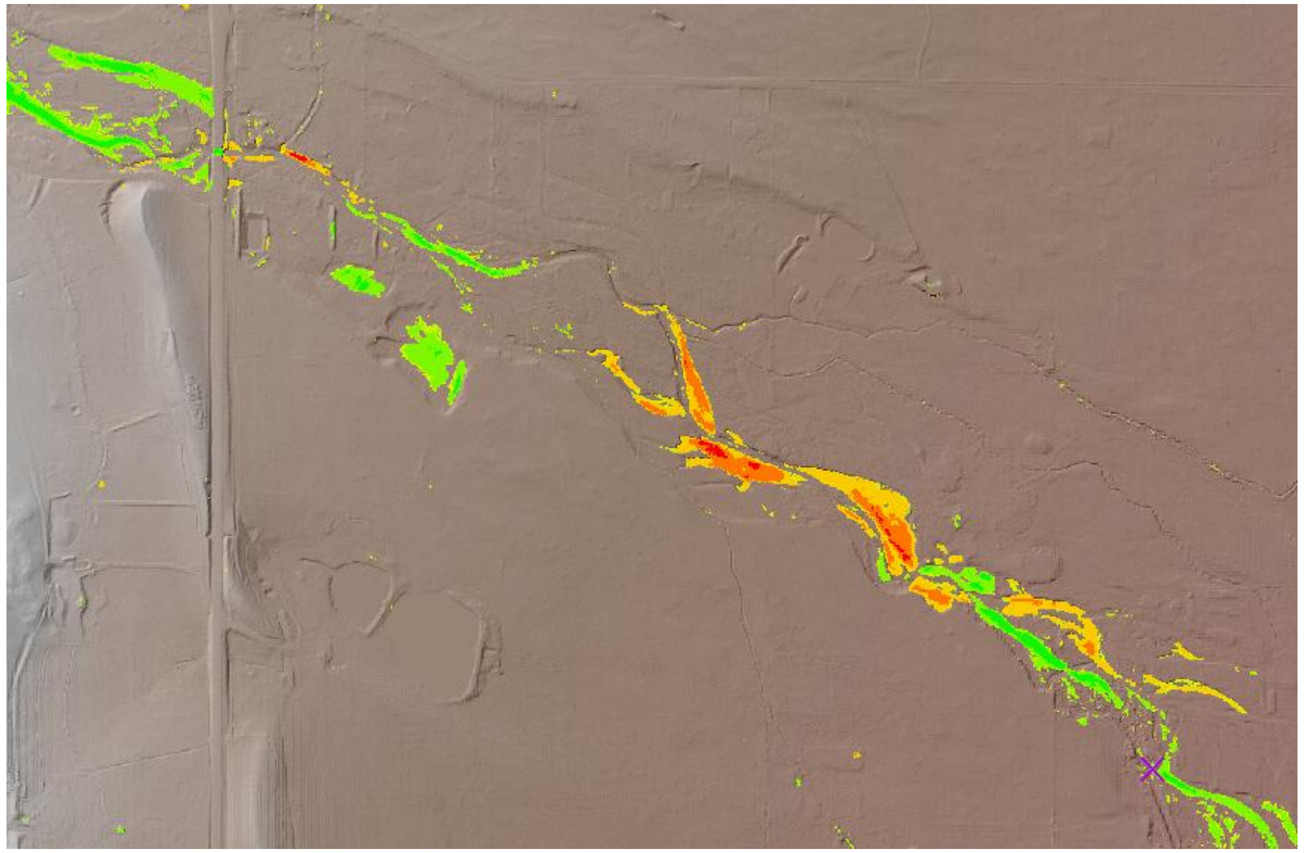


Figure 18. Scour and Deposition Downstream of US 36
DEM of difference for the reach just downstream of US 36. Red/orange/yellow indicate scour, green indicates deposition.

The DEM of Difference also offers much information about the condition of each reach and the means by which the reach adjusts to flood flows. In **Figure 18** above, as the flows drop much sediment and debris in response to the change in confinement and gradient, the stream expends energy by adjusting laterally. This results in the migrations and avulsions that can be seen in the DEM of Difference. Clearly, restoration and channel work that attempt to hard armor the channel in place will have a slim chance of success. The strategy in reaches like this should be to first explore options for letting the channel spread out, dissipate energy and migrate across the floodplain.

The LiDAR terrain model itself also offers much insight into the landscape and river behavior. Valley confinement can be assessed by measuring channel and valley widths, noting the position of the channel relative to the valley floor. Channel incision can be estimated by cutting virtual cross sections at any location. These types of measurements and observations offer a lot to the reach risk assessment tasks, but the DEM of Difference and LiDAR terrain model represent a static snapshot in time. Much channel work has taken place since the datasets were collected, so the assessments completed on the desktop were field verified.

4.3.1.2 Fieldwork

In order to inform, and confirm the results of, the desktop assessment, sampling and assessment locations representative of each reach were identified and visited during the course of a week. Geomorphic assessments, including channel geometry measurements and pebble counts, were conducted in each reach. Key geomorphic characteristics such as channel confinement, bank condition and failure modes, and channel evolution/flood response were recorded. Reach-representative locations were determined for channel geometry and pebble counts. Due to the timing of these assessments (i.e., taking place after a historically large flood event), much of the channel has expanded and has yet to develop significant bedforms (e.g., pools, riffles). As a result, many reaches appear to be one long riffle.

Pebble counts were conducted in order to assess bed stability. Again, given the post-flood timing of these assessments, the counts are marginally useful – many of the larger grains are packed with fines and sand making them likely to transport during larger flow events. As flows begin to develop bedforms, the grain size distributions for project sites will need to be re-assessed. **An example field sheet, showing grain size distribution data from Reach 8, can be found in Appendix B.**

4.3.2 Results

4.3.2.1 Identification of River Styles

The LHCWMP classifies each section of creek into one of six River Styles. This classification structure allows for the assessment and evaluation of multiple sections of creek that are similar in need, but may be geographically dispersed throughout the study area. A large emphasis is placed on valley confinement because it is a key control over the channel's ability to adjust. For example, in the confined reaches of the mountain and canyon portions of the watershed, the location of floodplain indicates where the channel can source or store sediment. Floodplains are also locations where streams can dissipate flood energy. In addition to valley confinement, channel planform, geomorphic units and position within the landscape were used to group each of the reaches reach into six River Styles.

The traits and properties of each River Style are discussed in detail in Section **4.3.2.2**. Key properties of each River Style are summarized as follows, and a map of the distribution throughout the watershed is shown in **Figure 19**:

1. Headwater
   - Relatively steep and straight with single thread channel
   - Located high in watershed, few inputs
   - Negligible floodplain
2. Confined Valley with Limited Floodplain
   - Relatively steep and straight with single thread channel
   - Tightly confined valley
   - Negligible floodplain
   - Step-pool morphology with episodic bedload transport
3. Confined Valley with Bedrock-controlled Floodplain Pockets
   - Relatively steep and straight with single thread channel
   - Mostly confined by valley
   - Contains some pockets of floodplain
   - Step-pool morphology with episodic bedload transport
4. Partly-confined, Wandering Channel
   - Moderate gradient with anastamosing channel
   - Partly confined
   - Well developed floodplain in places
   - Pool-riffle morphology with episodic bedload transport
5. Unconfined, Continuous Floodplain
   - Lower gradient with sinuous, anastamosing channel

- Unconfined
- Well developed, extensive floodplain
- Pool-riffle morphology with episodic bedload transport

6. Entrenched, Residential Channel
    - Low gradient , straightened, single thread channel
    - Entrenched
    - Little connection to floodplain
    - Sand bed channel with frequent bedload transport

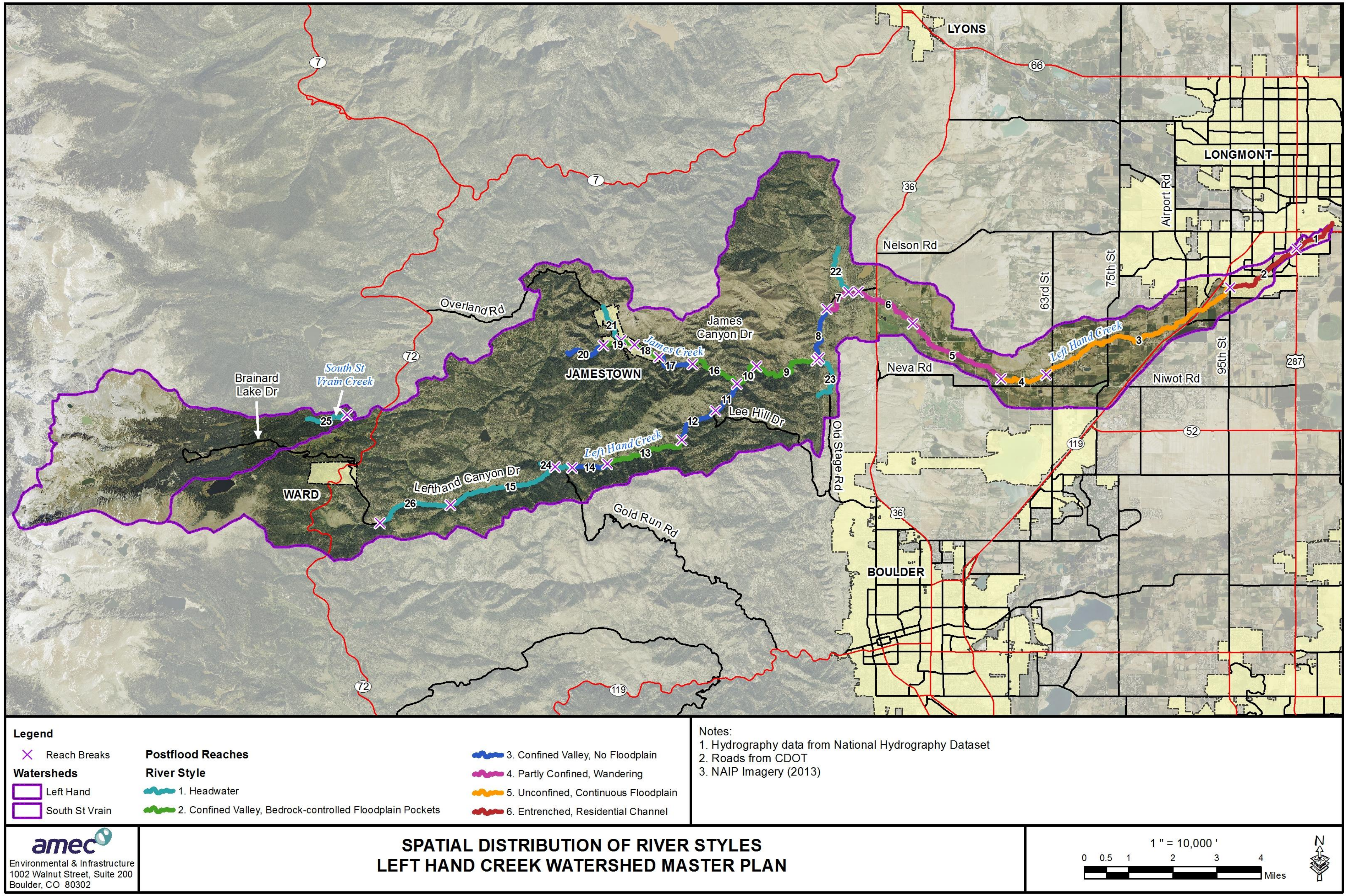


Figure 19. River Styles Spatial Distribution

4.3.2.2 River Styles Definitions

The following definitions have been developed for each River Style to further detail the properties and behavior of each. The information presented in each definition includes descriptions of physical characteristics of each reach (including typical plan, profile, and cross section representations) that should be considered when undertaking restoration and engineering projects in the Left Hand Creek watershed. Additionally, criteria used for the geomorphic condition assessment are included.

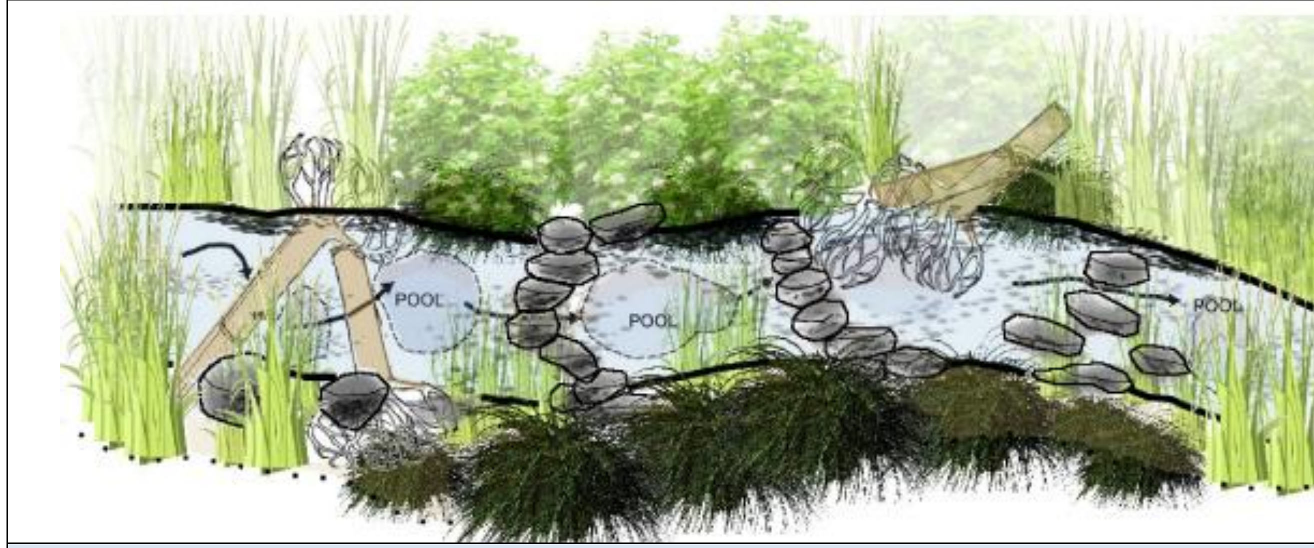
Headwater

Properties: Reaches are generally quite steep and located high in the drainage with no significant tributaries. Channel is fully confined, abutting the valley wall through its length.

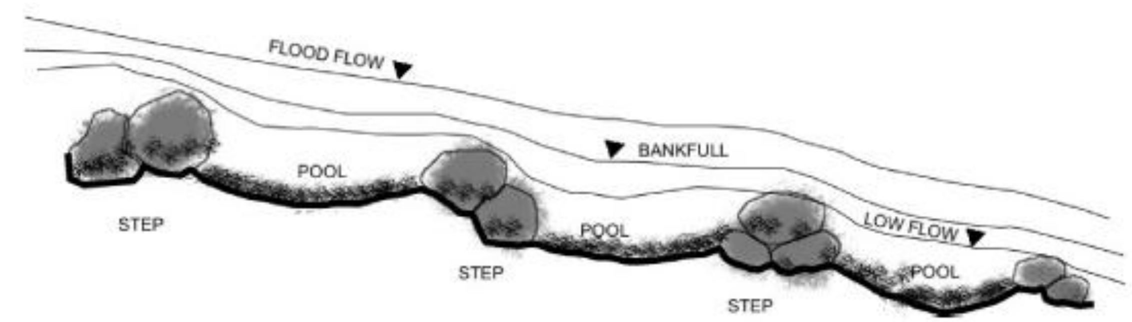
Reaches Observed:	15, 21, 22, 23, 24, 25, 26
RIVER CHARACTER	
Valley Setting	Confined
Channel Planform	Channel is generally straight and laterally stable, being fully confined by the valley walls. Channel adjustments are usually vertical, in response in increased discharge and sediment supply.
Bed Morphology	Bed morphology reflects the channel gradient - step-pool with elements of cascade and rapids.
Geomorphic Units	Pools Bedrock Outcrops and Steps Jams - Located at constrictions Slackwater Deposits - behind and below boulders, LWD Glides or Shallow Pools
RIVER BEHAVIOR	
Flood Response	Flood response in headwater reaches is generally downcutting and scour with the potential for significant influences from culverts and other infrastructure. Plugged culverts can cause backwater impacts leading to extensive deposition.
Stage Behavior	Flows at low, bankfull and flood stages in Headwater reaches are generally concentrated into single channels. Sediment rapidly pulses downstream due to generally steep gradients, depending on the formation of steps and jams. At these locations sediment will deposit in pools. In other locations, sediment will collect along channel margins in poorly formed bars and in slackwater deposits behind boulders, logs and such.
Restoration Considerations	Restoration and rebuilding projects in Headwater reaches should focus on dissipating high energy flows with the use of jams and grade control structures. Headwater reaches have the ability to quickly generate relatively high stream power values, quickly downcutting to bedrock.

Headwater River Style (Cont.)

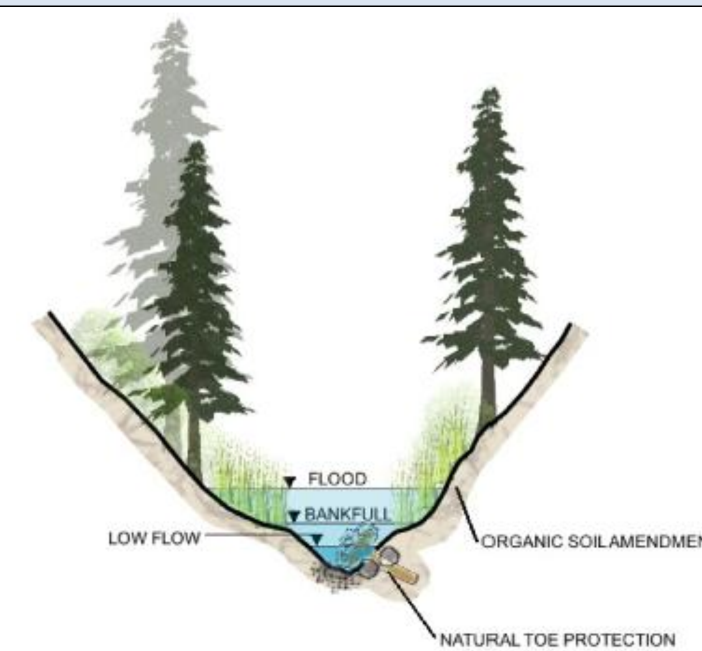
Recommended Restoration Plan



Typical Profile



Typical Cross Section



Headwater River Style (Cont.)	Conditions Assessment Criteria	
Good	Fair	Poor
• Vertically and laterally Stable • Little man-made armor • Intact riparian vegetation • Structural wood present • Well-established bedforms (step-pool, rapids, cascades) • Clean gravels (low embeddedness) organized in instream units • Fines present, but exist as transient deposits • Little evidence of aggradation or degradation	• Eroding Banks (fluvial) • Degraded riparian veg. • Armor (riprap, concrete) present in few locations • Large wood in channel, but may not be structural • Fines present, but organized in bedforms (moderate embeddedness) • Fines present but organized in bedforms (moderate embeddedness) • Bedforms present but not stable • Evidence of aggradation or degradation	• Banks destroyed by mass wasting • Little riparian veg. • Banks heavily armored, grouted riprap used • Channel stripped of large wood • High embeddedness • Channel bedforms absent • Little evidence of aggradation or degradation • Channel clearly aggrading or degrading

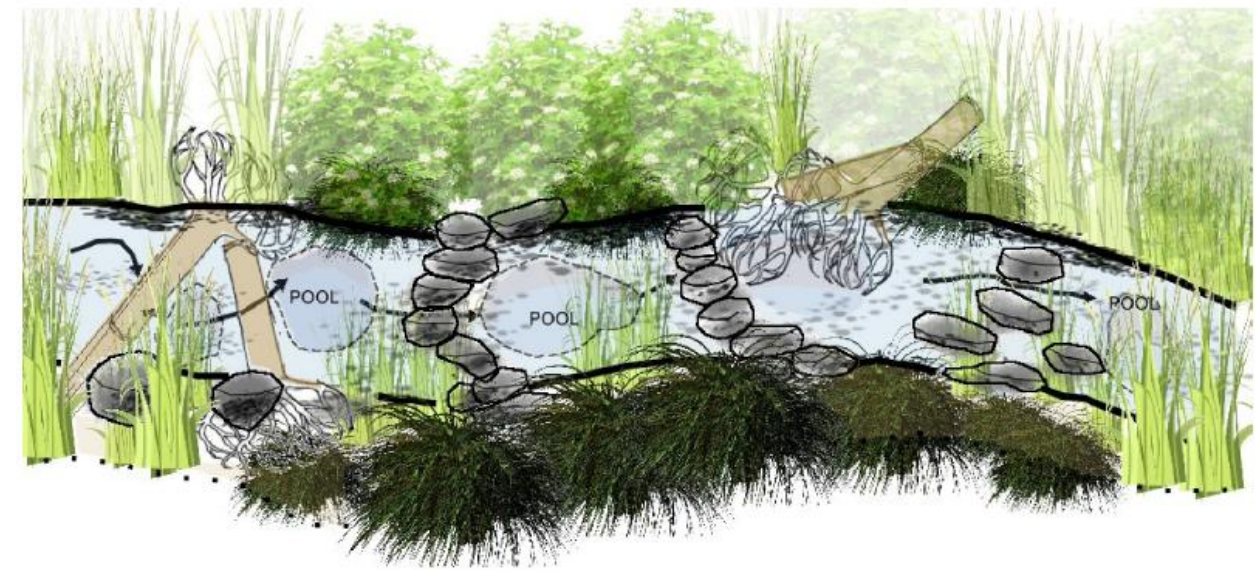
Confined Valley with Bedrock-Controlled Floodplain Pockets

Properties: Reaches are generally tightly confined by the valley margin except for breaks in the bedrock where the valley widens. This channel type mainly occurs in the canyon landscape zone. The breaks in the bedrock accumulate alluvium (and colluvium, which causes a local decrease in channel gradient. These areas act as floodplain, storing sediment, capturing debris and dissipating flood energy.

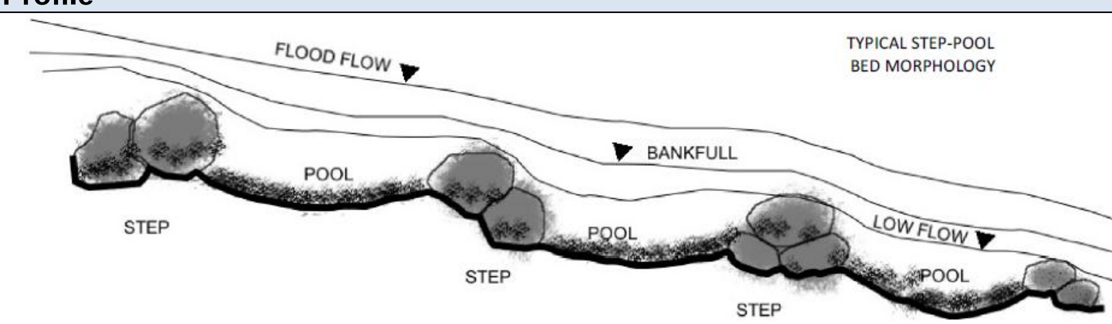
Reaches Observed:	9, 10, 13, 16, 18, 19

RIVER CHARACTER	
Valley Setting	Mostly Confined
Channel Planform	Channel is generally single thread and straight, but pockets likely contain overflow, secondary, and chute channels. Channel adjustments are vertical - mainly incision, expansion, and aggradation.
Bed Morphology	Bed morphology is generally step-pool, but may have sections of pool-riffle at lower gradient pockets.
Geomorphic Units	Pools Bedrock Outcrops and Steps Jams - Located at constrictions Longitudinal, lateral, and mid-channel bars Relatively deep pools Structural LWD
RIVER BEHAVIOR	
Flood Response	Floodplain stripping and the flushing of accumulated alluvium are common flood responses. The pockets generally aggrade, inundating homes and infrastructure. Stream crossings cause major issues as blockages lead to avulsion, expansion, and flood surges.
Stage Behavior	Low flows are generally concentrated into single threads, piling up below steps and on the outside of bends. Fine sediments are accumulated on bar margins and in pools. Bankfull flows are generally single thread and move sediments downstream, reworking bar structure and complexes. Flood flows generally lead to vertical accretion on floodplains, forming chute channels. Overflow channels are formed by the shortcutting of channel bends. Floods also have the ability to strip floodplains, but pockets are generally protected by bedrock outcrops.
Restoration Considerations	Restoration of these reaches should focus on stabilizing aggraded pockets and facilitating the establishment of step-pool sequences in confined sections. Grading and channel establishment in the pockets should reconnect channel and floodplain processes, giving the channel room to flood and inundate secondary channels and dissipate flood energy. Confined reaches should establish step-pool sequences through the use of grade control structures which will help dissipate the stream energy exerted on channel banks and adjacent infrastructure.

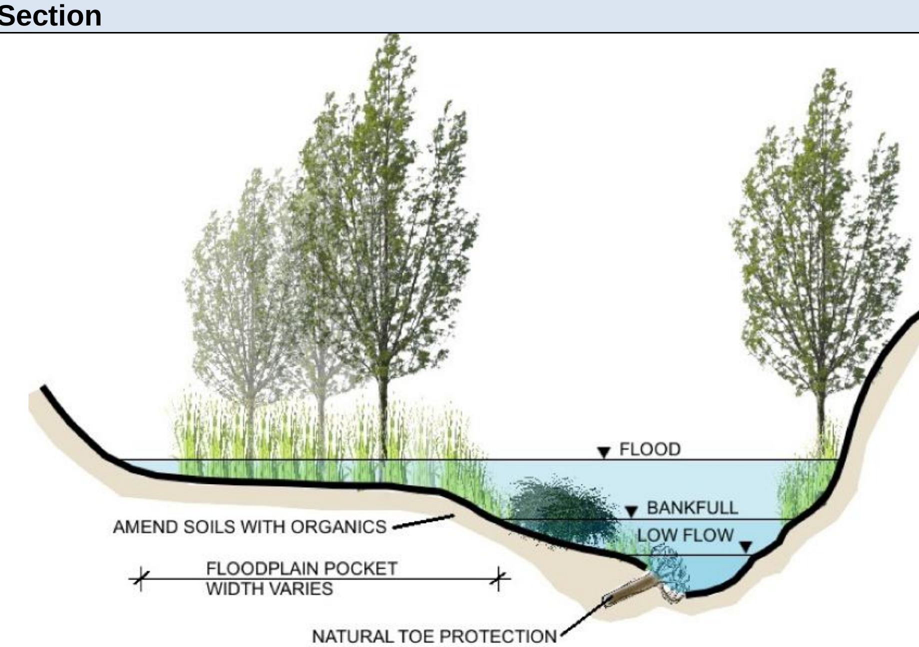
Confined Valley with Bedrock-Controlled Floodplain Pockets River Style (Cont.)	Recommended Restoration Plan



Typical Profile



Typical Cross Section



Confined Valley with Bedrock-Controlled Floodplain Pockets River Style (Cont.)	Conditions Assessment Criteria	
Good	Fair	Poor
• Laterally and vertically stable or flood re-working in established pockets • Floodplain pockets accessible • Little man-made armor • Intact riparian vegetation • Structural wood present • Well-established bedforms (step-pool sequences with some pool-riffle and rapid elements • Clean gravels (low embeddedness) organized in instream units • Fines present, but exist as transient deposits	• Eroding Banks (fluvial) • Degraded riparian veg. • Armor (riprap, concrete) present in few locations • Floodplain pockets somewhat accessible • Channel may be perched above pocket, post-flood • Large wood in channel, but may not be structural • Fines present but organized in bedforms (moderate embeddedness) • Bedforms present but not stable	• Banks destroyed by mass wasting • Little riparian veg. • Banks heavily armored, grouted riprap used • Floodplain pockets inaccessible, channel entrenched • Channel stripped of large wood • Channel geometry obscured • High embeddedness Channel bedforms absent

Confined Valley, Limited Floodplain

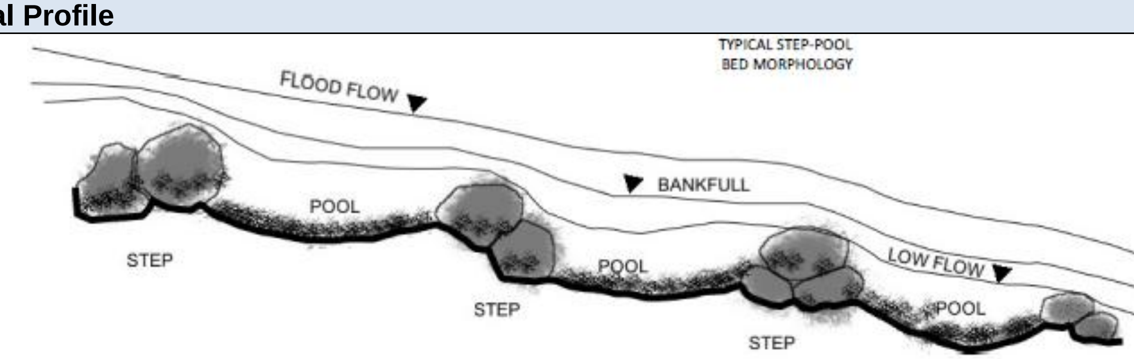
Properties: Channel is fully confined throughout its length and located in the moderate relief upland and canyon landscape units. Reaches are generally steep and well armored. Primary modes of adjustment are vertical.

Reaches Observed:	8, 11, 12, 14, 17, 20
RIVER CHARACTER	
Valley Setting	Confined
Channel Planform	Channel is generally single thread and straight. Channel adjustments are vertical - mainly incision and expansion.
Bed Morphology	Bed morphology is generally step-pool, but may have elements of pool-riffle, rapid and cascade.
Geomorphic Units	Pools Bedrock Outcrops and Steps Jams - Located at constrictions Relatively deep pools Structural LWD
RIVER BEHAVIOR	
Flood Response	The response of these channels to the flood involved the complete destruction of the channel, stripping of the channel margins, and/or the flushing of alluvium. These reaches are still adjusting to the September flood and yet to re-establish bedforms.
Stage Behavior	Low flows are generally concentrated into single threads, piling up below steps and on the outside of bends. Fine sediments are accumulated on bank margins and in pools. Bankfull flows are single thread and flush sediments downstream from pool to pool. Flood flows smooth out channel roughness elements and have the capability to generate very high stream power values, recruiting LWD and re-working the bed and banks.
Restoration Considerations	Restoration of these reaches should focus on re-establishing step-pool sequences using natural materials where possible. Consideration of low flows will maintain sediment transport and facilitate the passage of aquatic organisms which will depend on the quality of pools to survive. Many of these reaches are directly adjacent to the road and restoration projects will need to be planned in conjunction with the roadwork.

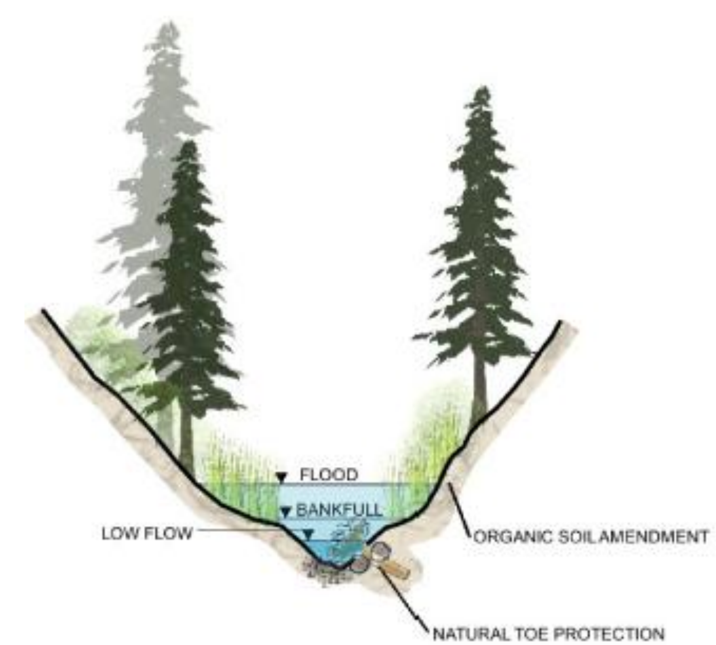
Confined Valley, Limited Floodplain River Style (Cont.)

Recommended Restoration Plan

Typical Profile



Typical Cross Section



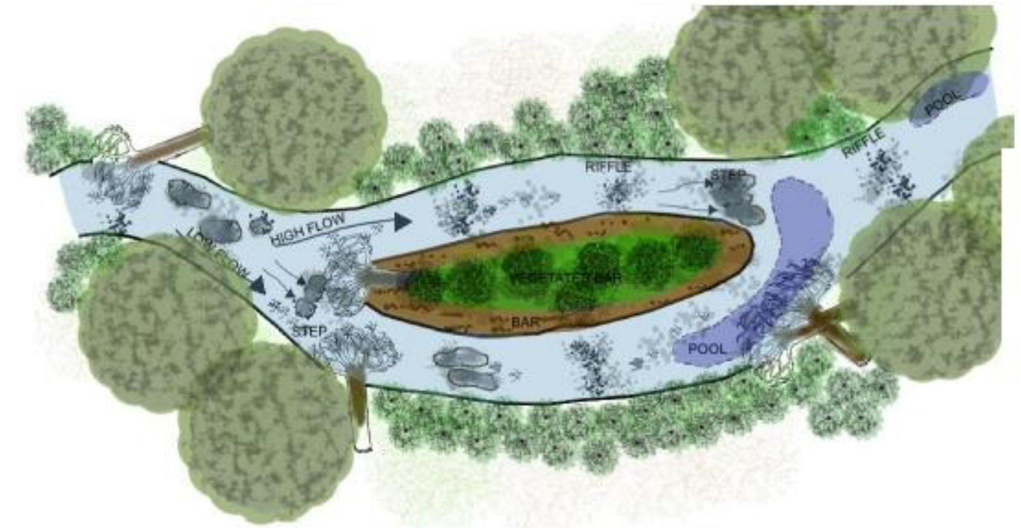
Confined Valley, Limited Floodplain River Style (Cont.)	Conditions Assessment Criteria	
Good	Fair	Poor
• Vertically and laterally Stable • Little man-made armor • Intact riparian vegetation • Structural wood present • Well-established bedforms (step-pool sequences with rapid and cascade elements) • Clean gravels (low embeddedness) organized in instream units • Fines present, but exist as transient deposits	• Eroding Banks (fluvial) • Degraded riparian veg. • Armor (riprap, concrete) present in few locations • Large wood in channel, but may not be structural • Fines present but organized in bedforms (moderate embeddedness) • Bedforms present but not stable	• Banks destroyed by mass wasting • Little riparian veg. • Banks heavily armored, grouted riprap used • Channel stripped of large wood • High embeddedness • Channel bedforms absent

Partly Confined, Wandering

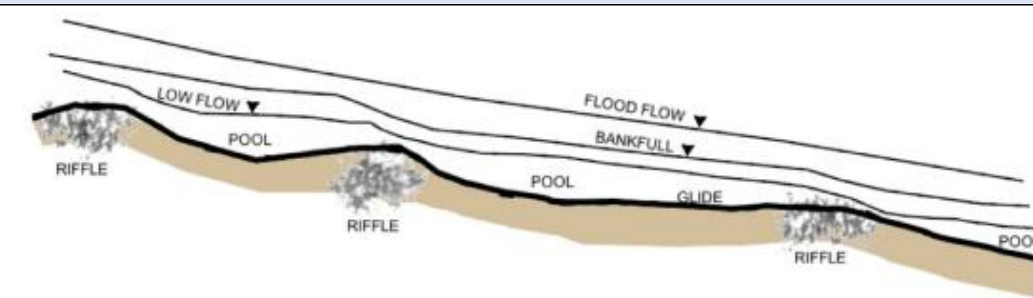
Properties: Partly confined, wandering channels occupy the transition from the canyon to alluvial plain landscape units. They are partly confined by valley walls, old terraces and anthropogenic sources such as roads, bridges, and developments.

Reaches Observed:	5, 6, 7
RIVER CHARACTER	
Valley Setting	Partly confined
Channel Planform	Channel has low sinuosity. It may have islands and/or side and overflow channels, backwater ponds and possibly wetlands in areas of lower local gradient.
Bed Morphology	Bed morphology is composed of pool-riffle sequences with step-pool in higher gradient areas.
Geomorphic Units	Pools, riffles, glides Bedrock Outcrops and Steps LWD Lateral and longitudinal bars Glides and Pools Islands, benches, terraces
RIVER BEHAVIOR	
Flood Response	Channel avulsions and migrations were the primary flood response as sediment-laden flood flows responded to local changes in gradient and confinement (e.g., crossings). Channel changes are both vertical and lateral.
Stage Behavior	Low flows are generally confined to a single thread, accumulating on the outside of meander bends and in pools. Bankfull flows inundate secondary channels and transfer sediment downstream, re-working bars and banks. Flood flows will inundate all channel features between older flood terraces. Bend apexes and steps are subjected to the highest relative stream power values. High sediment loads will initiate channel avulsions into accessible relic or paleo channels. Terrace faces may collapse or be undercut. LWD will be recruited into the channel.
Restoration Considerations	The restoration of these laterally dynamic channels is difficult, given this river style's propensity for drastic change. This river style should be given as much floodplain space as possible to account for flood change. The reconnection of the floodplain, along with the construction of wetlands, bars, and backwater areas will help traps sediments and reduce flood energy. Steeper reaches will benefit from the establishment of step-pool sequences constructed with natural materials. Crossings will require maintenance as sediment will accumulate in these areas.

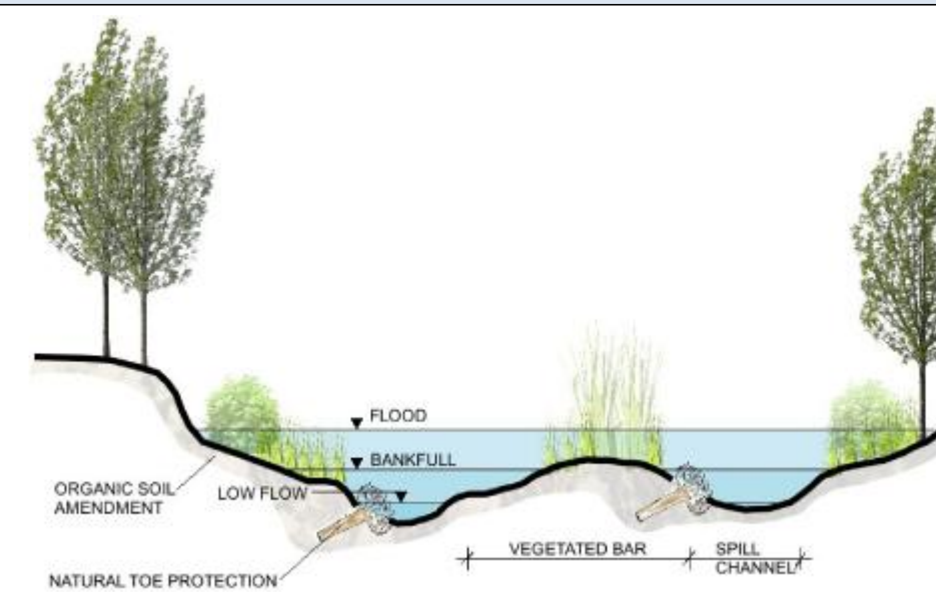
Partly Confined, Wandering River Style (Cont.)	Recommended Restoration Plan



Typical Profile



Typical Cross Section



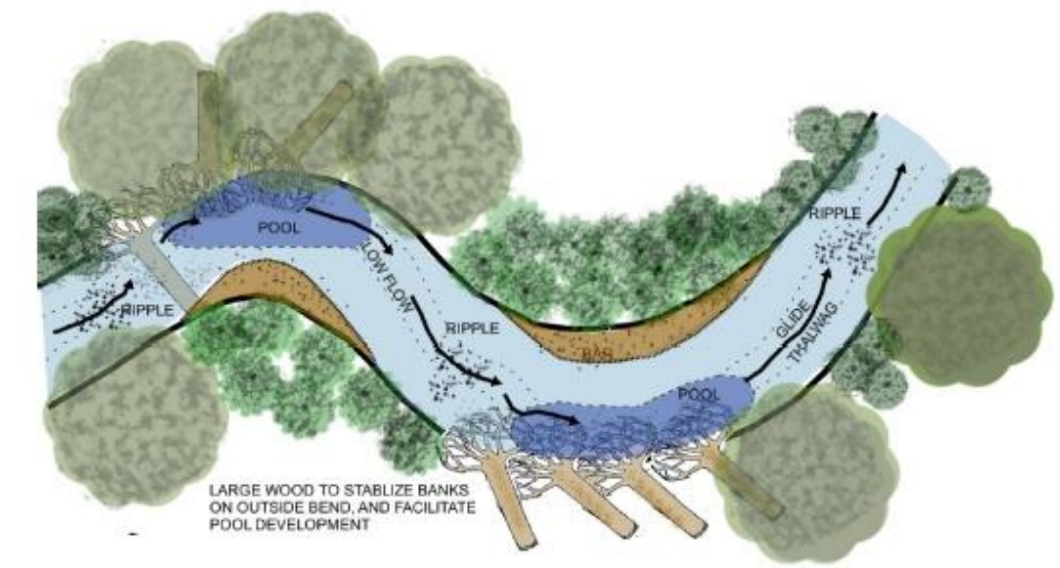
Partly Confined, Wandering River Style (Cont.)	Conditions Assessment Criteria	
Good	Fair	Poor
Laterally stable or flood re-working in floodplain • Floodplain accessible • Little man-made armor • Intact riparian vegetation • LWD assemblages present • Well-established bedforms (step-pool, pool-riffle) • Clean gravels (low embeddedness) organized in instream units • Aggrading or degrading to promote connection with floodplain • Confinement sources from valley, terraces not manmade features (channel has room to wander) • Well-defined low-flow channel, side and overflow channels	• Localized Eroding Banks (fluvial and mass wasting) • Degraded riparian veg. • Armor (riprap, concrete) present in few locations • Floodplain somewhat accessible (localized disconnections) • Large wood in channel, but not enough to influence • Few locations contain overflow, side channels • Low-flow channel poorly defined, high width/depth ratio • Fines present but organized in bedforms (moderate embeddedness) • Localized bedforms present • Manmade confinement limited	• Banks destroyed by mass wasting • Channel avulsions present • Little riparian veg. • Banks heavily armored, grouted riprap used • Floodplain inaccessible, channel entrenched • Low-flow channel obscured, or destroyed (very high width-depth • Channel stripped of large wood • Channel geometry obscured • High embeddedness • Channel bedforms absent • Channel cut off from floodplain by manmade confining features

Unconfined, Continuous Floodplain	
Properties: These reaches sit low in the watershed, in the alluvial plain landscape zone. They are generally unconfined laterally, but adjacent land use has narrowed the riparian corridor and likely straightened the channel.	
Reaches Observed:	3, 4

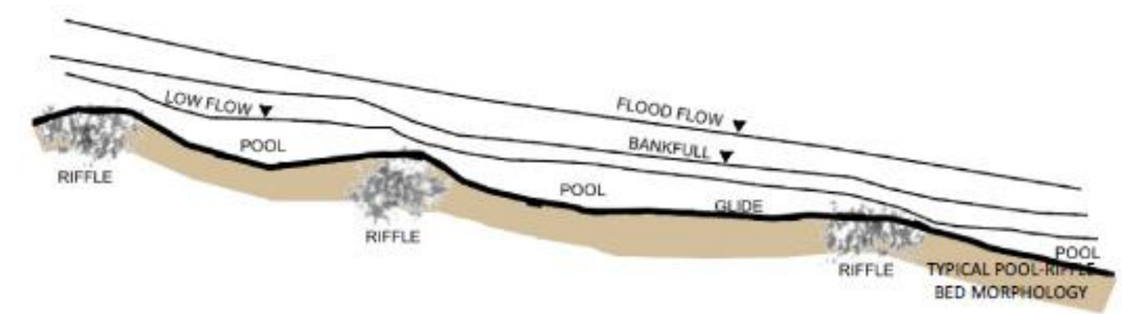
RIVER CHARACTER	
Valley Setting	Unconfined
Channel Planform	Channel has low sinuosity. It may have islands and/or side and overflow channels, backwater ponds and possibly wetlands in areas of lower local gradient.
Bed Morphology	Pool-riffle transitioning to sand bed.
Geomorphic Units	Pools, riffles, glides Bedrock Outcrops and Steps LWD Lateral and longitudinal bars Islands, benches, terraces
RIVER BEHAVIOR	
Flood Response	These reaches generally responded to the flood by in-channel aggradation and extensive floodplain deposition. The blocking of channel crossings added to the aggradation with adjacent sections of channel displaying a braided morphology.
Stage Behavior	Low flows are generally confined to a single thread, accumulating on the outside of meander bends and in pools. Bankfull flows inundate secondary channels and transfer sediment downstream, re-working bars and banks. Flood flows will inundate all channel features and extensive areas of the floodplain, depositing fine sediments.
Restoration Considerations	Restoration of the channels should focus on establishing a low flow channel to encourage sediment transport. Development in floodplains should be limited and reserved for dissipating flood energy and storing sediment. Opportunities to use low flow crossings instead of bridges and culverts should be considered. Native riparian vegetation should be used to expand the (currently) limited riparian corridor.

Unconfined, Continuous Floodplain River Style (Cont.)

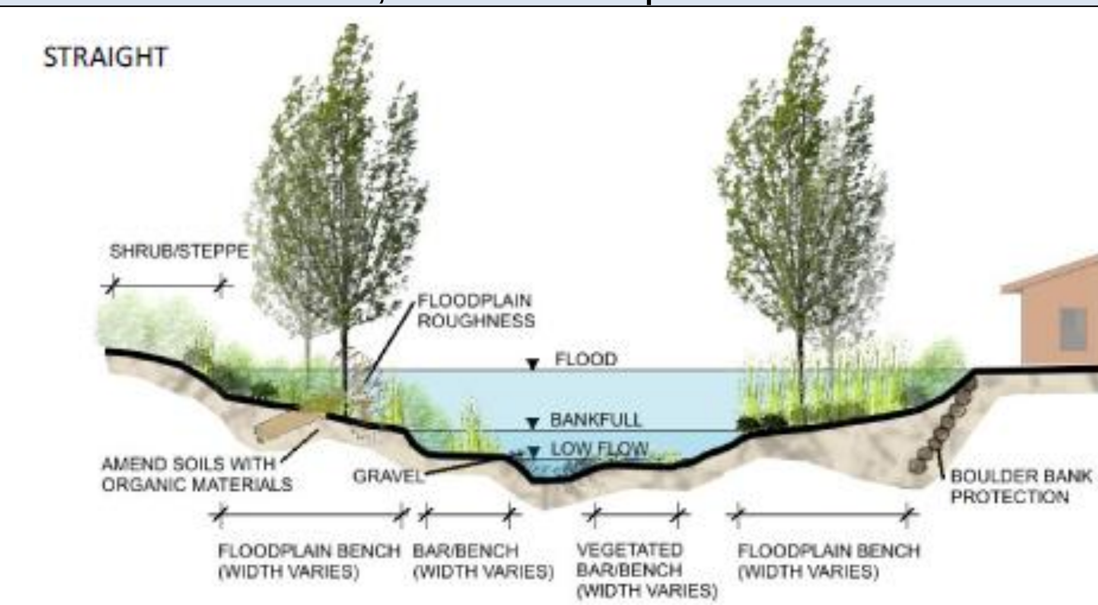
Recommended Restoration Plan



Typical Profile - Unconfined, Continuous Floodplain



Typical Cross Section - Unconfined, Continuous Floodplain



Unconfined, Continuous Floodplain River Style (Cont.)	Conditions Assessment Criteria	
Good	Fair	Poor
• Laterally stable or flood re-working in floodplain • Floodplain accessible • Stepped cross-section with high flow accessible terraces and bars • Little man-made armor • Intact riparian vegetation • LWD assemblages present • Well-established bedforms (pool-riffle sequences) • Bed stable, but aggrading or degrading to promote connection with floodplain • Few manmade confining features (channel has room to wander) • Well-defined low-flow channel, side and overflow channels • few artificial contractions/expansions • Moderate to high sinuosity	• Localized Eroding Banks (fluvial and mass wasting) • Channel straightened, low sinuosity • Degraded riparian veg. • Armor (riprap, concrete) present in few locations • Floodplain somewhat accessible (localized disconnections) • Large wood in channel, but not enough to influence • Few locations contain overflow, side channels • Low-flow channel poorly defined, high width/depth ratio • Fines present but organized in bedforms (moderate embeddedness) • Bedforms present but not stable • Manmade confinement limited	• Banks destroyed by mass wasting • Channel avulsions present • Channel straight • Little riparian veg. • Banks heavily armored, grouted riprap used • Floodplain inaccessible, channel entrenched • Low-flow channel obscured, or destroyed (very high width-depth • Channel stripped of large wood • Channel geometry obscured • High embeddedness • Channel bedforms absent • Channel cut off from floodplain by manmade confining features • Contractions, expansions artificial, disconnecting channel from floodplain or preventing sediment transport

Entrenched, Residential

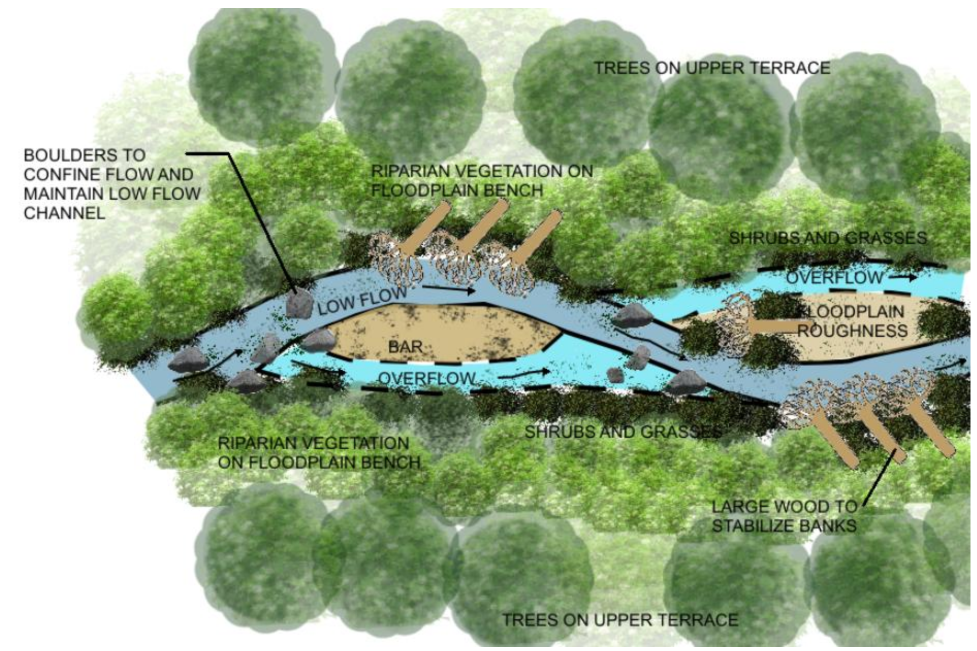
Properties: The entrenched, residential river style is found at the bottom of the watershed, in the alluvial plain landscape unit. These are unconfined, continuous floodplain channels that have been modified to maximize capacity for flood control in highly populated areas.

Reaches Observed:	1, 2

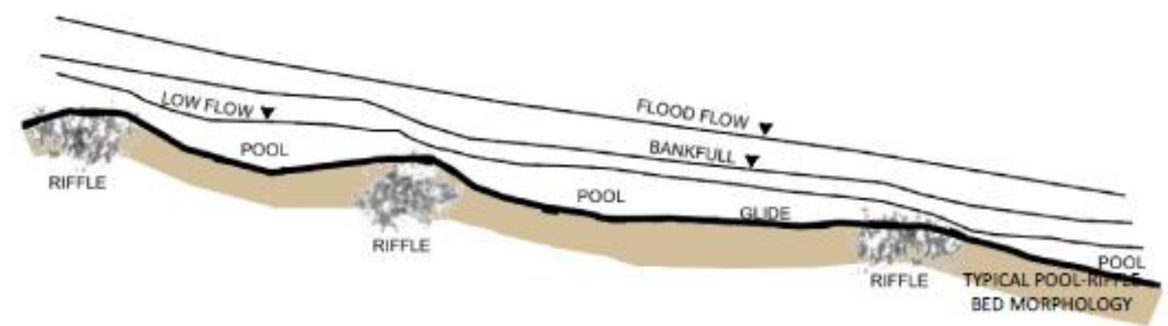
RIVER CHARACTER	
Valley Setting	Confined
Channel Planform	Channels are generally single thread and straight, but depending on the design width, may develop low sinuosity within the constructed width.
Bed Morphology	Sand bed, fairly homogenous channels that may contain pool-riffle sections in meanders.
Geomorphic Units	Pools, riffles, glides sand sheets, sediment slugs Islands, benches, terraces Lateral and longitudinal bars
RIVER BEHAVIOR	
Flood Response	Flood response is limited to aggradation and the re-working of a low caliber bed. Restrictions at crossings may initiate bank failure.
Stage Behavior	Generally single thread in low, bankfull, and flood stages. Sections of channel that develop some sinuosity and complexity may appear multithread at or near the bankfull stage.
Restoration Considerations	Restoration is generally limited as the channel must first meet flood control and capacity requirements. Developing a low flow channel will help with sediment transport issues and also provide conditions to maintain aquatic organisms. To the degree possible, channel complexity should be increased through the use of habitat features (e.g., rootwads, boulders, logs). Increasing channel complexity will need to be accompanied by increased width, as the additional roughness will decrease capacity.

Entrenched, Residential River Style (Cont.)

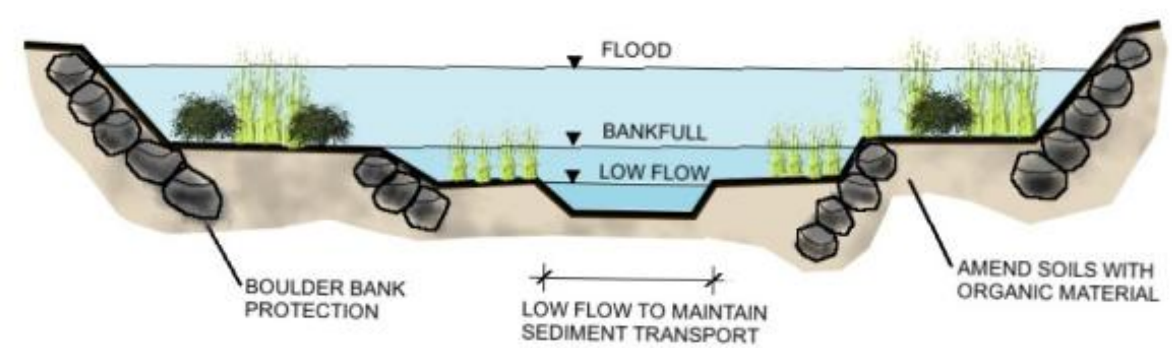
Recommended Restoration Plan



Typical Profile



Typical Cross Section



Entrenched, Residential River Style (Cont.)	**Conditions Assessment Criteria**	
Good	Fair	Poor
• Laterally and vertically stable • Stepped cross-section with high flow accessible terraces and bars • Little man-made armor • Intact riparian vegetation • Well-established bedforms (pool-riffle sequences) • Bed stable • LWD used to stabilize banks, dissipate high flow energy • Energy dissipating structures in place that promote sediment transport at low flows • Well-defined low-flow channel • crossings maintain sediment transport • Low-flow channel has moderate to high sinuosity	• Localized Eroding Banks (fluvial and mass wasting) • Channel straightened, low sinuosity • Degraded riparian veg. • Armor (riprap, concrete) present only where necessary to protect structures • Floodplain somewhat accessible (localized disconnections) • Low-flow channel poorly defined, high width/depth ratio • Fines present but organized in bedforms (moderate embeddedness) • Bedforms present but not stable	Banks destroyed by mass wasting • Channel avulsions present • Channel straight • Little riparian veg. • Banks heavily armored, grouted riprap used • Low-flow channel obscured, or destroyed (very high width-depth • Channel geometry obscured • High embeddedness • Channel bedforms absent • Contractions, expansions too wide, promote deposition – no low-flow channel

4.3.2.3 Geomorphic Condition

The geomorphic condition of each reach was assessed through a comparison of the reach's current condition relative to expected conditions for each particular River Style. Given the wide spatial extent of the flood damage, opportunities to find ideal reference sites were limited. Geomorphic condition was therefore evaluated relative to whether or not the reach in its current state could support the functions that its particular River Style would be expected to provide without major changes to its current configuration. For example, in which locations (if any) is the reach able to convey flows while maintaining bank structure, geomorphic unit organization (i.e., the sequence of pools, riffles, steps, and other channel features), and sediment transport?

Reaches were assessed using a good-fair-poor scale using the criteria for each river style detailed in the River Styles definitions in Section **4.3.2.2**. In general, reaches with good geomorphic condition have functioning geomorphic units, complex channels, and intact riparian corridors consisting of native vegetation complexes. Reaches receiving a fair rating have local disturbances to several properties and an overall degraded condition. Fair reaches are able to withstand disturbance events without fundamentally changing their river style. These reaches could evolve by either increasing or decreasing their geomorphic condition. Reaches with a poor rating have systemic degradation and lack functioning riparian vegetation. These reaches have changed their behavior in response to disturbance and will require restoration actions in order to improve their stability.

Geomorphic characterizations and data collected as part of the field effort were used to rate the geomorphological condition relative to the criteria outlined in the River Styles definitions. The results are presented in **Table 7** (for reach locations refer back to **Figure 19**). Properties from conditions assessment criteria were grouped into broader categories to offer insight into what factors were controlling the rating. These limiting factors can then be used to guide the project development phase of this project. The categories include those properties relating to channel stability (e.g., bank condition, presence of LWD), bed character (e.g., embeddedness, bedforms), and planform (e.g., sinuosity, confinement). With the geomorphic condition assessed following the methods above, the next step in the geomorphic risk assessment is to determine likely trajectories for each reach.

Table 7. Geomorphological Condition Ratings by River Styles and Reach

Reach	Stability	Bed Character	Planform	Geomorphic Condition
Entrenched, Residential Channel				
1	Fair	Poor	Fair	Poor
2	Fair	Poor	Poor	Poor
Unconfined, Continuous Floodplain				
3	Fair	Poor	Fair	Poor
4	Poor	Fair	Poor	Poor
Partly confined, wandering				
5	Fair	Fair	Fair	Fair
6	Poor	Fair	Fair	Poor
7	Fair	Poor	Fair	Poor
Confined Valley with Bedrock-Controlled Floodplain Pockets				
9	Poor	Fair	Fair	Poor
10	Poor	Fair	Fair	Poor
13	Fair	Fair	Good	Fair
16	Poor	Poor	Poor	Poor
18	Good	Good	Good	Good
19	Good	Good	Good	Good
Confined Valley, No floodplain				
8	Fair	Fair	Good	Fair
11	Fair	Poor	Fair	Poor
12	Fair	Fair	Fair	Fair
14	Fair	Fair	Good	Fair
17	Poor	Poor	Poor	Poor
20	Fair	Good	Fair	Fair
Headwater				
15	Fair	Fair	Good	Fair
21	Poor	Poor	Poor	Poor
23	Fair	Fair	Fair	Fair
24	Poor	Fair	Fair	Poor
25	Good	Good	Good	Good
26	Good	Good	Good	Good
22	Poor	Poor	Fair	Poor

4.3.2.4 Downstream Patterns of River Change

With the geomorphic condition of each reach defined, the downstream pattern of change, or trajectory, can be examined. Each stream section, or reach, is examined in the context of the surrounding reaches and larger system. **Figure 20** below shows this trajectory for James Creek. The profile of James Creek is shown along with valley and channel width measurements and valley setting. Results from the CDOT hydrology report (CDOT, 2014) were used to calculate gross stream power at several discrete locations along James Creek. Stream Power (the product of the specific weight of water, discharge, and slope) is a measure of the stream's ability to work the bed and banks. The calculation provides relative information about the magnitude of change a particular flow is capable of exerting on the channel and floodplain.

Figure 21 and **Figure 22** below show similar diagrams for the other major stream branches in the watershed – mountains and plains portions of Left Hand Creek.

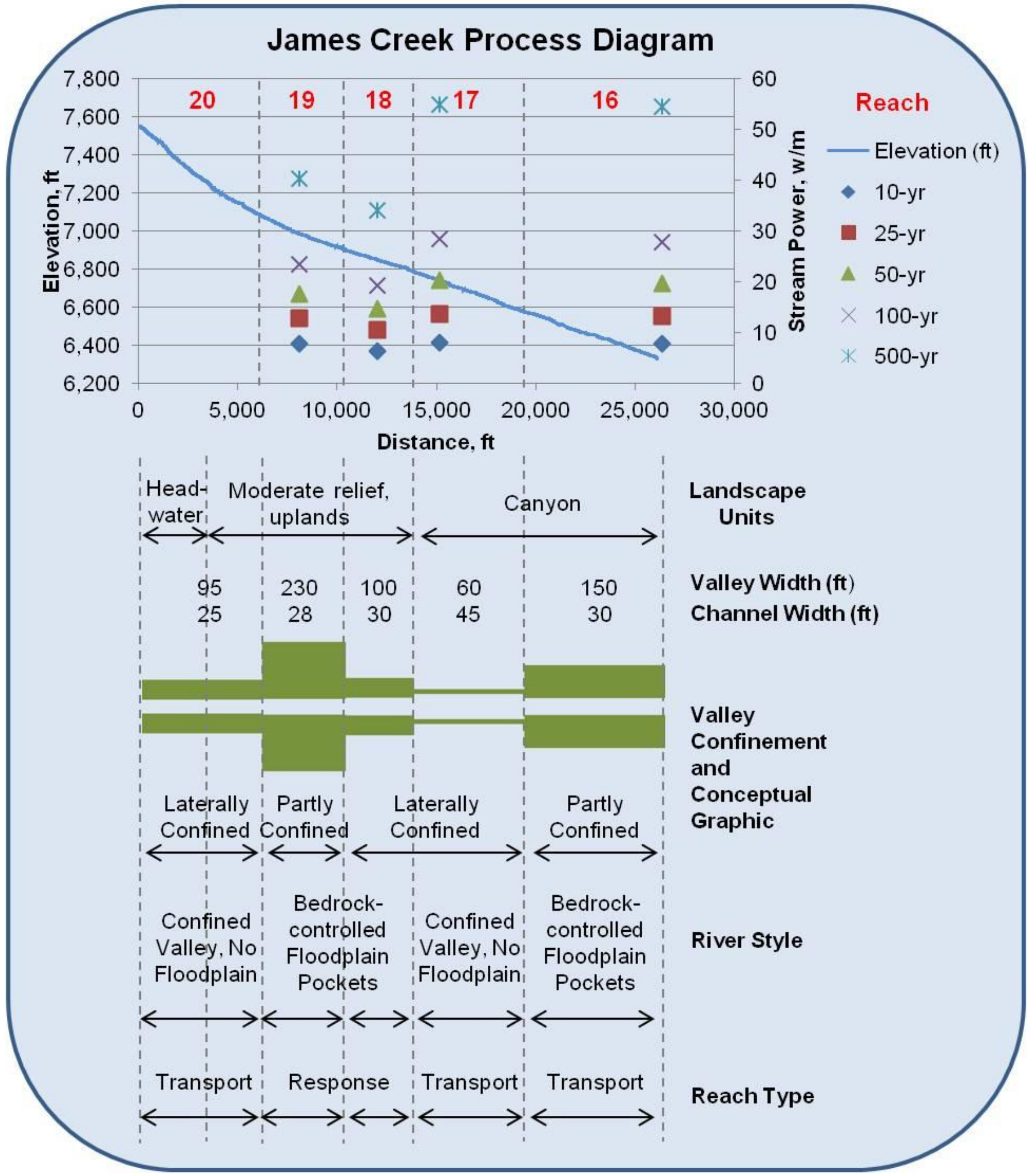


Figure 20. James Creek Process Diagram

Controls on the downstream pattern of channel development for James Creek. Moving downstream, channel widths gradually increase along James Creek, with the exception of Reach 17. In Reach 17, a confined valley, no floodplain River Style, the channel has widened considerably. This behavior is a response to the flood and a direct result of the confined nature of the reach. Without floodplain areas in which to disperse energy, the flow condensed, destroying the channel and flushing much of the alluvium (and road surface) downstream. Note that the highest calculated gross stream power values also occur in this reach.

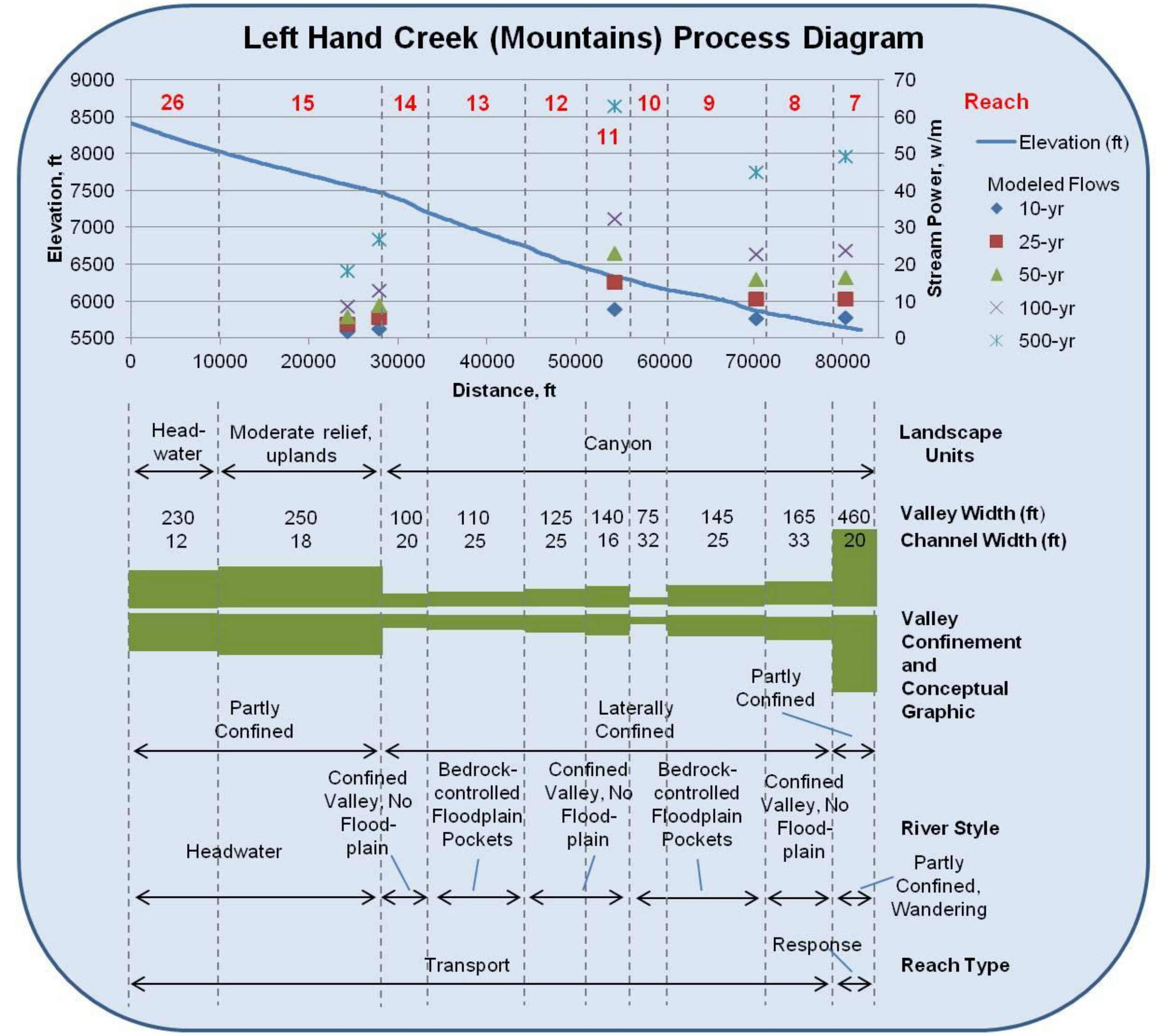


Figure 21. Left Hand Creek (Mountains) Process Diagram

Stream process diagram for the portion of Left Hand Creek west of the canyon mouth, including reaches 7 – 15 and 26. Along this branch of the creek the valley tightens moving from the moderate relief upland landscape zone to the canyon. Gross stream power values increase in the canyon, a result of the increase in slope. Sediment and debris are transported through this area until the valley widens and there is an opportunity to store sediment in Reach 7. Many of the reaches in the canyon reach share common flood response traits: destroyed banks, pockets of scour and deposition, widened and incised channel, and a lack of organized bedforms. These reaches have damaged roads, culverts, and private crossings. Restoration of this reach should look to stabilize banks and dissipate stream energy while maintaining sediment transport to the lower reaches

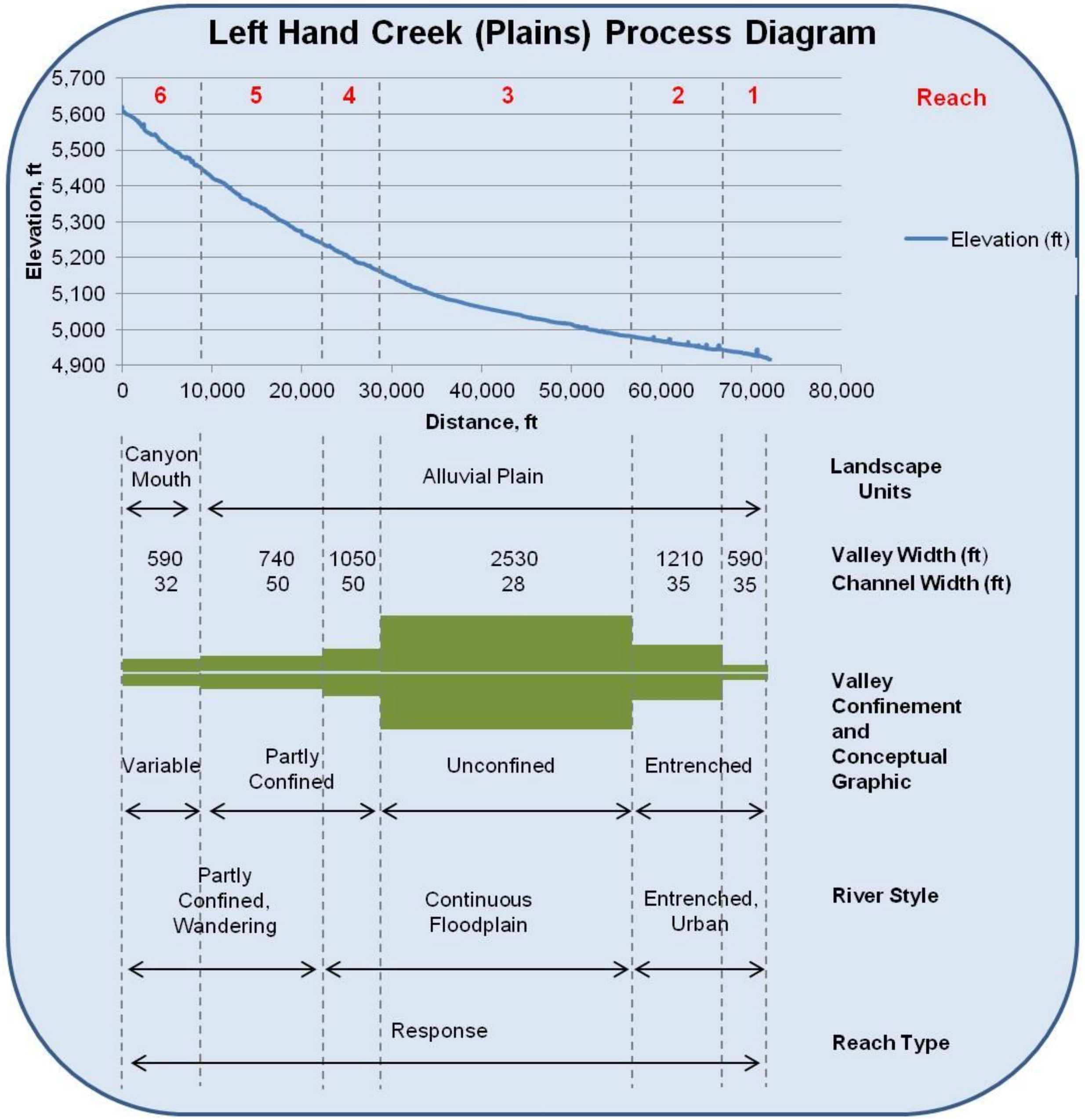


Figure 22. Left Hand Creek (Plains) Process Diagram

The plains portion of Left Hand Creek shows a decreasing channel gradient with a widening valley. As valley width increases the stream pattern would usually be a multithread, anastamosing channel, but the channel is confined by human development (e.g., roads, irrigation ditches, diversion structures, and crossings). However, Left Hand Creek through the plains is a single thread channel, transitioning from gravel-bed to sand bed by the downstream end of reach 3. Flood response for reaches 5 and 6 consisted of migration and avulsion (lateral shifts) and incision and downcutting in reach 4. Reach 3 experienced lower flood energy, with flood flows inundating the floodplain and depositing a considerable amount of sediment and debris. In reaches 1 and 2, the channel becomes entrenched as it travels through Longmont. These reaches experienced extensive bank failure, mostly a result of failed infrastructure. Note – hydrology was not modeled for the plains reaches, therefore stream power could not be calculated.

Given the geomorphic condition, the downstream pattern of change, or trajectory, for each reach can be determined in the context of those reaches above and below it. With the determination of the likely future trajectory, risk can then be assessed by an examination of the vulnerabilities (e.g., property, infrastructure) present in the reach. **Table 8** shows a breakdown of the geomorphic condition (also presented in **Table 7**), trajectory, vulnerabilities, and geomorphic risk for each of the reaches. Geomorphic risk for this study is the result of the reach condition, trajectory, and vulnerabilities. Reaches receiving a risk rating of 'High' are generally in poor condition, have considerable vulnerabilities, and/or the potential to impact downstream reaches. For example, while Reach 16 has relatively few homes, it contains two very unstable floodplain pockets that have accumulated large amounts of debris. To compound matters, the creek has been channelized with loose, unsorted berms which will not survive high flow conditions. A breach of the berms will mobilize large portions of the floodplain impacting downstream properties and infrastructure. Therefore, Reach 16 receives a 'High' risk rating.

Table 8. Summary of Geomorphological Risk by Reach

	Reach	Geomorphic Condition	Trajectory	Vulnerabilities	Geomorphic Risk
PLAINS REACHES	1	Poor	Aggradation	Bridges	Low
	2	Poor	Aggradation	Homes, roads, bridges, businesses	Low
	3	Poor	Aggradation, migration	Bridges, homes, roads, railroad tracks, diversion structures	High
	4	Poor	Incision, bank failure	CBT canal, homes, roads, crossings, private property, diversion structures	Medium
	5	Fair	Headcutting, migration, aggradation, bank failure	homes, diversion structures, pastureland, bridges, culverts, roads	Medium
	6	Poor	Headcutting, migration, aggradation, bank failure	homes, diversion structures, pastureland, bridges, culverts, roads	High
MOUNTAIN REACHES	7	Poor	Migration, bank failure, incision	homes, diversion structures, road, gage	Low
	8	Fair	Stable - bedrock controlled	Road, culvert, homes, gage, diversion structure	Low
	9	Poor	Bank failure, avulsion, aggradation, degradation	Road, culvert	Medium
	10	Poor	Bank failure, aggradation	Road, culvert	Medium
	11	Poor	Bank failure, degradation	Road, culvert, homes, private crossings	Medium
	12	Fair	Bank erosion, degradation	Road, culvert, homes, private crossings	Low
	13	Fair	Bank erosion, degradation	Road, culvert, homes, private crossings	Low
	14	Fair	Bank erosion, degradation	Road, culvert, homes, private crossings	Low
	15	Fair	Bank erosion, degradation	Road, culvert, homes, private crossings	Low

Table 8. Summary of Geomorphic Risk by Reach (Cont.)

	Reach	Geomorphic Condition	Trajectory	Vulnerabilities	Geomorphic Risk
MOUNTAIN REACHES	16	Poor	Aggradation, avulsion, degradation	Road, culvert, homes, private crossings	High
	17	Poor	Aggradation	Home, road	High
	18	Good	Restored Reach	Road, culverts, homes, bridge, utilities, reclaimed mine waste	Low
	19	Good	Restored Reach	Road, culverts, homes, bridges, utilities, businesses	Low
	20	Fair	Aggradation, avulsion, bank failure	None	Medium
	21	Poor	Degradation, bank erosion	Road, homes, culvert	Low
	22	Poor	Degradation, bank erosion	Road, home, culvert	Low
	23	Fair	Bank erosion, degradation	Road, homes, culvert	Low
	24	Poor	Bank erosion	Road, home, culvert	Low
	25	Good	Relatively stable	Diversion structure	Low
	26	Good	Bank erosion, degradation	Road, culvert, homes, private crossings	Low

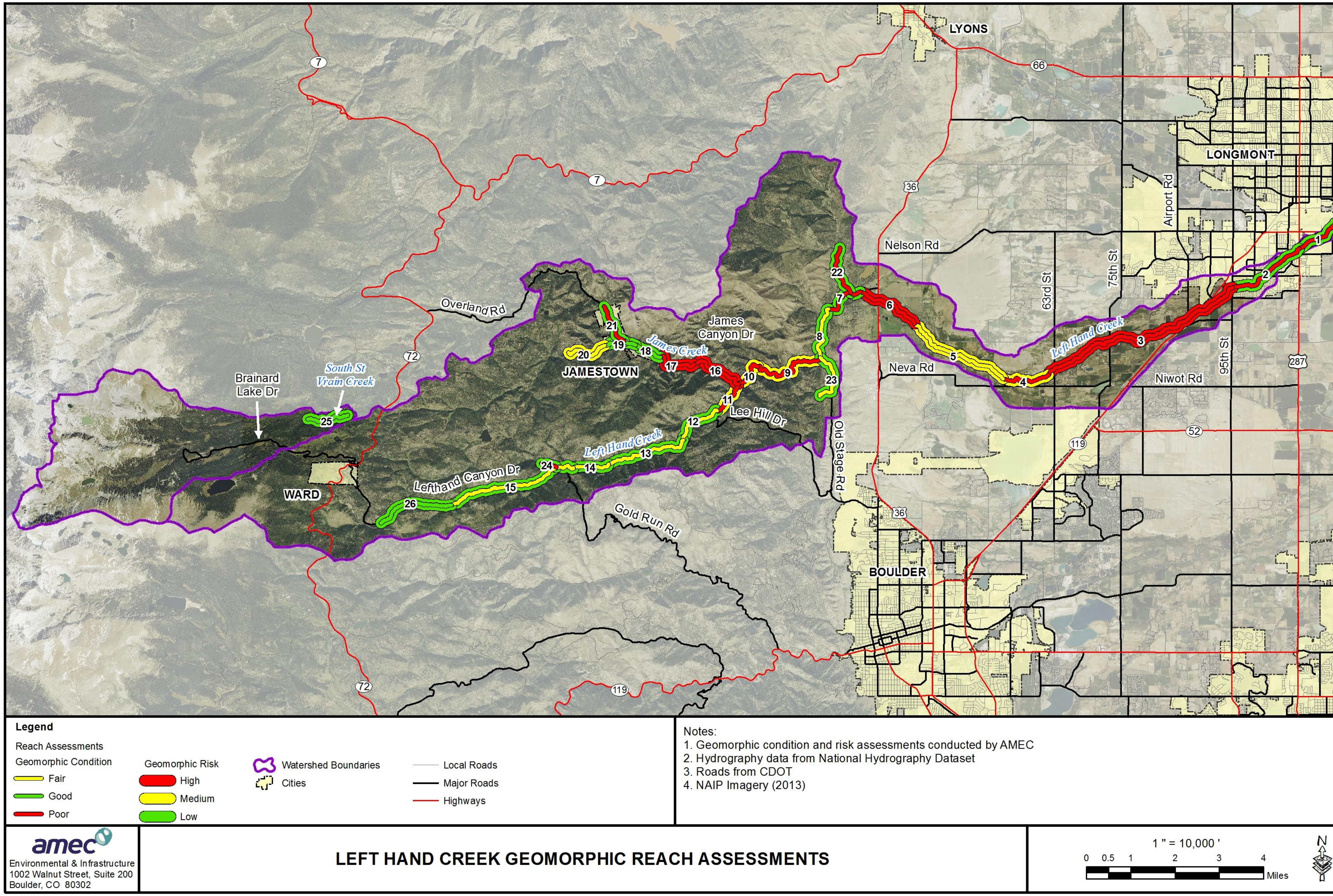


Figure 23. Geomorphic Reach Assessments

4.4 Ecosystem

A healthy, resilient stream ecosystem is one that maintains key ecological and physical functions through varied hydrologic conditions, through space and through time. Many factors influence the health of a stream system including: physical structures, energy sources, biotic elements, chemical variables and flow regime. The physical structure of a healthy stream corridor displays a complex and diverse set of features, including channel form (meanders, pools, riffles, backwaters, wetlands), channel profile (stream gradient, width, and depth), materials that have fallen into the channel (trees and bank material), overhanging vegetation, roots extending into the flow, and streambed materials (sand, gravel, rocks, and boulders). This complexity influences the physical function of the stream (i.e., increases channel roughness, which in turn dissipates the energy of water and reduces its erosive power) and increases the potential for higher diversity of aquatic species.

4.4.1 Methods

As part of the Left Hand Creek watershed master planning effort, scientists and engineers from Walsh Environmental completed a rapid ecologic stream assessment of Left Hand Creek. The ecological stream assessment was completed using the Stream Visual Assessment Protocol (SVAP2), developed by the US Natural Resources Conservation Service (NRCS, 2009). The SVAP2 is a national protocol that provides an initial evaluation of the overall condition of streams, their riparian zones, and their in-stream habitats. It is often used as a tool for conservation planning, identifying restoration goals and objectives, and assessing trends in stream and riparian conditions through time. For the purposes of this analysis the results will be used to identify critical riparian ecosystem elements that are damaged or absent from the river system, as well as to identify highly degraded areas. The evaluations are intended to supplement an overall understanding of the vulnerabilities that certain key species may have in Left Hand Creek and assist with focusing appropriate restoration strategies.

The application of the SVAP2 protocol includes the evaluation of stream systems features that affect overall stream conditions and generally encompass the following categories:

1. Channel stability (channel condition, bank condition)
2. Water quantity (hydrologic alteration)
3. Water quality (nutrient enrichment and manure/human waste)
4. Vegetation (riparian area quantity/quality and canopy cover)
5. Instream habitat (pools, habitat complexity, embeddedness)

A description of the specific elements evaluated as part of the SVAP2 protocol is presented in **Table 16** *SVAP2 Ecologic Stream Assessment – Ecosystem Elements* in **Appendix B**. At completion of the SVAP2 protocol stream reaches are classified into one of the following categories:

Severely Degraded: Channel and banks are highly unstable and/or covered with rip-rap or concrete; homogenous channel bed lacking in habitat complexity; natural flow regime is significantly altered; limited floodplain access; and there is little to no riparian vegetation.

Poor: Channel is unstable with fairly homogenous channel bed lacking in habitat complexity; inadequate riparian corridor with large gaps of vegetation along the reach; developments in floodplain, or inaccessible floodplain, with diverted flow altering the natural flow regime.

Fair: Channel may be displaying some instability, with marginal connections between the active channel and floodplain; narrow riparian corridor with large gaps of vegetation along the reach and limited canopy cover; limited habitat complexity.

Good: Channel may be displaying some instability, but the active channel and floodplain are connected in most areas; some development in floodplain, but does not significantly alter natural flow regime; adequate riparian corridor is present, but may have gaps along reach; moderate habitat complexity.

Excellent: Channel is stable with continuous floodplain access, complex fish habitat including numerous shallow and deep pools; extensive and diverse riparian corridor; natural flow regime prevails.

Reaches were broken down further for the ecologic risk assessment, as described in **Table 9**.

Table 9. Left Hand Creek Reach Break Descriptors

Reach #	Downstream End	Upstream End
1	Confluence with St. Vrain Creek	US-287
2a	U.S. 287	Pike Rd.
2b	Pike Rd.	95th St.
3a	95th St.	Hwy 119
3b	CO-119	Nimbus Rd.
3c	Nimbus Rd.	Williams Ditch diversion (west of 63rd St.)
4	Williams Ditch diversion (west of 63rd St.)	Boulder Feeder Canal diversion
5	Boulder Feeder Canal diversion	Crocker #2 Ditch diversion (west of Ogallala Rd.)
6a	Crocker #2 Ditch diversion (west of Ogallala Rd.)	US-36
6b	US-36	Haldi Pipeline diversion
7	Haldi Pipeline diversion	Allens Lake Diversion
8	Allens Lake Diversion	Just upstream from confluence with Sixmile Canyon
9	Just upstream from confluence with Sixmile Canyon	40° 6'28.82"N 105°20'0.49"W
10	40° 6'28.82"N 105°20'0.49"W	Confluence with James Creek
11	Confluence with James Creek	Lefthand Canyon Dr. crossing northeast of Lee Hill Dr. intersection
12	Highway crossing northeast of Lee Hill Dr. intersection	40° 5'1.44"N 105°21'55.01"W
13a	40° 5'1.44"N 105°21'55.01"W	40° 4'53.88"N 105°22'20.01"W
13b	40° 4'53.88"N 105°22'20.01"W	Lefthand Canyon Dr. crossing from north to south
13c	Lefthand Canyon Dr. crossing from north to south	40° 4'32.65"N 105°23'49.39"W
14	40° 4'32.65"N 105°23'49.39"W	40° 4'28.46"N 105°24'43.59"W
15	40° 4'28.46"N 105°24'43.59"W	40° 3'43.75"N 105°27'50.60"W
16	James Creek: confluence with Left Hand Creek	James Creek: 40° 6'31.11"N 105°21'38.83"W
17	James Creek: 40° 6'31.11"N 105°21'38.83"W	James Creek: downstream end of Jamestown
18	James Creek: downstream end of Jamestown	James Creek: upstream end of Jamestown
19	James Creek: upstream end of Jamestown	James Creek: 40° 6'52.57"N 105°23'56.26"W
20	James Creek: 40° 6'52.57"N 105°23'56.26"W	-
21	Little James Creek: confluence with James Creek	Little James Creek: downstream of CR-87

Table 9. Left Hand Creek Reach Break Descriptors (Cont.)

Reach #	Downstream End	Upstream End
22	Geer Canyon: confluence with Left Hand Creek	-
23	Sixmile Canyon: confluence with Left Hand Creek	-
24	Spring Gulch: confluence with Left Hand Creek	-
25	South St. Vrain: diversion into James Creek	South St. Vrain: Brainard Lake
26	40° 3'43.75"N 105°27'50.60"W	40° 3'21.75"N 105°29'38.96"W

4.4.2 Results

The resulting SVAP2 scores are presented in **Table 10** and the overall score is mapped by reach in **Figure 24**. The overall ecological score for each reach were classified using the following categories:

- Score of 1 to 2.9: Severely Degraded
- Score of 3 to 4.9: Poor
- Score of 5 to 6.9: Fair
- Score of 7 to 8.9: Good
- Score of 9 to 10: Excellent

The majority of the plains reach of Left Hand Creek received "fair" to "poor" overall ecosystem scores. The lower reaches below the Highway 36 crossing, tend to lack quality riparian vegetation and canopy cover, have very homogenous streambeds with little to no habitat complexity or pools, and have numerous diversion structures that act as barriers to fish movement as well as reducing flow in Left Hand Creek. The lower reaches of Left Hand Creek also have highly altered flow regimes and there are reaches of the creek that run dry during summer days. Due to varying levels of vegetation and hydrologic alterations in several of reaches, subreaches (2a, 2b) were broken out to better reflect the current conditions in the river corridor.

The canyon reaches of the Left Hand system received "fair" to "good" overall ecosystem scores. In general, the vegetation and canopy represented a more natural condition and the hydrology is more representative of a natural flow regime. The canyon reaches, however, still have limited habitat complexity and lack large and small woody material in the stream and floodplain and only shallow pools, which are critical overwinter habitat for native fish species.

Table 10. SVAP2 Results for Left Hand Creek

Reach	Channel Condition	Hydrologic Alteration	Bank Condition	Riparian Quantity	Riparian Quality	Canopy Cover	Vegetation Composite	Nutrient Enrichment	Manure or Septic	Pools	Barriers to Movement	Fish Habitat Complexity	Aquatic Invertebrate Habitat	Overall Ecosystem Score
1	7	2	8	8	5.5	3	5.5	10	10	1	2	2	2	5.0
2a	2	2	5	5	4.5	3	4.2	-	10	2	7	2	2	4.0
2b	5	2	6	6.5	4	6	5.5	7	10	3	4	5	6	5.4
3a	8	2	9	7.5	8	9	8.2	10	10	3	10	5	6	7.3

Table 10. SVAP2 Results for Left Hand Creek (Cont.)

Reach	Channel Condition	Hydrologic Alteration	Bank Condition	Riparian Quantity	Riparian Quality	Canopy Cover	Vegetation Composite	Nutrient Enrichment	Manure or Septic	Pools	Barriers to Movement	Fish Habitat Complexity	Aquatic Invertebrate Habitat	Overall Ecosystem Score
3b	3	2	6	7.5	6	8	7.2	8	8	2	2	2	3	4.8
3c	6	2	5	6	4.5	5	5.2	4	10	2	0	5	6	4.6
4	3	3	4	7	5	6	6.0	6	10	7	4	8	9	6.0
5	6	4	7	8	9	9	8.7	9	10	5	3	7	8	7.1
6a	4	4	2	4	4	3	3.7	-	3	3	2	6	7	3.8
6b	7	5	8	0.5	1.5	1	1.0	-	10	1	10	3	4	4.6
7	5	6	4	7	5.5	2	4.8	10	10	4	5	6	7	6.0
8	5	8	6	7.5	5.5	2	5.0	10	10	6	3	8	9	6.7
9	5	8	5	5.5	4.5	2	4.0	10	10	7	10	6	7	6.7
10	3	8	4	2	2	2	2.0	10	10	8	10	6	7	6.0
11	5	8	7	4.5	5	4	4.2	10	10	9	10	8	9	7.5
12	6	8	6	6.5	6.5	5	6.0	10	10	5	7	6	7	6.9
13a	7	8	7	7.5	8	6	7.2	10	10	7	8	8	9	8.0
13b	3	8	4	8	7	5	6.7	10	10	9	0	8	9	6.8
13c	6	8	6	7.5	6.5	6	6.7	10	10	9	8	8	9	7.8
14	5	8	5	6	5.5	3	4.8	10	10	9	10	8	9	7.4
15	8	8	8	8.5	8.5	8	8.3	10	10	9	10	8	9	8.8
16	5	8	4	5.5	4	1	3.5	10	10	3	10	5	6	6.0
17	5	8	6	4	4	1	3.0	10	10	6	10	6	7	6.4
18	5	7	5	4	4	3	3.7	10	10	8	1	5	6	5.7
19	5	8	5	4	5	2	3.7	10	10	10	1	4	5	5.8
20	4	9	4	5	5	2	4.0	10	10	9	1	7	8	6.2
21	5	8	4	5.5	4.5	3	4.3	5	10	4	4	6	7	5.5
22	6	8	5	1	2	1	1.3	5	7	-	-	-	-	4.4
23	4	8	4	2.5	3.5	0	2.0	7	10	-	-	-	-	4.9
24	5	8	6	8.5	6.5	5	6.7	10	10	5	10	7	8	7.4
25	10	8	9	9	9	8	8.7	10	10	10	10	10	10	9.4
26	8	8	8	8.5	7	8	7.8	10	8	6	10	7	8	8.0

4.4.2.1 Channel Stability

Channel stability including channel and bank condition was observed for each reach, as shown in **Table 10**. None of the reaches (with the exception of the upper James Creek reach) were considered stable. Most reaches had evidence of either active or past incision, with many reaches disconnected from their floodplains. The bank condition for over half the reaches in the Left Hand Creek system was characterized as moderately unstable, with fabricated structures over more than half of the reach or excessive bank erosion/failures.

4.4.2.2 Water Quantity

Hydrologic alteration scores for the entire Left Hand Creek system are shown in **Figure 25**. The SVAP2 protocol for water quantity relates current conditions to pre-settlement or native conditions for which the indigenous plants and animals evolved to cope and thrive. In Left Hand Creek, this means that seasonal and yearly variations in high and low flows are present which allow for lateral and longitudinal connectivity for aquatic species within the creek channel. This also means there are yearly and seasonal variations in stream power that allow for, but also disrupt, the native riparian vegetation establishment cycles.

Water quantity and flow timing in upper Left Hand Creek is mostly unaltered and the natural flow regime prevails. Little James Creek also has a relatively unaltered hydrology. James Creek, however, experiences significant additional flow coming from St. Vrain creek through the Left Hand Ditch diversion upstream of Highway 72, and as a result, James Creek downstream of this diversion has an altered hydrology and seldom experiences the continuous low to moderate flows that used to occur in this reach during summer, fall, and winter. This alteration propagates downstream through the confluence of James Creek and Left Hand Creek and into the plains reaches. Water quantity and flow timing in lower Left Hand Creek is altered by numerous diversions starting in Reach 7 through Reach 3c, as well as floodplain development throughout the urban corridor. Many of these diversions take the majority of the flow from the main channel, at times leaving very little flow in the plains reaches (e.g., Reach 3c).

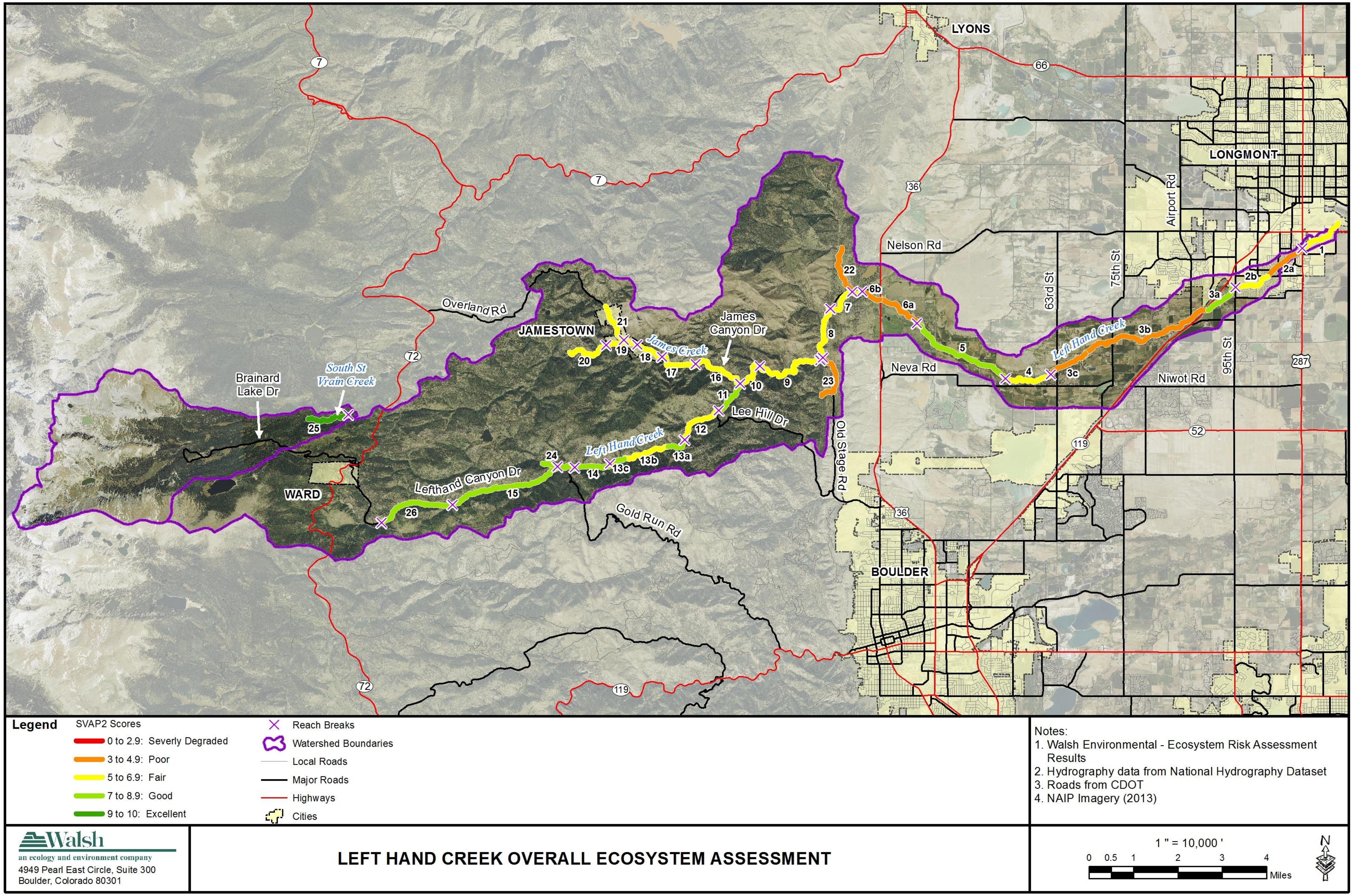


Figure 24. Overall Ecosystem Assessment

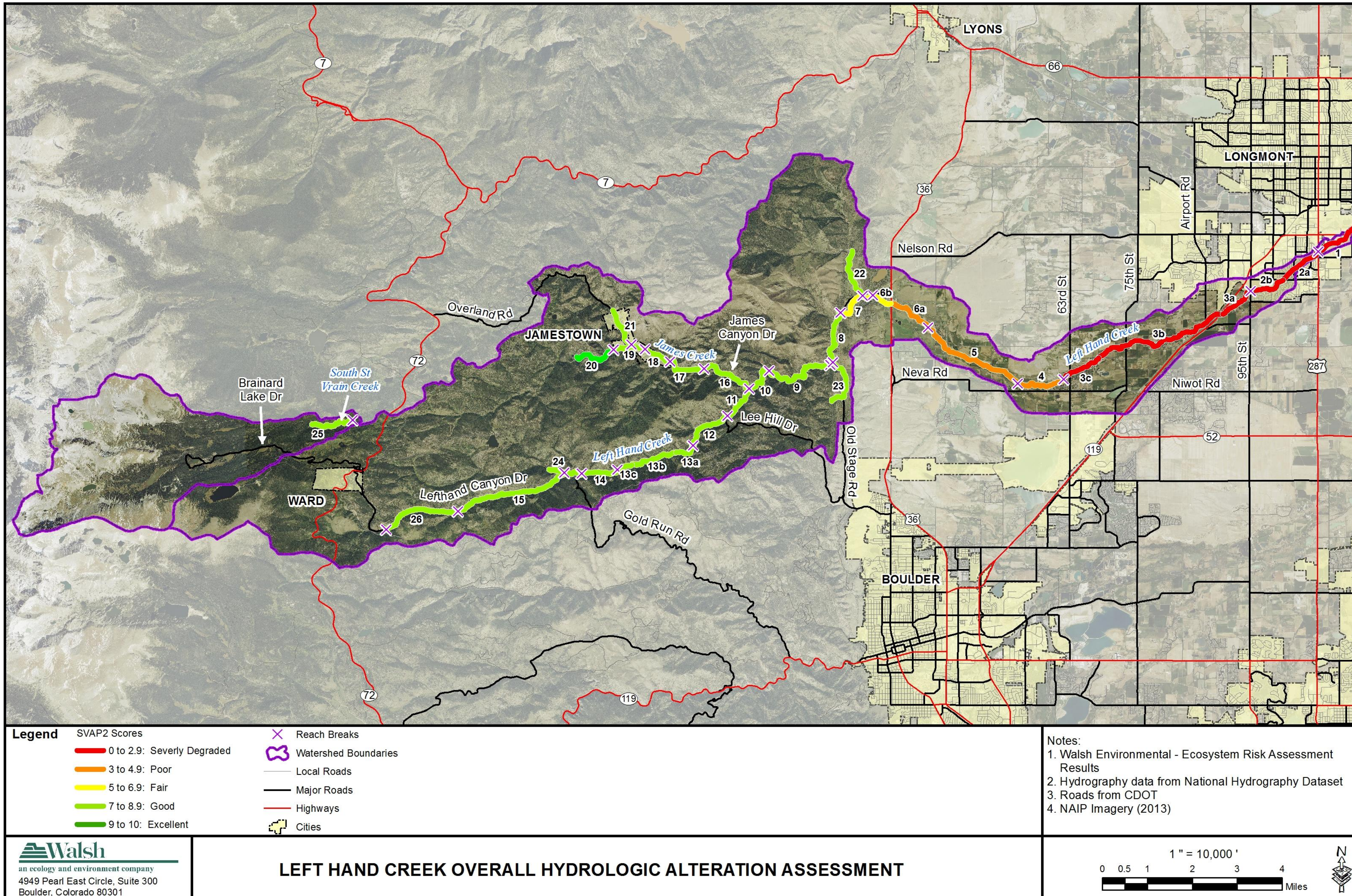


Figure 25. Hydrologic Alteration Assessment

4.4.2.3 Water Quality

General water quality related to the excess of nutrients and presence of manure and/or septic was visually assessed along the Left Hand Creek corridor. Horse pastures located in the floodplain or manure observed in the corridor were noted in four reaches (3b, 6a, 16, 23). Algal growth was noted in Reaches 2b, 3b through 5, 22, 23, and 24.

4.4.2.4 Vegetation

The scores for vegetation quantity and quality and canopy cover for each reach were averaged into one score (vegetation composite; **Table 10**). Only six reaches along Left Hand Creek displayed adequate riparian vegetation, corridor width, and canopy cover, with a rating of "good." The majority of the remaining Left Hand Creek reaches scored "poor." Two reaches on Left Hand Creek (6b and 10), Geer Canyon (Reach 23), and Sixmile Canyon (Reach 24) were all rated as having "severely degraded" vegetation, mainly because of flood damage. The entire James Creek corridor (Reaches 17 through 22) was rated as having "poor" vegetation, also mainly because of flood damage.

4.4.2.5 Instream Habitat

An assessment of instream habitat, including pool presence, barriers to fish movement, and fish and aquatic invertebrate habitat complexity, for the Left Hand Creek corridor is presented in **Table 10**. The tributaries Geer and Sixmile were not scored for these categories given they had little to no flow during the time of the assessment. The majority of reaches within the Left Hand Creek watershed displayed "good" to "fair" fish and aquatic invertebrate habitat, two reaches (6b and 20) were rated as "poor," and three reaches (1, 2a, 3b) were rated as "severely degraded." Additionally, Left Hand Creek has numerous barriers to aquatic species movement, involving full-width diversion structures in the lower reaches and culvert/road crossings (with scour on the downstream end causing substantial drops) in the upper reaches. The recently constructed grade control structures on James Creek (Reaches 19 and 20) impede aquatic species movement the majority of the year, due to the height of the steps.

4.4.3 Summary

A list of recommended habitat enhancements for each reach is presented in **Table 11**. Many of these recommendations are included in projects scoped for most of the reaches. The guidelines in **Table 11** can be used to guide restoration strategies for those areas of the channel not covered by defined projects.

Table 11. Left Hand Creek Ecosystem Recommendations

Reach #	Recommendations
1	Short Term: passive Restoration, repair/vegetate exposed/eroded banks to minimize sediment loading to channel; create defined and stabilized low flow channel. Long Term: addition of woody material and riffle/pool complexity; addition of woody plantings to increase cover. Encourage partnerships and agreements to develop plans for continuous in-stream flow.
2a	Short Term: stabilize banks, create defined and stabilized low flow channel Long Term: addition of woody material and riffle/pool complexity; investigate whether grade control structure upstream of pedestrian bridge impedes aquatic organism passage. Encourage partnerships and agreements to develop plans for continuous in-stream flow.
2b	Short Term: stabilize banks, create defined and stabilized low flow channel. Reestablish channel at S. Sunset Bridge to address shallow flow, acquire parcel on river left for restoration project. Long Term: implement large floodplain and creek habitat rehabilitation project between 95th St and S. Sunset Road. Encourage partnerships and agreements to develop plans for continuous in-stream flow.

Table 11. Left Hand Creek Ecosystem Recommendations (Cont.)

Reach #	Recommendations
3a	Stabilize banks in upstream portion of reach; addition of channel complexity (shallow flow with cobbles/gravels covered in sand). Short Term: Passive Restoration. Aggressive ELJ to stabilize railroad embankment Long Term: Long Term Monitoring of physical and ecological characteristics. Encourage partnerships and agreements to develop plans for continuous in-stream flow.
3b	Rebuild floodplain benches/stabilize banks; narrow channel, add riffle/pool complexity, and reestablish riparian vegetation to address aggradation in reach with shallow/braided flow. Encourage partnerships and agreements to develop plans for continuous in-stream flow.
3c	Addition of woody material and creation of deeper pools. Encourage partnerships and agreements to develop plans for continuous in-stream flow.
4	Golf Course: Stabilize and knock back cut banks; integrate floodplain benches with establishment of additional riparian vegetation; creation of deeper pools; investigate whether diversion structure (Boulder Feeder Canal) and/or the low water crossing at upstream end of reach impedes aquatic organism passage. Brigadoon Glen: Bank Stabilization, re-establish floodway and sediment transport capacity. Re-establish low flow channel. Encourage partnerships and agreements to develop plans for continuous in-stream flow.
5	Address potential aquatic organism passage barriers in the vicinity of 49th St. bridge. Encourage partnerships and agreements to develop plans for continuous in-stream flow.
6a	Mid-reach - stabilize banks/headcuts, integrate floodplain benches with establishment of additional riparian vegetation; investigate whether diversion structures (Crocker Ditch, Badger Ditch) at upstream end of reach impedes aquatic organism passage. Encourage partnerships and agreements to develop plans for continuous in-stream flow.
6b	Create more planform complexity (deeper pools, more sinuosity); integrate floodplain benches with reestablishment of riparian vegetation (addition of woody plantings to increase cover); replace/enlarge culverts under US-36 to minimize aggradation upstream. Encourage partnerships and agreements to develop plans for continuous in-stream flow.
7	Create more planform complexity (deeper pools and more woody material); stabilize banks, integrate floodplain benches with reestablishment of riparian vegetation (addition of woody plantings to increase cover); investigate whether diversion structure (Allen's Lake diversion) impedes aquatic organism passage. Encourage partnerships and agreements to develop plans for continuous in-stream flow.
8	Mid-reach: create more planform complexity (sinuosity, deeper pools and more woody material); potential for floodplain benches with additional near-channel riparian vegetation; investigate whether weir at lower end of reach and culvert at mid-reach impedes aquatic organism passage
9	Addition of riparian vegetation near-channel; investigate sizing of culvert mid-reach and whether it impedes aquatic organism passage
10	Addition of riparian vegetation near-channel and woody material
11	Investigate sizing of culvert at upstream end of reach and whether it impedes aquatic organism passage; create more planform complexity (deeper pools and more woody material);
12	Stabilize banks upstream; investigate sizing of culvert at downstream end of reach and whether it impedes aquatic organism passage; addition of woody material to create more pools
13a	Investigate sizing of culvert mid-reach and whether it impedes aquatic organism passage
13b	Investigate sizing of culvert mid-reach and at upstream end of reach to determine whether they impedes aquatic organism passage; stabilize banks
13c	Investigate sizing of culvert at downstream end of reach and whether it impedes aquatic organism passage
14	Stabilize banks; addition of riparian vegetation
15	Protect and preserve riparian corridor

Table 11. Left Hand Creek Ecosystem Recommendations (Cont.)

Reach #	Recommendations
16	Addition of riparian vegetation near-channel and create more planform complexity (pools)
17	Addition of riparian vegetation near-channel; stabilize eroding banks
18	Reduce height of steps to encourage aquatic organism passage; addition of riparian vegetation near-channel and addition of woody material
19	Reduce height of steps to encourage aquatic organism passage; addition of riparian vegetation near-channel and addition of woody material
20	Reestablish riparian vegetation
21	Investigate sizing of culvert at downstream end of reach and mid-reach - impedes aquatic organism passage; investigate white precipitate mid-reach; stabilize slopes
22	Stabilize banks, integrate floodplain benches with reestablishment of riparian vegetation; investigate option of manipulating the aggraded material to allow surface flow the entire reach; investigate whether Lefthand Canyon Dr. culvert at downstream end of reach impedes aquatic organism passage
23	Stabilize banks, integrate low flow channel with reestablishment of riparian vegetation
24	Stabilize eroding banks at downstream end of reach
25	Protect and preserve riparian corridor
26	Protect and preserve riparian corridor

5 Project Recommendations

5.1 Overview

Project recommendations for LHCWMP are the products of both analyses and stakeholder input. Community members were able to provide input during neighborhood and public meetings, and through comments submitted to the project website and/or email address. Coalition members and community members provided watershed recovery and restoration input that helped to draw attention to missed issues and to also place channel behavior in both historical and flood contexts. Field investigations and desktop analyses were used to identify problem areas and to record and brainstorm potential restoration strategies. The risk assessments helped to place site specific issues in context with reach and system processes. All of these information sources were then compiled with the help of the project GIS to lay out a framework for identifying appropriate treatments for each reach in the study area. Nearly 50 individual projects were identified for the LHCWMP.

Individual Treatments were then grouped into projects based on spatial extent, property lines (where appropriate) and dependencies (i.e., individual treatments that need to be complete in tandem with adjacent treatments). However, it is important to note that while the success of downstream projects is certainly enhanced by the completion of those upstream, the recommended projects, as grouped in the following plans, can stand alone as individual efforts. In general, most of the recommended projects are located near infrastructure. In other locations, the channel is likely to re-habilitate itself. Property owners looking to augment the restoration process in these locations should refer to the conceptual strategies for that reach type. For example, if a landowner is located in stretch of creek that does not have a defined project, that landowner can refer to the River Styles definitions (Section **4.3.2.2**) for information and restoration strategies for their property.

In addition to the projects depicted in the mapbook, there are some system level recommendations that should be applied to the entire watershed. Examples include strategies for dealing with sediment and debris at crossings and diversion structures and approaches for restoring each River Style. Finally, projects were ranked on a number of criteria, including how they address flood, geomorphic, and ecosystem risks, as well as how they address community values as communicated at the public meetings. The top 5 most important projects are detailed and a table of rankings for all of the identified projects included.

To reiterate, the conceptual designs depicted below and in the mapbook are meant to create a vision for the future of the watershed. These sketches and illustrations are meant to convey concepts that can help create a more flood-resilient watershed. All recommendations in this plan will still need to comply with all federal, state, and local requirements prior to implementation. This includes but is not limited to additional environmental and engineering studies, detailed engineering design, permitting, local land use and property ownership, and local public engagement processes.

5.1.1 How to Use the Project Mapbook

The plans in the attached mapbook offer conceptual representations of the treatments identified and recommended as part of this plan. Every attempt has been made to convey the values of both the coalition and community to the degree possible given the time and budget constraints associated with this project. The point of the plans is to suggest conceptual solutions to the issues associated with flood recovery and long-term planning. The idea is that this plan conveys information and ideas that can be used when the engineering work required to implement these projects begins. By the time the project implementation and funding request phases begin, most of the scoping-level work will have been completed by the work performed for this plan. Watershed stakeholders will then have in hand conceptual strategies, as well as an analysis of the physical constraints and considerations for implementing restoration projects in the project study area.

The mapbook starts at the bottom of the project area and moves upstream. The entire length of each reach is not presented, rather only those river sections that contain projects. (Strategies for areas not detailed on a project sheet are included in the section below, System-wide Recommendations – River Style Restoration Strategies.) Each sheet contains six major elements (**Figure 22**):

1) **Planform Map** - depicts conceptual representations of channel location and recommended restoration actions.
2) **Reach Typical Designs** - section contains information about the reach River Style and typical strategies for reach restoration.
3) **Reach Special Designs –** show where to find the detail for any special cross sections depicted in the planform map
4) **Project Descriptions** - simple description of the project(s) depicted on that sheet.
5) **Reach Trajectories** - section contains pertinent restoration information about the depicted project's likely future behavior. These symbols are meant to quickly convey the reach trajectory. For example, in reaches showing aggradation as a stream trajectory, restoration actions should have a plan for managing the sediment load.
6) **Title Block** - contains the reach and project codes for those projects depicted in the planform map.

When using the mapbook, the reader should refer to information contained in elements (2) and (3) for the location of conceptual drawings that present the restoration concepts developed for that project and/or reach. If map element (3) is blank, then the project depicted should follow the concepts listed in (2), which indicate the restoration goals for that particular reach's River Style. In the example in Figure 28, restoration conceptual drawings can be found on mapbook sheet T-1, located in the back of the mapbook.

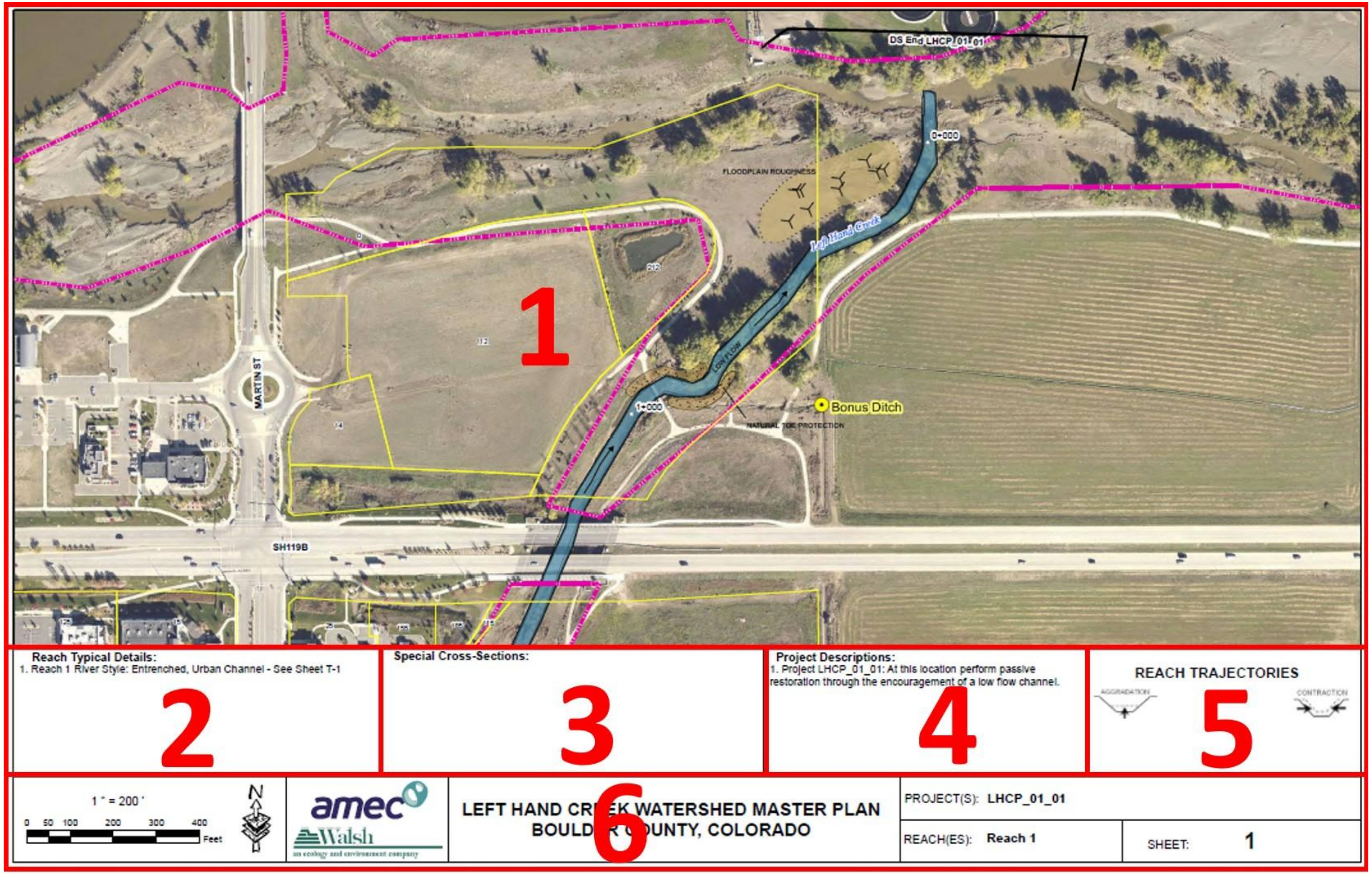


Figure 26. Example layout with annotations identifying the sections of the plan sheets.

Linework contained in the planform map is meant to show the approximate upstream and downstream extents of where the noted cross section should be applied. Where no cross section is specified, the typical sketches for the River Style listed for that reach should be used.

5.2 System-wide Recommendations

5.2.1 River Style Restoration Strategies

Each River Style is representative of a particular stream type, and each stream type responds differently to particular restoration strategies. The restoration goals for each stream type are realistic from a cost and permitting standpoint and consider the existing river conditions as well as the predicted trajectories determined for each reach. For example, a headwater stream type that has an incision trajectory requires different treatments than an aggrading section of a partly confined, wandering channel. To address these issues, standard plans, profiles, and cross sections have been developed for each River Style. These standard plans depict restoration strategies for those sections of stream not covered by projects. The drawings are meant to illustrate concepts to be considered during the implementation of restoration projects. Residents that live along the stream can use these guidelines to inform the engineers hired for their own restoration projects. In this manner, they have a better chance of implementing projects that consider the system and reach behavior, and thus the investment in the creek likely will last longer and perform better than solutions that only consider local or property-specific conditions. Standard plans for each river style are detailed in the attached mapbook (Sheets T-1 through T-6), but should be used only as a basis for, not in place of, detailed engineering design and construction drawings that incorporate the unique qualities and characteristics of an individual site. Furthermore, trajectories for each reach are included on the project plan sheets as well as in the reach descriptions.

> *The term restoration can imply many possible courses of action, including returning the river to its pre-flood configuration or attempting to return the creek to some pre-development condition. For this study, restoration means re-establishing river function. Any particular river channel is the product of discharge and sediment supply, as controlled by the presence of physical features and valley constraints. The strategies proposed in this plan are meant to improve the creek's ability to handle a range of water flows and sediment supply, while improving the stability of the channel where it is constrained and providing an appropriate floodplain corridor where it is likely to change course over time, even as the flow and sediment supply increases during typical seasonal high water events. For reference, the damage to the channel and floodplain resulting from the September 2013 flood is the channel's response to a dramatically increased discharge and sediment supply.*

General strategies for all River Styles include:

- Provide space for the stream to adjust to changes in sediment load and discharge which will occur as Left Hand Creek establishes new equilibriums in the wake of the September 2013 floods. This includes reconnecting the channel and floodplain.
- Identify locations that can be used to capture debris and sediment before they impact infrastructure. These are relatively flat locations that become inundated as flows rise. The overland flow can then spread out and drop much of its sediment load before connecting back to the channel.
- Re-vegetate bare stream banks and enhance native vegetation in floodplain areas. Vegetation serves a number of functions including energy dissipation, bank stability, runoff capture and filtration, and ecosystem enhancement. Guidelines specific to the Left Hand Creek system include:
  1. Plantings should utilize seed mixtures with an appropriate diverse species of grasses and forbs suitable for the soil type and elevation.
  2. Near homes, chokecherries and other fruit/nut producing species should be avoided in restoration plantings to minimize the chance of attracting black bears to the area.
  3. Leaving some woody material, tree boles etc. on riparian and upland sites will enhance the diversity of habitat types and the plant species supported by the site, which will benefit a larger variety of wildlife.
  4. Restoration efforts should use fence designs that minimize impact to wildlife and their movement. Appropriate designs may be found at http://cpw.state.co.us/Documents/WildlifeSpecies/Coexisting/fencing.pdf or in consultation with your local District Wildlife Manager.

5.2.2 Public Roads, Bridges and Culverts

5.2.2.1 Overview

The September 2013 flood had a devastating impact on public and private roads and crossings in the Left Hand Creek watershed. Extensive sections of road were damaged limiting the ability of many residents to evacuate during the flood and return to their homes in a timely manner. (Maps of the flood damage to public roads and infrastructure can be found in Section **3.4**.) Culverts and crossings throughout the system plugged with debris causing the stream to flank the structures and avulse, causing damage to roads, structures, and adjacent lands. The LHCWMP recommends a series of recovery strategies for re-building the public and private transportation infrastructure with considerations of predicted stream behavior for each River Style. Left Hand Creek, however, is a very dynamic system that presents a number of engineering and geomorphic challenges, and it is unlikely that the river will be "controlled" by implementing the recommended measures. Constructing roads, bridges, and embankments capable of withstanding the magnitude and duration of the September 2013 floods may not be possible or practical, particularly if the existing roadway alignments will be kept. Much can be gained in smaller events, however, by thoughtful incorporation of the recommended features. There will also be dramatic increases in public safety as the transportation infrastructure is re-established if careful considerations for how each structure should and will fail are incorporated into the design and construction.

5.2.2.2 Road-Stream Interface

For much of the mountain portion of the watershed, the road and stream share the same narrow canyon corridor. As much of the roadway was damaged by the flood and will need to be rebuilt, the opportunity arises to couple the road design and construction with the river restoration. In this manner, the river can be restored with features that help relieve stress on the road embankment while the road can be designed to accommodate stream behavior. The goal is to build a single road-river system that improves the stream ecosystem, restores river function, and ultimately, is more resilient to future floods.

In general, the strategy is to dissipate stream energy, add flow and spatial complexity, and reduce areas of high velocity by using features seen in natural river systems as a means to stabilize the river system as well as reduce stress on the road embankment. The most efficient means to reduce sheer stress on the channel bed, banks, and road embankment is to reduce the water depth by increasing the width of the stream corridor i.e. creating floodplain benches at or near bankfull depths or by removing berms and levees that disconnect the stream from the natural floodplain. Energy dissipation will occur as the river bends and meanders, and as flow encounters roughness elements such as large woody debris, boulders and boulder clusters, and woody vegetation. Re-introducing these elements into the channel is recommended in all locations where the river and road share an alignment. Additionally, positive impacts to water quality can be provided by filtering road runoff and stabilizing sediment sources by including a vegetated area between the road and the creek.

The dominant River Styles in the mountains are Headwater, Confined Valley, and Confined Valley with Bedrock-controlled Floodplain Pockets. The Headwater and Confined Valley River Styles are unlikely to have enough valley width to provide much separation between the river and road. In these locations, riprap with the understanding that in a large flood event these areas are likely to be the most vulnerable may be the best option. In locations with less width, the establishment of a vegetative buffer between the channel and road becomes more challenging, but should be implemented where possible.

In the Bedrock-controlled Floodplain Pockets River Style reaches, however, the pockets provide locations to capture debris, dissipate stream energy, and establish vegetation between the road and river.

Figure 27 shows conceptual cross sections for the road-stream interface for the Confined Valley, and Confined Valley with Bedrock-controlled Floodplain Pockets River Styles. These drawings are solely meant to convey concepts to be included after detailed engineering analysis in the final design of the road-river system.

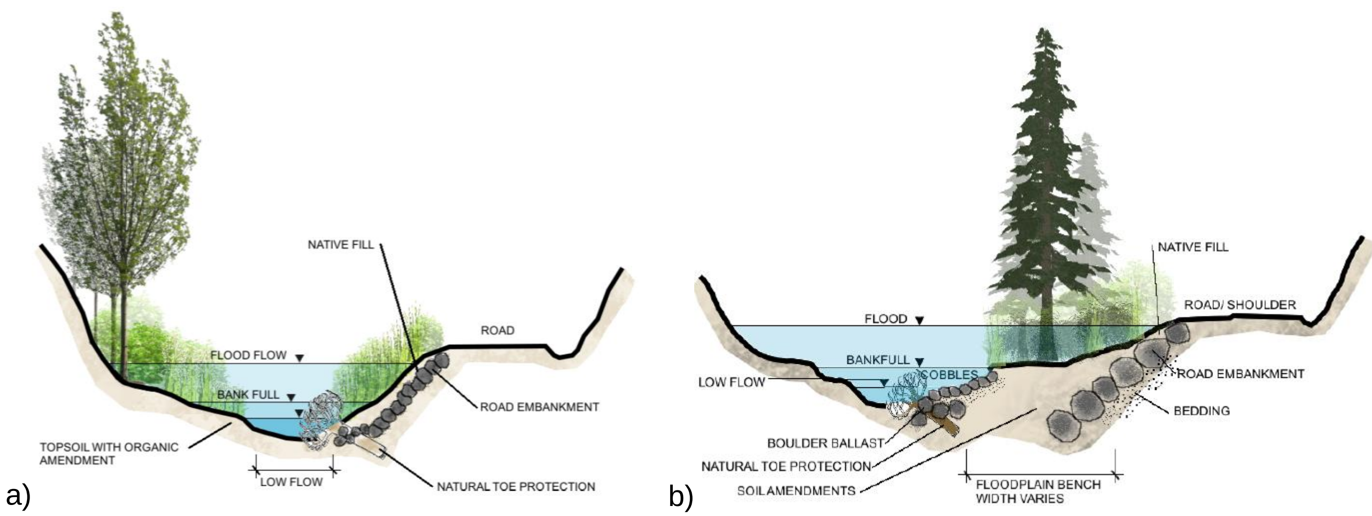


Figure 27. Conceptual cross sections for road-stream interface reaches with varying valley widths. (a) Depicts the Confined Valley River Style. (b) Depicts the Confined Valley with Bedrock-Controlled Floodplain Pockets.

The implementation of these concepts will depend upon the road design, stable channel dimensions, and valley width. Where space is available, setback riprap can be used to protect the road. Burying and re-establishing vegetation on top of the riprap provides a vegetative buffer between the road and stream, filtering out contaminants and absorbing runoff. The pocket or bench should be stabilized with vegetation, dissipating flood energy by providing floodplain and floodplain roughness, and enhancing the local ecosystem. Natural materials, such as large woody debris (LWD) may be used to stabilize a compound channel consisting of low, bankfull, and flood flow channels. LWD can also be used to provide energy dissipation on the outside of bends. The inclusion of large woody debris as a channel stabilizing feature will need to be carefully designed, considering the grain size composition of the channel and hydraulics.

All of the reaches where the road and river should be designed together are in the mountains and will generally exhibit a step-pool channel morphology. The steps provide energy dissipation by flattening the local channel gradient. These sequences (e.g., step-pool-step) will re-establish themselves naturally, but this process may take longer than fits with the construction schedules. Speeding up the process through stream restoration will allow for the steps to be used in locations where fast flows impact the road embankment. To protect native fish species that are unable to jump, structures should avoid vertical faces.

Next steps, important notes, and/or action items:

- In order to implement these concepts, terrain, hydrology, and hydraulic data need to be collected, modeled, and used to create the site-specific designs.
- These concepts require engineering design and permit approvals before they can be implemented.

5.2.2.3 Public Crossings (Bridges and Culverts)

During the September 2013 flood, many private and public road crossings created problems by accumulating sediment and debris and restricting flow and in some cases the channel cut a new path across the road and/or through private property once the crossing was overwhelmed. Many of the crossings in the Left Hand Creek watershed are fairly new or have already been rebuilt since the September 2013 flood. In general, crossings are sized based on the guidance and best available data available at the time they were designed, but accommodating passage of sediment and debris during an extreme event may not have been considered at the time. Post-flood sediment supply will continue to be high while the creek system adjusts to the disturbance caused by the flood. Many of the crossings are quite wide (to accommodate larger flood flows), and constructed with a flat or gently sloping profile. This has the effect of reducing the sediment transport capacity through it and reducing the ability of aquatic organisms to freely pass through the crossing. As a result, areas directly upstream of the crossings tend to aggrade, or accumulate material, reducing flood capacity.

To account for the loss in conveyance capacity, the crossings should be monitored and excessive sediment cleaned out when necessary. In order to estimate the frequency at which proposed maintenance will likely be needed at a particular crossing, a sediment budget and additional analyses would be needed at each crossing. Furthermore, undersized culverts tend to convey water out their downstream end at elevated velocities, which can scour streambed material there and over time create a perched outlet.

Moving forward, local jurisdictions and regulatory agencies should consider stream crossing designs that provide adequate flow conveyance and also effective sediment and debris transport and aquatic organism passage through the crossing (**Figure 28**). Resources commonly used to design crossings that facilitate the transport of debris and aquatic organisms include the USFS Stream Simulation (Forest Service Stream-Simulation Working Group, 2008) or FHWA (Federal Highway Administration) HEC-26 methodologies (FHWA, 2010).). In addition to the design guidance provided by the federal government and the State of Colorado, many good references exist in other localities. One such example is the 2013 Water Crossing Design Guidelines document available from Washington State Department of Fish & Wildlife. These tools should help size structures to emulate the function of the adjacent stream channel by minimizing the disruption of the movement of water, sediment, debris, and aquatic organisms. However, the magnitude and duration of the September 2013 flood was such that designing crossings to handle the debris load of a flood of that magnitude is likely not realistic or practical. Crossings, while necessary for vehicular traffic, typically concentrate stream flows to a small portion of the former stream floodplain and therefore increase the risk that sediment and debris could cause problems there.

Many of the stream crossings in the lower reaches in the plains have aggraded significantly, with sediment depths ranging from inches to feet of sediment accumulated under and adjacent to the crossing. For example, the bike path underneath the crossing at Airport Road is buried under sediment deposited during the flood and the stream channel is now perched above the pre-flood elevation. The story is similar for crossings upstream to 81st and downstream to 95th. These crossings were designed to pass flood flows, but the wide crossing and flat gradient contributed to sediment and debris settling out. Debris blockages also slow the flow down in the main channel and force conveyance to the overbank area, causing sediment and debris to settle out.

The long-term strategy to addressing this issue is to establish a compound channel, including a low-flow channel which will promote appropriate sediment transport and a floodplain to provide conveyance of water and debris during floods. The compound channel needs to be extended upstream and downstream an adequate distance to provide a transition to the remainder of the stream corridor. A correctly sized compound channel will facilitate sediment transport for a range of flows, but is still likely to require maintenance until the base levels adjust by flushing fines downstream, through the system. Grade control structures can help maintain gradient and channel structure. Examples include drop structures, boulders, and cross vanes, and must be designed based on site-specific information. Crossings with additional challenges, such as the buried bike path below Airport Road, may require additional design considerations.

While a compound channel should increase sediment movement through aggraded areas over the long term, it will likely not be completely effective in the short term without a more systematic approach and until the sediment availability returns to background levels. Many of the affected structures are flanked by private land, and landowner permission may be needed to work on those portions of the channel.

Maintenance will be required, especially if private landowners are unable to perform the channel work on their property. It is recommended that once the hydrology and hydraulics have been updated for the plains reaches of Left Hand Creek, stable channel dimensions be calculated based upon the design criteria and the recommended geometry be made available publicly to provide a consistent approach and minimize duplication of efforts. References for stable compound channel design include manuals produced by the Army Corps of Engineers (Soar and & Thorne, 2001) and the NRCS National Engineering Handbook 654 (NRCS, 2007).

The maintenance activities described above are appropriate for all of the public crossings. Bridges at 81st, 63rd, and through the City of Longmont currently have the greatest need for maintenance to remove accumulated sediment. A monitoring program could be as simple as recurring photographs of a crossing over time. Monitoring will help determine which crossings are aggrading at the highest rate. Design for sediment removal and features to promote sediment transport should be designed in such a way that the likelihood of follow-up work is minimized because of the negative short-term impacts from the construction work. Maintenance access points will need to be well planned out with precautions taken to mitigate harm. CPW has developed resources detailing BMPs for working in and around stream channels and wetlands, which can be found at: http://cpw.state.co.us/aboutus/Pages/CNAP-Publications.aspx

Next steps, important notes, and/or action items:

- Develop and use the best available guidance to design crossings to promote sediment transport, flow conveyance, debris passage, and aquatic organism passage.
- Crossings may require periodic sediment removal to maintain flood capacity until a stable compound channel can be established at the crossing and in the stream reach.
- A monitoring program will help determine when sediment removal is warranted.
- Designs that involve sediment removal should provide adequate protections to aquatic life and the function of the stream corridor.

Figure 28. Graphical example of existing crossing constructed with low-flow channel that facilitates aquatic organism passage and sediment transport.

5.2.3 Diversion Structures

The majority of the diversion structures in the Left Hand Watershed are channel spanning with large vertical drops. This traditional design hinders sediment transport and blocks the passage of aquatic organisms. As a result, the areas immediately upstream of the diversions are aggrading and the blockage of water slows the flow causing fine sediment to be deposited in the vicinity of the ditch inlets and headgates which can then be swept into the ditch network. Both the large scale aggradation, which also has the potential to raise flood surface elevations upstream, and the fine sediment in the ditches create a substantial maintenance tasks. Replacing and/or rebuilding these structures to facilitate sediment transport past the structure could reduce the amount of maintenance required. There are a number of high-head weirs that should be evaluated to determine if they can be retrofitted and moved to achieve these goals.

In the recovery efforts, there is an opportunity to work with coalition members to meet all stakeholder needs, fulfilling water decrees, enhancing ecosystems and recreational opportunities as well as building trust and relationships that will better serve all parties when future disasters or hardships occur.
The CWCB and CPW have provided resources and guidance for designing diversion structures for multiple uses. More information can be found at http://cwcb.state.co.us/Documents/ShortTermHomePage/CPWCWCBRebuildFactSheet.pdf

Next steps, important notes, and/or action items:

- Work with LHDC to identify potential funding sources for retrofitting the diversion structures with fish passage or replacing them altogether.
- Identifying the demand at each diversion will help determine of the structure can be replaced with a multi-purpose structure.


a) b)

Figure 29. New Diversion Structure at Canyon Mouth
a) Photograph looking upstream at the newly constructed diversion structure at the canyon mouth, on the border of reaches 7 and 8. b) Photograph of diversion structure that facilitates aquatic organism passage and sediment transport.

5.2.4 Floodplain Management

5.2.4.1 Special Flood Hazard Area Mapping

The last major study of the watershed in terms of characterizing channel conveyance, structure capacity and erosion potential occurred over 30 years ago, utilizing hydrology which had been developed a number of years before that. Currently, a hydrologic evaluation is being prepared for the entire watershed using modern techniques including GIS and radar rainfall data. A patchwork of LOMR's have been incorporated into the mapping near urban areas of the watershed, and currently there are numerous CLOMR's being developed for projects related to the 2013 flood event, mainly in the Longmont area. Repairs to infrastructure in both Left Hand and James canyons have altered the shape and capacity of the channel there, and numerous private crossings have been either repaired or replaced. In order to have the most comprehensive and complete special flood hazard area maps for regulatory purposes, as well as maps that incorporate the cumulative effects of the 2013 floods and the subsequent floodplain, crossing, and diversion structure construction, it is recommended that a new Flood Insurance Study (FIS) be undertaken for the entirety of Left Hand Creek. It is likely that a new study will be faster and less expensive than reach-scale or property-scale LOMRs.

Much of Jamestown was devastated during the 2013 event and is currently rebuilding bridges and engaging in stream stabilization measures. At the conclusion of major restoration activities, a LOMR will be processed to revise the DFIRM for the area. Upstream and downstream of this work however, Boulder County has repaired miles of road embankment, the LHDC has repaired several gate structures, and debris is slowly being cleaned up. The interim flood mapping noted above is of limited use a basis for regulation on the upper portions of Left Hand and James creeks, although with the automated sampling methodology described earlier, this modeling approach could be expanded to include field verification of structures and tributary drainageways to improve its utility as "better available information for purposes of administering the local floodplain ordinance during the flood recovery and redevelopment process". FEMA has, as of the writing of this document (Special Response R8-4145 CRCC, November 6, 2014) just accepted the new hydrologic study for the mainstem of Lefthand Creek as "Best Available Data". Until this information is adopted for use in future studies, it is recommended that the current regulatory flows for any re-study reach be compared to the new flows, and that the larger of the two be used in order to be conservative.

Below Foothills Highway, the Plains Region should be re-studied in its entirety to include the urban developments and channel improvements down to the mouth at St. Vrain creek. This would provide a sound basis for future improvements including a full evaluation of gravel mining operations and urban infrastructure. The potential savings in damage would easily outweigh the cost of updating the entire reach by providing a means to identify risk hazard due to channel migration. In addition, a floodway re-delineation should be required for the entire lower reach and land use restrictions should be re-evaluated for consistency and applicability.

In areas of high debris potential, floodplain administration should evaluate the relative merit of enforcing elevation standards exceeding current federal guidelines that currently only consider backwater from structures and not debris, as well as to require more stringent structural standards for exposed foundations or foundations in highly erodible banks. Flood protection elevation standards typically presume the flow to consist of water only. Therefore, when the flood is likely to include hyper-concentrated flow containing a very heavy sediment load and floating debris, it is prudent to recognize the tendency for flood levels to super-elevate above water-only flood levels, and for debris to cause additional damage both above and below the base flood level. Increased elevation standards and more stringent structural requirements would add a needed factor of safety for heavy debris streams, and could be based on a benefit to cost analysis to establish appropriate increases in standards.

Boulder County has hired a consultant to identify their unmet flood hazard hydraulic and FEMA flood mapping needs for Left Hand Canyon. AMEC largely agrees with their initial assessment. It is assumed that the CDOT hydrology will provide the basis for the mountain portion of the drainage, and the County roads project will provide the hydraulics. However, much work needs to be completed for the plains reaches. Table 12 below outlines the unmet needs for the creeks covered by this study. The analysis presented in Section 4.2.2 was used to guide the priority rating for each creek. Since the plains portion of the watershed is lacking any form of updated information and has a relatively high density of homes and infrastructure, it receives a high rating. Those reaches with a medium rating have existing needs, but have also received updated information. Geer Creek receives the lowest priority because it has some updated data and relatively little infrastructure.

Table 12. Left Hand Creek Watershed Flood Hazard Data Unmet Needs

Creek	Reaches	Extents	Updates Needed?	Priority	Explanation	Estimated Hydraulics Cost	Estimated FEMA Map Update Cost
Left Hand	1-6	Left Hand Creek from confluence with St. Vrain to US 36	Yes	High	Existing data is not accurate due to changes in channel elevation, channel alignment and floodplain configuration. Existing and updated hydrology studies do not cover this portion of Left Hand Creek.	$181,000	$89,000
Left Hand	6-15, 26	US 36 to Upstream Limit	Partial	Medium	Existing data is not accurate due to changes in channel elevation, channel alignment and floodplain configuration. Hydrology has been updated by the CDOT study. Hydraulics are scheduled to be updated by the Boulder County Roads project.	N/A	$78,000
James	16-20	Confluence with Left Hand to Upstream Limit	Partial	Medium	Existing data is not accurate due to changes in channel elevation, channel alignment and floodplain configuration. Hydrology has been updated by the CDOT study. Hydraulics are scheduled to be updated by the Boulder County Roads project. Additionally, the Town of Jamestown will be updated through existing infrastructure projects.	N/A	$34,000
Little James	21	Confluence with James to Upstream Limit	Partial	Medium	Existing data is not accurate due to changes in channel elevation, channel alignment and floodplain configuration. Hydrology has been updated by the CDOT study. Hydraulics are scheduled to be updated by the Boulder County Roads project. Additionally, the Town of Jamestown will be updated through existing infrastructure projects.	N/A	$23,000
Geer	22	Confluence with Left Hand to Upstream Limit	Partial	Low	Existing data is not accurate due to changes in channel elevation, channel alignment and floodplain configuration. Hydrology has been updated by the CDOT study. Hydraulics are scheduled to be updated by the Boulder County Roads project.	N/A	$23,000

Finally, a benefit to cost analysis is required for any project funded through the federal grant process. This applies to all projects that address flood-impacted infrastructure improvements, acquisitions, and flood control. For example, replacing flood-damaged public road crossings would require a benefit-cost analysis. This crucial step should begin immediately so that project initiatives may be identified in order to prioritize funding opportunities.

5.2.4.2 Channel Migration Zone

Debris flow and sediment had a major impact on the flood behavior in the Left Hand Creek system during the September 2013 flood. For much of the watershed, channel changes (e.g., migrations, avulsions) posed a much greater hazard to residents than overbank flows. Local jurisdictions may look to implement a Channel Migration Zone model, similar to that employed in the Pacific Northwest. The model works by identifying and defining different zones of channel change (e.g., historic migration zone, avulsion zone, erosion hazard area) that can then be used to guide the alignment of roads and the planning of future development. Implementation of such a model could work in tandem with the existing FEMA regulatory model by potentially offering incentives to communities that use channel migration zone analyses to inform local zoning regulations. There are several river systems in Colorado for which draft Channel Migration Zones have already been developed including the St. Vrain System, Fish Creek, and Fall River in Estes Park. Since the methods were developed for Pacific Northwest rivers, some additional study and application discussions may be required to tailor the methods to Colorado rivers. The potential savings in damage, something FEMA is currently assessing on the St. Vrain System, could easily outweigh the cost of identifying risk hazard due to fluvial migration. These maps also serve as a tremendous educational tool for informing land owners and residents of their risk both for the purposes of insurance as well as evacuation and life safety.

Next steps, important notes, and/or action items:

- Establish a task force to re-examine and make recommendations for updated crossing and road embankment design parameters that account for high sediment load and debris laden flows.
- Floodplain re-mapping efforts should focus on identifying resources to address data inadequacies for the area below US 36.
- A flood early warning system to help alert residents to danger. The Town of Jamestown is implementing a system that can provide the basis for a watershed-wide system.
- Benefit-cost analyses need to be performed for any project funded through the federal grant process.
- Provide incentives for communities to delineate channel migration zones in order to more clearly define flood risk for residents and increase community resiliency.

5.2.4.3 Flood Warning System

One option to increase system resiliency is to develop an early warning network in order to reduce life hazard issues, especially in debris-prone areas. The Town of Jamestown is currently in the process of implementing a basic flood warning system. This system could provide the foundations for a more comprehensive, watershed wide early warning system. A basic monitoring system may consist of simple river stage and precipitation observations coupled with a listserv to disseminate warnings. Additional data points could include nearby SNOTEL stations and/or National Weather Service point forecasts. The recent hydrologic study commissioned by CWCB may be incorporated into the river forecast mode when complete. The optimal configuration of new and existing data points, as well as the specifics of warning dissemination should be explored with further study.

The early warning network should also be integrated with the existing HAM radio (BCARES) and emergency services network (fire departments, Rocky Mountain Search and Rescue, Sherriff and local police) already in place for the mountain communities. Funding, organizational support, and training should be provided for these groups as the first responders and communication pathways in rural and mountainous Boulder County.

5.2.5 In-Stream Flow Quantity and Timing

5.2.5.1 Establishing Partnerships and Agreements for Continuous In-Stream Flows

This plan encourages the establishment of partnerships that maintain continuous in-stream flows that have the potential to serve multiple purposes. The flow quantity and timing in the lower reaches of Left Hand Creek is highly altered and results in periodically dry river beds. Re-establishing continuous flows has both geomorphic and ecosystem benefits allowing fine sediments to flush through the system and providing connectivity and habitat to aquatic organisms and support for in-stream flows was expressed by many members of the public and land owners at the public outreach events. Agreements to achieve these benefits can take many forms ranging from regulatory and statutory mandates to hand-shake agreements between stakeholders. An example of the latter is the Poudre River Joint Ops Plan between the U.S. Forest Service and water users. This plan was designed to increase the limited winter time aquatic habitat for the trout fishery without causing a net decrease in water supply via coordinated reservoir operations throughout the basin. Monitoring has shown that both objectives of the agreement have been met, even in dry years. As the Left Hand Coalition matures, the issue of in-stream flows should be examined and though it will require further study to provide frameworks and operational criteria, because it is only a change in management protocol, this recommendation will likely be less expensive than many of the structural solutions that are proposed to increase fine sediment transport and enhance riparian ecosystems.

5.2.6 Protect and Preserve Riparian Corridors

5.2.6.1 Reducing Risk and Enhancing Ecosystems via Land Use and Zoning

Several reaches in the upper most parts of the Left Hand Creek system have limited threats to life and property simply because little infrastructure and few residences exist in those areas. It is in these reaches that we also find the most functional riparian ecosystems with the best in-stream habitat, lateral connectivity, and vegetation quantity and quality. The most effective means to reduce future flood and geomorphic risk in these areas, as well as in areas lower in the watershed that remain undeveloped, is to discourage or limit significant infrastructure or residential development. Intensity of development and investment should be related to the risk the area is exposed to. As the new FIS is completed and Channel Migration Zones mapped, it is recommended that local jurisdictions adopt these changes into their Land Use and Zoning Plans and Codes and provide guidance on development in these areas. Floodplains play an important role in dissipating stream energy and provide low-risk locations for natural sediment deposition in addition to providing ecological complexity and good riparian habitat. For decades, the prevailing theory was that river channelization benefited flood control due to resultant perpetually scouring channels. As a result, river systems have been cut off from their floodplains by berms, levees, and other aggressive channelization, yet successful flood control has not resulted from these efforts. Over the last couple decades, this channelization for flood control theory has proven problematic and prevailing philosophies on efficient (for both sediment and water) river systems have trended towards floodplain reconnections with multi-stage channels.

Overflow channels and flood chutes carved though the floodplains during the 2013 flood provide opportunities for seasonal floodplain access. It is recommended that the LHCC prioritize protecting and restoring these locations as well as the wider channel corridor from the impacts of development, in order to reap the multiple benefits of increased flood protection and improved stream health provided by floodplain access and seasonal side channels.

5.3 Reach Summaries

5.3.1 Overview

The following summaries are meant to present an overview of each reach, including a brief narrative discussing the reach groups and general restoration recommendations and strategies. The reaches have been grouped by River Style because reaches of the same River Style generally responded similarly to the flood and will require equivalent restoration strategies. The tables following each narrative summarize the reach location, ecosystem and geomorphic risk results, and projects identified for that reach. The mapbook pages are included so reaches and projects can be quickly identified in the accompanying mapbook. A reach map can be found in **Figure 17** and in the mapbook on sheet *Reaches*.

Readers interested in a more thorough explanation of the methods used to develop the summary information should look to Section **4.3** for the geomorphology risk assessment and Section **4.4** for the ecosystem risk assessment.

5.3.2 The Headwater River Style (Reaches 15, 21, 22, 23, 24, 25, 26)

Reaches 15, 21, 22, 23, 24, 25, 26 are located high in the watershed and represent the headwater channel type. These channel types respond to flooding by expanding and subsequently jamming as result of the recruitment of large wood into the channel. As a result, many of these channel types have completely destroyed banks, plugged or destroyed culverts and infrastructure, and scoured to bedrock. The ecosystem ratings for these reaches range from “poor” to “excellent.”

Restoration for the headwater channel type mainly involves stabilizing channel banks, reestablishing riparian vegetation, and reducing flood energy through the increase of channel roughness and complexity.

Many culverts plugged in this channel type – a result of the uncommonly large flows experienced high in the watershed. Drainage issues have been exacerbated. Much of the recommended work to re-establish drainage and unplug (or resize) will need to be coordinated with the roads project.

Reaches 15, 21, 22, 23, 24, 25, 26 contain 6 projects, covering ~5.1 river miles of the channel.

River Style:	Headwater				
Reaches 15, 21, 22, 23, 24, 25, 26			River Style Definition:	p.33	(Report)
Location					
Reach	Creek	Lower Bounds		Upper Bounds	Mapbook Panels
15	Left Hand Creek	40° 4'28.46"N 105°24'43.59"W		40° 3'43.75"N 105°27'50.60"W	47-48
21	Little James Creek	James Creek: 40° 6'52.57"N 105°23'56.26"W		-	59-61
22	Geer Canyon	Little James Creek: confluence with James Creek		Little James Creek: downstream of CR-87	26,62-66
23	Sixmile Canyon	Geer Canyon: confluence with Left Hand Creek		-	67-70
24	Spring Gulch	Sixmile Canyon: confluence with Left Hand Creek		-	49
25	South St. Vrain Creek	Spring Gulch: confluence with Left Hand Creek		-	-
26	Left Hand Creek	South St. Vrain: diversion into James Creek		South St. Vrain: Brainard Lake	-
	Geomorphic Risk			Ecosystem Risk	
Reach	Condition	Trajectory	Risk	Score	Rating
15	Fair	Incision, Expansion	Low	8.6	Good
21	Poor	Incision, Expansion	Low	5.8	Fair
22	Poor	Aggradation, avulsion	Low	5.5	Poor
23	Fair	Incision, Expansion, Aggradation	Low	4.3	Poor
24	Poor	Incision, Expansion	Low	4.6	Good
25	Good	Stable	Low	7.2	Excellent
26	Good	Stable	Low	9.4	Good

River Style:	Headwater		
Projects			
Reach	Project Code	Project Name	Mapbook Panels
9	LHCM_15_26	**Stream and drainage improvements near the Lickskillet Road and Left Hand Canyon Drive intersection**	47
9	Description:	For this project develop stream crossing Improvements and stabilize the channel. Constructing a sediment detention basin on the ephemeral tributary can help reduce sediment loading from Lickskillet Road. Long-term reductions in sediment will require drainage improvements to Lickskillet Road.	
9	LHCM_15_27	**10487 Left Hand Canyon**	48
9	Description:	Restore channel capacity, regrade the floodplain and stabilize the channel banks where appropriate. This project will help stabilize the stream in this location.	
9	LJCM_21_01	**Little James Creek**	59-61
9	Description:	Stream improvements include stabilizing the road-river interface and channel by applying the concepts depicted in the Confined Road River Interface sheet.	
10	GCM_22_01	**Geer Canyon**	62-66
10	Description:	The road and creek are adjacent for much of the study reach. Improving the road-river interface and stabilize the floodplain will control a potential sediment source zone.	
10	SMCM_23_01	**Sixmile cutbank stabilization**	67-70
10	Description:	The flood incised into alluvium creating unstable cutbanks. Establishing drainage with grade control will help stabilize the area.	
18	SGM_24_01	**10332 Left Hand**	49
18	Description:	For this project stabilize the channel banks to control sediment inputs.	

5.3.3 The Confined Valley with Bedrock-Controlled Floodplain Pockets River Style (Reaches 9, 10, 13, 16, 18, and 19)

Reaches 9, 10, 13, 16, 18, and 19 are located amongst the mountain reaches and represent channel types that generally sit at the bottom of a tight valley, but have periodic pockets of floodplain. These floodplain pockets are important to the system as they present opportunities to dissipate flood energy, capture sediment and debris, and enhance the ecosystem for biota. The response of these reaches to the flood is to strip material and destroy the channel in the confined portions, and subsequently deposit that material in the pocket. As a result, many of these pockets have accumulated feet of sediment and debris, acting as sediment source zones for the watershed. The channel through these pockets is perched, meaning that it sits higher than the adjacent floodplain and has great potential to capture, or move into, the deposited material in the pocket. Ecosystem ratings for these reaches were "fair" and "good."

Restoration for Reaches 9, 10, 13, 16, 18, and 19 generally involves dissipating flood energy in the confined sections and stabilizing the floodplain pockets. Increasing channel complexity and riparian vegetation throughout each reach will increase ecosystem value and reduce flood and geomorphic risk. Large wood and the establishment of step-pool sequences will help dissipate stream energy and provide habitat. Grading and re-vegetating the pocket areas will both stabilize the channel and restore floodplain function. Additionally, in-stream structures and/or crossings should be evaluated for potential impedance to aquatic organism passage. Again, much of this work will need to be coordinated with the roads project.

Reaches 9, 10, 13, 16, 18, and 19 contain 14 projects, covering ~6.5 river miles of the channel.

River Style:	**Confined Valley with Bedrock-Controlled Floodplain Pockets**			
Reaches 9, 10, 13, 16, 18, 19		**River Style Definition:**	p.35	(Report)
Location				
Reach	**Creek**	**Lower Bounds**	**Upper Bounds**	**Mapbook Panels**
9	Left Hand Creek	Just upstream from confluence with Sixmile Canyon	40° 6'28.82"N 105°20'0.49"W	32-35
10	Left Hand Creek	40° 6'28.82"N 105°20'0.49"W	Confluence with James Creek	35-36
13	Left Hand Creek	40° 5'1.44"N 105°21'55.01"W	40° 4'32.65"N 105°23'49.39"W	42-46
16	James Creek	40° 3'43.75"N 105°27'50.60"W	40° 3'21.75"N 105°29'38.96"W	50-52
18	James Creek	James Creek: 40° 6'31.11"N 105°21'38.83"W	James Creek: downstream end of Jamestown	54-55
19	James Creek	James Creek: downstream end of Jamestown	James Creek: upstream end of Jamestown	56-57

River Style:	**Confined Valley with Bedrock-Controlled Floodplain Pockets**				
	Geomorphic Risk			**Ecosystem Risk**	
Reach	**Condition**	**Trajectory**	**Risk**	**Score**	**Rating**
9	Poor	Expansion, avulsion, aggradation	Medium	6.4	Fair
10	Poor	Contraction, aggradation, incision	Medium	5.6	Fair
13	Fair	Aggradation, incision	Low	-	-
13a	-	-	-	7.8	Good
13b	-	-	-	6.5	Fair
13c	-	-	-	7.6	Good
16	Poor	Aggradation, avulsion, degradation, incision	High	7.9	Fair
18	Good	Aggradation	Low	6.1	Fair
19	Good	Aggradation	Low	5.3	Fair

Projects			
Reach	**Project Code**	**Project Name**	**Mapbook Panels**
9	**LHCM_09_08**	**Reach 9 Box culvert to Reach break**	**32**
	Description:	Stabilize the channel and road river interface. Grade control structures, typical of step-pool channels will help alleviate stress on the road embankment.	
9	**LHCM_09_09**	**Below Left Hand Canyon Mountain Park to Box Culvert/Crossing**	**33-34**
	Description:	Improve road-river interface, perform stream restoration and develop fish passages. Also stabilize both the channel and floodplain and perform grade control measures.	
9	**LHCM_09_10**	**3988 Left Hand**	**33**
	Description:	Access to USFS OHV area is currently a sediment source zone. Stabilizing the area, establishing drainage, and using a sediment detention basin to capture runoff will help control this source zone.	
9	**LHCM_09_11**	**Left Hand Canyon Mountain Park**	**34-35**

River Style:	Confined Valley with Bedrock-Controlled Floodplain Pockets		
	Description:	This project involves creation of mountain park that provides public access and recreation opportunities as well as riparian corridor enhancement and preservation. Stream restoration should be coupled with the creation of parking areas and a trail.	
10	**LHCM_10_12**	**4333 Left Hand Canyon**	**35**
	Description:	Improve the road-river interface, stabilize the channel using grade control structures typical of step-pool channels.	
10	**LHCM_10_13**	**5001 Left Hand Canyon**	**36**
	Description:	Address road embankment damage and stabilize the channel using the cross sections specified in the mapbook.	
13	**LHCM_13_19**	**Glendale Gulch Drainage and River**	**43**
	Description:	Improve drainage for the fire station, include river crossings and stabilize the road-river interface. Stabilize the toe of the local debris flow and stabilize the channel as needed.	
13	**LHCM_13_20**	**7933 -7817 Left Hand Canyon**	**44**
	Description:	For this project, remove any unstable berms, re-grade the sediment piles into floodplain and stabilize the channel. Shared and/or low-water crossings are recommended but will require resident cooperation.	
13	**LHCM_13_22**	**8404-8398 Left Hand Canyon**	**45**
	Description:	Improve the road road-river interface at this site, stabilizing both the channel and bank.	
13	**LHCM_13_24**	**8973 Left Hand Canyon**	**45**
	Description:	For this project, emergency channel work created a bend in the stream that is unstable and eroding bank. The channel needs to be straightened, stabilized and cut approximately 3-6'. Grade control structures will help dissipate stream energy.	
16	**JCM_16_01**	**Lower James Canyon Neighborhood**	**50-52**
	Description:	Stabilize sediment source zones by grading area into functional floodplain. Channel is currently perched above floodplain and may need to be cut. Unstable emergency berms should be removed. Stretch near 639 James Canyon Drive has aggraded substantially and will need to be lowered if property cannot be acquired.	
16	**JCM_16_02**	**Lower James Canyon - The Farmers**	**52**
	Description:	Stabilize sediment source zone by grading deposition into functional floodplain. Perched channel may need to be cut down. Remove unstable berm constructed as part of emergency relief efforts. Re-vegetate in cooperation with landowners.	
18	**JCM_18_05**	**Augmentation of EWP Work**	**54-57**
	Description:	Re-vegetate graded areas shaped during EWP project. (Jamestown has applied for a grant for this.) Add large wood to channel. Examine drop structures for fish passage.	

5.3.4 The Confined Valley, No Floodplain River Style (Reaches 8, 11, 12, 14, 17 and 20)

Reaches 8, 11, 12, 14, 17, and 20 represent channel types that are highly confined and located in the canyon. These channel types create high stream energies under flood conditions and have the capacity for great destruction. In many cases, the channel has been completely destroyed, eroding the valley to bedrock. Many sections of road were destroyed in these reaches as the channel expanded in response to dramatic increases in sediment and flooding. The channel in these reaches is generally homogenous and will take time to re-establish bedforms. Ecosystem ratings for these reaches were "fair" and "good."

Much of the recommended restoration for Reaches 8, 11, 12, 14, 17, and 20 involves coordinating restoration activities with the re-building of the roads. Increasing channel complexity (e.g., deeper pools, additional woody material) will help to increase the ecosystem value as well as dissipate stream energy, mitigating the impacts of high(er) flows on private property and infrastructure. The consideration of a low flow channel will help maintain sediment transport and aquatic organism passage as the system rebounds from the flood. As crossings were points of failure throughout the system, opportunities to share or use low water crossings should be explored with individual property owners. Additional ecosystem recommendations include stabilizing eroding banks to minimize sediment loading to the channel; reestablishing riparian vegetation to increase cover and bank stability; and investigating whether in-stream structures and/or crossings impede aquatic organism passage.

These reaches contain 12 projects, addressing issues in ~4.7 miles of stream.

River Style:	Confined Valley, No Floodplain			
Reaches 8, 11, 12, 14, 17, 20			**River Style Definition:**	p.37 (Report)
Location				
Reach	**Creek**	**Lower Bounds**	**Upper Bounds**	**Mapbook Panels**
8	Left Hand Creek	Allens Lake Diversion	Just upstream from confluence with Sixmile Canyon	28-32
11	Left Hand Creek	Confluence with James Creek	Lefthand Canyon Dr. crossing northeast of Lee Hill Dr. intersection	36-39
12	Left Hand Creek	Highway crossing northeast of Lee Hill Dr. intersection	40° 5'1.44"N 105°21'55.01"W	39-42
14	Left Hand Creek	40° 4'32.65"N 105°23'49.39"W	40° 4'28.46"N 105°24'43.59"W	46-47
17	James Creek	James Creek: confluence with Left Hand Creek	James Creek: 40° 6'31.11"N 105°21'38.83"W	52-54
20	James Creek	James Creek: upstream end of Jamestown	James Creek: 40° 6'52.57"N 105°23'56.26"W	57-58

River Style:	Confined Valley, No Floodplain				
	Geomorphic Risk			Ecosystem Risk	
Reach	Condition	Trajectory	Risk	Score	Rating
8	Fair	Expansion	Low	6.4	Fair
11	Poor	Aggradation, incision	Medium	7.1	Good
12	Fair	Aggradation	Low	6.6	Fair
14	Fair	Expansion	Low	7.1	Good
17	Poor	Aggradation	High	5.6	Fair
20	Fair	Aggradation, avulsion	Medium	5.4	Fair

Projects

Reach	Project Code	Project Name	Mapbook Panels
8	**LHCM_08_04**	**1540 Left Hand Road Drainage**	**28**
	Description:	Perform grading and drainage stabilization and install a new culvert at this site. A sediment detention basin upstream of the culvert will help provide sediment source control.	
8	**LHCM_08_05**	**2156 Left Hand through 1934 Left Hand**	**29-30**
	Description:	Improve the road-river interface and stabilize the channel.	
8	**LHCM_08_06**	**Buckingham Park to crossing**	**31**
	Description:	Reach is mostly bedrock-controlled. Improve the road-river interface and stabilize the channel where necessary (those sections that are not bedrock controlled).	
8	**LHCM_08_07**	**Buckingham Park**	**31-32**
	Description:	Incorporate weed control and other passive restoration measures through continued monitoring.	
11	**LHCM_11_14**	**5901 - 5001 Left Hand Canyon**	**37-39**
	Description:	Improve the road-river interface and stabilize the channel. Grade control structures typical of step-pool channels will help dissipate stream energy. The confluence is a sensitive area that should be preserved.	
12	**LHCM_12_15**	**5974 Left Hand Canyon**	**39**
	Description:	Consider up-sizing the crossing at this location to facilitate sediment transport and debris passage.	
12	**LHCM_12_16**	**6232 Left Hand Canyon**	**40**
	Description:	Improve the road-river interface and stabilize both the channel and toe of the local debris flow. Re-seeding the debris flow outfall will help stabilize a potential source zone. Channel may need to be cut down as it is perched above the property at 6496 Lefthand Canyon Drive. Sediment has also buried portions of the property at 6496 and should be removed and the area re-graded to eliminate low spots that could capture flood flows.	
12	**LHCM_12_17**	**6897 - 6738 Left Hand Canyon**	**41-42**
	Description:	For this project improve the road-river interface and stabilize the channel.	
12	**LHCM_12_18**	**7164 - 7160 Left Hand Canyon**	**42**
	Description:	The channel banks and adjacent area need stabilization. The concepts depicted in the Confined Valley River Style sheet apply, as well as the Road-River Interface Confined special cross section.	
14	**LHCM_14_25**	**Left Hand Canyon Drive Road River Interface**	**46-47**
	Description:	For this project improve the road-river interface and stabilize the channel and banks.	
17	**JCM_17_03**	**1029 James Canyon to Lower end of EWP Work**	**53-54**
	Description:	Stabilize the road-river interface to control sediment source inputs and stabilize the channel. The County roads project needs to consider ways to widen the pinch created by the road embankment and bedrock outcrop.	

5.3.5 The Partly Confined, Wandering River Style (Reaches 5, 6, and 7)

Reaches 5, 6, and 7 cover the transition between the canyon reaches and the alluvial plain. These reaches cover the length of Left Hand Creek stretching from the top of reach 4 to the Allens Lake Diversion. Channel avulsions and migrations were the primary flood response for these reaches as sediment-laden flood flows responded to local changes in gradient and confinement (e.g., crossings). This behavior resulted in the channel headcutting into floodplains, capturing and moving to new areas of the floodplain, and extensive deposition as sediment-laden flows piled up behind infrastructure. For much of the area covered by these reaches, the pre-flood channel was completely destroyed. Reach 6, which contains the Streamcrest neighborhood, sits on an alluvial fan, an area where streams naturally change course in response to sediment loads and a change in gradient. This poses significant challenges for long-term restoration. Reaches 5, 6 and 7 received ecosystem ratings of “good,” “poor,” and “fair,” respectively.

Restoration strategies for Reaches 5, 6, and 7 include evaluating the crossing capacity at US 36, providing floodplain width within which this channel can adjust, and identifying locations where flood energy can be dissipated and sediment and debris stored. Step-pool sequences will work to dissipate stream energy in the higher gradient portions of these reaches. The channel through the Streamcrest neighborhood is straight and perched, or elevated, and will need to re-establish width, floodplain connectivity, and complexity. Crossings and the adjacent areas will benefit from periodic maintenance. Given the position of these reaches as a transition between canyon and plains, in-stream structures and crossings should be evaluated for the potential of impeding aquatic organism passage, and where necessary, installation of fish passage structures should be considered. Much of Reach 5 has received private restoration work that will need to be monitored. Additional ecosystem recommendations include stabilizing eroding banks and headcuts to minimize sediment loading to the channel; re-establishing riparian vegetation to increase cover and bank stability; adding channel complexity (e.g., riffles, pools and woody material), and encouraging partnerships and agreements to develop plans for continuous in-stream flow for the majority of Reaches 5 and 6.

Reaches 5, 6, and 7 contain seven projects covering ~3.4 miles of stream.

River Style:	**Partly Confined, Wandering**				
Reaches 5,6,7			**River Style Definition:**	p.39	(Report)
	Location				
Reach	**Creek**	**Lower Bounds**	**Upper Bounds**	**Mapbook Panels**	
5	Left Hand Creek	Boulder Feeder Canal diversion	Crocker #2 Ditch diversion	20-21	
6	Left Hand Creek	Crocker #2 Ditch diversion	Haldi Pipeline diversion	21-25	
7	Left Hand Creek	Haldi Pipeline diversion	Allens Lake Diversion	26-28	
	Geomorphic Risk			**Ecosystem Risk**	
Reach	**Condition**	**Trajectory**	**Risk**	**Score**	**Rating**
5	Fair	Incision, migration, aggradation, avulsion	Medium	6.9	Good
6	Poor	Incision, migration, aggradation, avulsion	High	-	-
6a	-	-	-	3.8	Poor
6b	-	-	-	4.6	Poor
7	Poor	Migration, incision	Low	5.6	Fair

	Projects		
Reach	**Project Code**	**Project Name**	**Mapbook Panels**
5	**LHCP_05_11**	**Brewbaker-Sorensen**	**20**
	Description:	Stabilize loose sediments and failing banks. Also create a low flow channel and establish wetlands or debris catchment within the project bounds. If possible move the berm back to create more width for the channel. Stabilize floodplain headcuts.	
5	**LHCP_05_12**	**8241-8249 39th St**	**21**
	Description:	For this project establish low-flow and spill channels. Also grade and stabilize the extensive deposition area and re-vegetate the area within the project bounds.	
6	**LHCP_06_13**	**3348 Plateau to 8249 39th St**	**23**
	Description:	Perform channel, bank and headcut stabilization, regrade and stabilize the floodplain and revegetate. Continue private restoration work.	
6	**LHCP_06_14**	**HWY 36 to 3348 Plateau**	**24-25**
	Description:	Perform channel, bank and floodplain stabilization at this site, establish a new low-flow channel, re-grade the floodplain and remove any extensive deposition in the floodplain. Continue any private restoration work upstream.	
6	**LHCM_06_01**	**Streamcrest**	**24-25**
	Description:	Lower the channel, reconnect the floodplain with the channel and increase local channel complexity. Add in LWD and habitat features to stabilize both the channel and dissipate flood energy. CDOT to re-size US 36 crossing, preferably with a bridge. Maintain an overflow channel around residence at 8785 Streamcrest Drive.	
7	**LHCM_07_02**	**845 Left Hand Canyon Drive**	**26**
	Description:	Perform bank stabilization where necessary, re-vegetate the area and add in large woody debris and habitat features.	
7	**LHCM_07_03**	**Allens Lake Diversion**	**27-28**
	Description:	Build a fish-passable diversion, perform road realignment and install multiple use diversion structure if possible. Perform channel work to control local sediment sources, improve habitat and stabilize both the channel and floodplain.	

5.3.6 The Unconfined, Continuous Floodplain River Style (Reaches 3 and 4)

Reaches 3 and 4 cover much of the lowland alluvial plain, stretching from 95th Street to the channel diversion structure located just upstream of the CBT Canal. The break between reaches 3 and 4 is Williamson Ditch diversion in the Brigadoon Glen neighborhood. Issues observed in these reaches include sediment and debris inundation (impacting both the channel and crossings), destroyed channel banks, and channel incision. Reaches 3 and 4 received ecosystem ratings of "poor" and "fair," respectively.

Restoration of Reaches 3 and 4 includes stabilizing channel banks through much of the reaches. Boulder County Open Space land provides opportunities to reconnect the channel to the floodplain, enhancing habitat while dissipating flood energy and capturing debris. In order to address flooding issues in the Brigadoon Glen and Oriole Estates neighborhoods channel alignment and capacity improvements have been recommended. The establishment of a low flow channel will help with the sediment inundation issues. Re-vegetating and widening the riparian corridor, where possible, will add cover for aquatic organisms and help reduce flood energy and capture sediment and debris. A maintenance program to periodically clean crossings will help maintain channel capacity at those locations. Additional ecosystem recommendations include the addition of channel complexity (e.g., riffles, pools and woody material), developing agreements to form plans for continuous in-stream flow for the majority of both Reach 3 and 4; and investigation of whether in-stream structures and/or crossings impede aquatic organism passage.

Reaches 3 and 4 contain six projects, covering ~4.7 river miles of channel.

River Style:	Unconfined, Continuous Floodplain				
Reaches 3,4			River Style Definition:	p.41	(Report)
Location					
Reach	Creek	Lower Bounds		Upper Bounds	Mapbook Panels
3	Left Hand Creek	95th St.		Williams Ditch diversion (west of 63rd St.)	8-17
4	Left Hand Creek	Williams Ditch diversion (west of 63rd St.)		Boulder Feeder Canal diversion	18-19
	Geomorphic Risk			Ecosystem Risk	
Reach	Condition	Trajectory	Risk	Score	Rating
3	Poor	Aggradation, migration	High	-	-
3a	-	-	-	7	Good
3b	-	-	-	4.5	Poor
3c	-	-	-	4.7	Poor
4	Poor	Incision, expansion	Medium	6	Fair
Projects					
Reach	Project Code	Project Name			Mapbook Panels
3	LHCP_03_04	BoCo Open Space Passive Restoration			8-9

River Style:	Unconfined, Continuous Floodplain		
	Description:	Provide passive restoration and monitoring of channel and banks on Boulder County Open Space land. A low water crossing is recommended at this location instead of a new bridge for the farmer.	
3	LHCP_03_05	BoCo Open Space Bielins-Hock Property	10
	Description:	For this project, perform bank and headcut stabilization, re-vegetate the area, maintain the pre-flood channel as an overflow channel and remove cars. The railroad should be protected from further migration. Options include a sequence of engineered log jams or setback riprap.	
3	LHCP_03_06	87th St Crossing Maintenance	11-13
	Description:	For this project perform sediment maintenance, passive restoration and re-vegetation. The Airport Road crossing has aggraded substantially leaving the bike path under feet of sediment. Options include excavating and establishing a compound channel, adding a flood protection wall, and periodic maintenance. The channel should be re-aligned and the cutbank stabilized to prohibit further migration toward HWY 119.	
3	LHCP_03_07	81st St. Crossing	14
	Description:	For this project perform sediment maintenance, flood-proofing, passive restoration and increase the channel capacity. A compound channel will help with aggradation under the bridge in the long term. Short term options require excavation and maintenance.	
3	LHCP_03_08	Left Hand Water District	15-16
	Description:	For this project, consider flood-proofing and establish a low-flow channel. Drainage issues caused by construction of private drive at end of Cardinal Lane cause ponding and need to be addressed. Relief can be provided to the Nimbus Road Bridge by installing an overflow culvert, debris capture zone, and raising the Water District's driveway. Options to raise the elevation of Nimbus Road to the east of the Water District's drive should be explored. Nimbus Road currently sits lower than the adjacent area, capturing over-bank flood flows.	
3,4	LHCP_03_09	Brigadoon Glen	17-19
	Description:	The project in this reach involves stabilizing the high cut banks near the golf course. The double box culvert on Strath should be re-sized and designed to pass debris and facilitate aquatic organism passage. Channel alignment improvements at 63rd can reduce maintenance required at the structure. Channel capacity downstream of the bridge should be increased if possible.	

5.3.7 The Entrenched, Residential Channel River Style (Reaches 1 and 2)

Reaches 1 and 2 are located at the bottom of the watershed, with Reach 1 extending upstream from the confluence of Left Hand Creek and the Saint Vrain River to Route 287 and Reach 2 from there up to 95th Street. These reaches have been heavily modified from a natural condition to provide maximum flood capacity. Issues in these reaches include the accumulation of sediment and debris, the collapse of channel banks, and the destruction of some crossings. Reaches 1 and 2 received ecosystem ratings of "fair" and "poor."

Reaches 1 and 2 are mostly covered by the City of Longmont's Phase II project which will increase the channel's capacity, or ability to convey higher flows, and stabilize the banks with riprap. Additional recommended actions include establishing a low flow channel to help transport sediment downstream; adding habitat features (e.g., riffle/pool complexity and addition of woody material) to increase the potential of these reaches to support aquatic organisms; repairing and re-vegetating eroding banks to minimize sediment loading and increase cover; adopting minimum in-stream flows; and investigating whether in-stream structures and/or crossings impede aquatic organism passage. For all of the plains reaches, the feasibility of establishing a crossing maintenance program will help maintain channel capacity at these locations. Finally, a section of the channel, between Sunset and 95th Streets is recommended for the development of floodplain habitat enhancement features that will serve double duty as energy dissipaters and debris catchment.

Reaches 1 and 2 contain three projects, covering ~2.6 river miles of channel.

River Style:	**Entrenched, Residential Channel**					
Reaches 1,2			**River Style Definition:**	p.43	(Report)	
Location						
Reach	**Creek**	**Lower Bounds**		**Upper Bounds**	**Mapbook Panels**	
1	Left Hand Creek	Confluence with St. Vrain Creek		US-287	1-3	
2	Left Hand Creek	U.S. 287		95th St.	4-7	
	Geomorphic Risk			**Ecosystem Risk**		
Reach	**Condition**	**Trajectory**	**Risk**	**Score**	**Rating**	
1	Poor	Aggradation, Contraction	Low	4.6	Fair	
2	Poor	Aggradation, Contraction	Low	-	-	
2a	-	-	-	4	Poor	
2b	-	-	-	5.2	Fair	
Projects						
Reach	**Project Code**	**Project Name**			**Mapbook Panels**	
1	**LHCP_01_01**	**Reach 1 Passive Restoration**			**1-3**	
	Description:	This reach experienced little damage from the flood, but the encouragement of a low flow channel will help maintain sediment transport and provide aquatic habitat.				
2	**LHCP_02_02**	**City of Longmont Flood Control Phase II**			**4-6**	
	Description:	At this site, there is an ongoing project to adopt and implement the City of Longmont's Lefthand Creek Flood Control Project - Main Street to Pike Road - Phase II. The goal of the project is to reduce base flood elevations in the project limits.				
2	**LHCP_02_03**	**West Longmont Riparian Park**			**7**	
	Description:	This project involves creation of prairie park that provides public access and recreation opportunities as well as riparian corridor enhancement and preservation. Backwater areas will dissipate flood energy and capture sediment and debris.				

5.4 Project Prioritization Recommendations

5.4.1 Overview

Project prioritizations were made by ranking each project in several categories. Projects were ranked by how well they addressed the flood, geomorphic and ecosystem risks identified in the risk assessments. Rankings involved assigning each of the three categories with *good, better, and best* ratings. These ratings reflect how well that project addresses the risks compared to other projects. Then, projects were ranked based on feedback from the two survey questions asked during the community meetings and on the website surveys. The top three most popular responses reflecting both community values and project priorities were assigned *fair, better, and best* ratings. Project costs were also estimated to an order of magnitude. Projects were then ordered based on the number of *best* and *better* rankings they received.

Using the table, as well as the watershed analyses and recommendations of the Coalition, the top five projects were identified, prioritizing safety above the other factors. Those projects are detailed below.

5.4.2 Project Ranking Tables and Opinions on Project Cost

As discussed above, each of the projects were ranked and this ranking provides a basis of prioritization for the suggested projects. This prioritization is not a static list, but serves as a tool that can be updated to include new information and/or be tailored to specific funding sources. **Table 13** summarizes the top five projects. **Table 14** presents the summarized results of all of the proposed projects.

Projects were ranked based on how well they would address the risks and limiting factors identified in the risk assessments. Each risk assessment category (flood, geomorphic, and ecosystem) received a subjective rating (e.g., fair, better, best) based on how well the proposed project is anticipated to address the identified risks. Some projects call for the creation or enhancement of public park space and are called out in the table through the use of a fourth category representing the expected enhancement of the proposed project. The rating for each category (e.g., fair, better, best) is meant to provide an indication of how well that project potentially addresses the risks, relative to the other projects. The projects as listed in the table are in order by reach. While all projects are recommended, those identified in **Table 13** represent projects identified that have a sense of urgency associated with them. They are projects that either contain unsafe conditions or are locations where the channel change is limiting the ability of the residents to access their homes.

Each project has been assigned a code corresponding to location, reach, and project number. For example, *LHCP_02_02* stands for Left Hand Creek – Plains, Reach 2, and is the second project in the plains region of Left Hand Creek.

Appendix A provides the full prioritization spreadsheet. The full spreadsheet provides guidance as to which aspects of each project address each of the three risk components. Also included in the full spreadsheet are rankings for the responses received to the survey issued at the first round of public meetings. Projects were again rated based on the top three responses to the community values and project priorities questions. Additionally, the full spreadsheet contains thoughts on project dependencies, indicating, for example, if the project depends on the road work or access to private land.

Cost estimates for each project were grouped into order-of-magnitude categories based on conceptual level estimates. Uncertainty in the cost estimates is a result of data inadequacies and therefore a range is presented for each project. The best available terrain data was acquired in October 2013 and does not reflect system adjustment to spring runoff or any channel, road, and crossing work conducted since that data was acquired. Additionally, neither a hydraulic model nor accurate floodplain model was made available for the project. Therefore, estimates of the quantity of material requiring excavation, transport, import, and/or disposal were not conducted. Project cost will depend upon the ability to use onsite materials, which will greatly affect the price. It is estimated that the quality of the available material is largely not adequate for channel work, thus requiring import. Availability of suitable channel construction material (e.g., boulders, rootwads) is largely unknown, and as more projects are implemented across the Front Range, demand and competition for those materials will increase. As more data and analyses become available project cost estimates can and should be refined.

Table 13. Top Five Projects

	Project	Reach	Project Code	Effect of Project on Ecosystem Risk	Effect of Project on Flood Risk	Effect of Project on Geomorphic Risk	Effect of Project on Rec, Social, and Educational Opportunities	Cost Estimate Range	
1	**Road Stream Interface in Canyons**							$3,300,000	$10,000,000
	8404-8398 Left Hand Canyon	13	LHCM_13_22	Better	Better	Better	N/A	$100,000	$500,000
	Left Hand Canyon Drive Road River Interface	14	LHCM_14_25	Better	Better	Better	N/A	$20,000	$100,000
	Glendale Gulch Drainage and River	13	LHCM_13_19	Better	Better	Better	Better	$100,000	$500,000
	6897 - 6738 Left Hand Canyon	12	LHCM_12_17	Better	Fair	Better	N/A	$100,000	$500,000
	6232 Left Hand Canyon	12	LHCM_12_16	Better	Fair	Better	N/A	$20,000	$100,000
	5901 - 5001 Left Hand Canyon	11	LHCM_11_14	Better	Better	Better	N/A	$100,000	$500,000
	5001 Left Hand Canyon	10	LHCM_10_13	Better	Fair	Better	N/A	$20,000	$100,000
	4333 Left Hand Canyon	10	LHCM_10_12	Better	Fair	Best	N/A	$100,000	$500,000
	Left Hand Canyon Mountain Park*	9	LHCM_09_11	Better	Fair	Best	Best	$100,000	$500,000
	Below Left Hand Canyon Mountain Park to Box Culvert/Crossing	9	LHCM_09_09	Better	Better	Better	Fair	$1,000,000	$3,000,000
	Reach 9 Box Culvert to Reach Break	9	LHCM_09_08	Better	Better	Better	N/A	$20,000	$100,000
	Buckingham Park to Crossing	8	LHCM_08_06	Better	Fair	Fair	N/A	$500,000	$1,000,000
	2156 Left Hand Through 1934 Left Hand	8	LHCM_08_05	Better	Fair	Better	N/A	$20,000	$100,000
	1029 James Canyon to Lower End of EWP Work	17	JCM_17_03	Better	Fair	Better	N/A	$100,000	$500,000
	Little James Creek	21	LJCM_21_01	Better	Fair	Better	N/A	$500,000	$1,000,000
	Geer Canyon	22	GCM_22_01	Better	Fair	Fair	Better	$500,000	$1,000,000
2	**Lower James Canyon Neighborhood**	**16**	JC_16_01	Fair	Fair	Best	Fair	$1,000,000	$3,000,000
3	**Streamcrest**	**6**	LHCM_06_01	Best	Best	Best	N/A	$500,000	$1,000,000
4	**Brigadoon Glen**	**4**	LHCP_03_09	Fair	Best	Fair	N/A	$1,000,000	$3,000,000
5	**City of Longmont Flood Control Phase 2**	**2**	LHCP_02_02	Fair	Best	N/A	N/A	$1,000,000	$3,000,000

*The CWCB awarded $200,000 for restoration work covering a 1.5 mile long stretch of James Creek. These funds will require a match which could potentially come from the CDBG-DR funds. The *Left Hand Canyon Mountain Park* project presents an excellent opportunity to apply these funds at a location that can demonstrate road-river interface resiliency strategies and provide public access to a restored section of stream.

Table 14. Project Prioritization Summary

Project	Reach	Project Code	Effect of Project on Ecosystem Risk	Effect of Project on Flood Risk	Effect of Project on Geomorphic Risk	Effect of Project on Rec, Social, and Educational Opportunities	Cost Estimate Range	
Lower James Canyon Neighborhood	16	JC_16_01	Fair	Fair	Best	Fair	$1,000,000	$3,000,000
Brigadoon Glen	4	LHCP_03_09	Fair	Best	Fair	N/A	$1,000,000	$3,000,000
Brewbaker-Sorensen	5	LHCP_05_11	Fair	Fair	Better	N/A	$100,000	$500,000
Left Hand Canyon Mountain Park*	9	LHCM_09_11	Better	Fair	Best	Best	$100,000	$500,000
West LoCo Riparian Park	2	LHCP_02_03	Better	Fair	Best	Best	$500,000	$1,000,000
City of Longmont Flood Control Phase 2	2	LHCP_02_02	Fair	Best	N/A	N/A	$1,000,000	$3,000,000
Reach 1 Passive Restoration	1	LHCP_01_01	Fair	Fair	Fair	Fair	$20,000	$100,000
BoCo Open Space Passive Restoration	3	LHCP_03_04	Fair	Fair	N/A	N/A	$20,000	$100,000
BoCo Open Space Bielins-Hock Property	3	LHCP_03_05	Better	Better	Best	N/A	$100,000	$500,000
87th St Crossing Maintenance	3	LHCP_03_06	Fair	Better	Fair	N/A	$20,000	$100,000
81st St. Crossing	3	LHCP_03_07	Fair	Better	Fair	N/A	$100,000	$500,000
Left Hand Water District	3	LHCP_03_08	Fair	Fair	Fair	N/A	$20,000	$100,000
3348 Plateau to 8249 39th	6	LHCP_06_13	Better	Fair	Best	N/A	$100,000	$500,000

Table 14. Project Prioritization Summary (Cont.)

Project	Reach	Project Code	Effect of Project on Ecosystem Risk	Effect of Project on Flood Risk	Effect of Project on Geomorphic Risk	Effect of Project on Rec, Social, and Educational Opportunities	Cost Estimate Range	
8241-8249 39th St	5	LHCP_05_12	Fair	Fair	Fair	N/A	$100,000	$500,000
HWY 36 to 3348 Plateau	6	LHCP_06_14	Fair	Better	Fair	N/A	$100,000	$500,000
HWY 36 Crossing	6	LHCP_06_15	Fair	Best	Best	N/A	$1,000,000	$3,000,000
Streamcrest	6	LHCM_06_01	Best	Best	Best	N/A	$500,000	$1,000,000
845 Left Hand Canyon Drive	7	LHCM_07_02	Fair	Fair	Fair	N/A	$20,000	$100,000
Allens Lake Diversion	7,8	LHCM_07_03	Better	Fair	Best	N/A	$1,000,000	$3,000,000
1540 Left Hand Road Drainage	8	LHCM_08_04	Fair	Fair	Fair	N/A	$20,000	$100,000
Augmentation of EWP Work	18,19	JCM_18_05	Fair	N/A	Fair	Fair	$20,000	$100,000
Lower James Canyon - The Farmers	16	JCM_16_02	Better	Fair	Best	N/A	$100,000	$500,000
10487 Left Hand Canyon	15	LHCM_15_27	Fair	Better	Better	N/A	$20,000	$100,000
10332 Left Hand Canyon	24	SGM_24_01	Fair	Fair	Fair	N/A	$20,000	$100,000
Lickskillet Road and Left Hand Canyon Drive Intersection Vicinity	15	LHCM_15_26	Fair	Fair	Fair	N/A	$100,000	$500,000
Left Hand Canyon Drive Road River Interface	14	LHCM_14_25	Better	Better	Better	N/A	$20,000	$100,000
8973 Left Hand Canyon	13	LHCM_13_24	Fair	Better	Better	N/A	$20,000	$100,000
8614 Left Hand Canyon	13	LHCM_13_23	Fair	Better	Fair	N/A	$100,000	$500,000
8404-8398 Left Hand Canyon	13	LHCM_13_22	Better	Better	Better	N/A	$100,000	$500,000
7933 -7817 Left Hand Canyon	13	LHCM_13_20	Better	Better	Best	N/A	$100,000	$500,000
Glendale Gulch Drainage and River	13	LHCM_13_19	Better	Better	Better	Better	$100,000	$500,000
7164 - 7160 Left Hand Canyon	12	LHCM_12_18	Better	Fair	Fair	N/A	$20,000	$100,000
6897 - 6738 Left Hand Canyon	12	LHCM_12_17	Better	Fair	Better	N/A	$100,000	$500,000
6232 Left Hand Canyon	12	LHCM_12_16	Better	Fair	Better	N/A	$20,000	$100,000
5974 Left Hand Canyon	12	LHCM_12_15	Fair	Better	Fair	N/A	$100,000	$500,000
5901 - 5001 Left Hand Canyon	11	LHCM_11_14	Better	Better	Better	N/A	$100,000	$500,000
5001 Left Hand Canyon	10	LHCM_10_13	Better	Fair	Better	N/A	$20,000	$100,000
4333 Left Hand Canyon	10	LHCM_10_12	Better	Fair	Best	N/A	$100,000	$500,000
3988 Left Hand Canyon	9	LHCM_09_10	Fair	Fair	Better	N/A	$100,000	$500,000
Below Left Hand Canyon Mountain Park to Box Culvert/Crossing	9	LHCM_09_09	Better	Better	Better	Fair	$1,000,000	$3,000,000
Reach 9 Box Culvert to Reach Break	9	LHCM_09_08	Better	Better	Better	N/A	$20,000	$100,000
Buckingham Park	8	LHCM_08_07	Fair	N/A	Fair	Better	$20,000	$100,000
Buckingham Park to Crossing	8	LHCM_08_06	Better	Fair	Fair	N/A	$500,000	$1,000,000
2156 Left Hand Through 1934 Left Hand	8	LHCM_08_05	Better	Fair	Better	N/A	$20,000	$100,000
1029 James Canyon to Lower End of EWP Work	17	JCM_17_03	Better	Fair	Better	N/A	$100,000	$500,000
Upper James Creek	20	JCM_20_06	Fair	N/A	N/A	N/A	$20,000	$100,000
Little James Creek	21	LJCM_21_01	Better	Fair	Better	N/A	$500,000	$1,000,000
Geer Canyon	22	GCM_22_01	Better	Fair	Fair	Better	$500,000	$1,000,000
Sixmile Cutbank Stabilization	23	SMCM_23_01	Fair	N/A	Better	N/A	$100,000	$500,000

5.4.3 Selected Projects

The following five projects represent those selected by AMEC as being the most important to increase the safety and stability of Left Hand Creek. They potentially increase the safety of local residents, address system instabilities, and/or address issues that have the ability to destabilize a large portion of the downstream channel.

5.4.3.1 Stream Stabilization along the Road-Stream Interface in the Canyon Reaches

Boulder County Transportation anticipates the cost to re-build the canyon roads being approximately $60 million. This cost estimate includes Left Hand Canyon Resiliency Elements such as the construction of structures, re-alignment of the creeks, and re-assessing the road elevation with the goal of reducing flood damage risk. Thus far, $8M of the $60M has been funded by FHWA, leaving $52M in unmet needs. They have sought input for the road repair work, including examining alternative road alignments and designing the interface between the road and stream. No other project has the potential to influence as much of the stream as the roads project and interfacing the roads with the stream will be key for establishing river channel stability.

In examining the landscape for alternative road alignments, strategies include eliminating crossings and moving the road off of high energy river bends. Through much of the canyon, the current road alignment remains on one side of the stream with relatively few crossings. Moving the road off of high energy bends would require additional crossings. As discussed in Section **5.2.2**, crossings can be designed to better facilitate the passage of sediment, debris, and aquatic organisms. Moving the road off of high energy bends can help protect the road from flood damage, but the resources need to be available to design the crossings appropriately. This could potentially eliminate some of the maintenance need in the watershed and is an option that should be explored more thoroughly.

Through much of the canyon, the road and river are directly adjacent to each other. Constructing the road and stream improvements in tandem offers the advantage of improving the function of each. For example, in higher energy reaches (e.g., Reach 9) energy dissipation features (e.g., drop structures) can be tied to the road embankment. The drop structure will reduce the force of the stream felt by the road embankment. The use of setback riprap facilitates the armoring of the road embankment while also facilitating ecosystem and stream function. Native materials should be graded over top of the riprap, but will require soil amendments in order to establish vegetation. In areas with enough width to accommodate it, the development of floodplain benches should be facilitated. Depending on their elevation relative to the stream, these benches can act as active floodplain, dissipate energy, store transported sediments, and capture debris.

5.4.3.2 Reach 16- Lower James Canyon Neighborhood

In the lower portion of James Canyon (Reach 16) a collection of homes line the road and river. The canyon is relatively tight through this reach and heavily influenced by bedrock spurs or pinches. This high energy environment has a large lower energy pocket before tightening back up as James Creek approaches the confluence of Left Hand Creek. The homes are located in the pocket, which aggraded considerably during the flood. As a result, the channel sits perched above (in some cases as much as 10 feet above the pre-flood channel) the surrounding floodplain which currently is inundated with sediment and debris. To make matters worse, the channel has been pushed against bedrock on the south side of the valley and confined in that location by an unstable berm constructed in response to the 2013 flood. In an emergency action, residents dammed the stream, redirecting flow back to their crossing so they could access their home. Unfortunately, the work is not stable and may catastrophically fail under higher flow conditions. Additionally, the channel is adjusting to this change in alignment by cutting into the upstream neighbor's yard. To further compound the aggradation, evidence exists in several locations of slope failures adding sediment and debris to the area. Overall, this area is very unstable, and in its current condition, will act as a sediment and debris source zone, impacting the reaches below. Given the instabilities present as a result of the emergency channel work, it is likely that the stream will breach the berms, flushing much sediment and debris downstream. Road drainage through this reach has been impacted, and several homes along this reach are regularly inundated from road and hillslope drainage.

The issues in this problem area are fairly straightforward and involve re-grading the channel and floodplain. The channel should be re-aligned and stabilized closer to the road through 762 and 639 James Canyon Drive, but can then be pushed further from the road at 556 James Canyon Drive. Drainage needs to be established in coordination with the road work at 764, 444, and 420 James Canyon Drive. Below these properties, 379 James Canyon Road has already received restoration work by the property owner. This stretch could benefit from additional drop structures as the stream gradient increases through here with the road and stream directly adjacent to each other. This section of road was heavily damaged and additional drop structures would help dissipate stream energy.

5.4.3.3 Streamcrest Neighborhood

The Streamcrest neighborhood is located on the upstream side of the US 36 crossing. During the flood, the US 36 crossing plugged up causing extensive aggradation through the neighborhood. In an emergency action, the NRCS excavated a channel, cleared debris and allowed flows to pass through the US 36 crossing. The excavated channel is fairly straight and homogenous, and is elevated 4-6 feet above the pre-flood channel. The level of aggradation in this reach has altered some of the drainage patterns, sending road runoff towards the home at 8696 Streamcrest Drive.

Streamcrest sits at an ecologically and geomorphologically sensitive location. Ecologically, the area is an important transition zone between the canyon and plains environments. Geomorphologically, the area is an alluvial fan, meaning that it is a landform shaped by the stream dropping transported material and frequently changing its alignment. This behavior makes restoration of this area challenging as it is very difficult to pin down a channel where its natural evolution is to frequently deposit sediment and change alignment.

The restoration strategy for this reach involves increasing the capacity of the US 36 crossing, lowering the channel, increasing channel complexity, and providing as much space for the channel to move as possible. This strategy hinges upon removing much of the deposited material so that the channel can both be lowered and given space to move. Natural stabilization techniques and materials should be utilized through this reach to both stabilize the channel and increase ecosystem function. At the upstream end of the project, the channel makes a sharp bend to the south. Flood flows are unlikely to make this bend, avulsing directly to the west toward the location of the NRCS channel. To account for this behavior, the channel established by the NRCS work should be maintained as an overflow channel. Establishing this overflow will give the stream an outlet, or release, during flood conditions. From this point downstream to the US 36 crossing, there is some flexibility about where to precisely put the channel. It is strongly recommended to give the channel as much width as possible, using the conceptual drawing for the Partly Confined, Wandering River Style as guidance. A compound channel, including side and overflow channels, will work to dissipate future flood energy and help capture sediment and debris. CDOT has initiated a project to re-size the culvert at the US 36 crossing. Given the sediment load and laterally active nature of the channel, a bridge would be preferred in this location. As discussed in the transportation section (**5.2.2**), maintaining a compound channel geometry through the bridge will help maintain sediment transport and aquatic organism passage. The entire Streamcrest area may require soil amendments for vegetation to grow as the composition of the deposition is mainly sand.

5.4.3.4 Neighborhood at 63rd and Niwot

The neighborhood at 63rd and Niwot (known as Brigadoon Glen west of 63rd and Oriole Estates east of 63rd) suffered much damage from the September floods. Upstream of the neighborhood, through the Haystack Public Golf Course and Driving Range, the channel has responded to the flood by incising into the floodplain, leaving unstable vertical banks. As seen throughout the watershed, crossings were plugged with debris and unable to pass water. As a result, properties on either side of the crossing were exposed to avulsion or backwater effects which destroyed stream banks and inundated homes. The crossing on Strath is a double span box culvert which partially plugged, causing the undercutting of large trees on the channel banks just downstream of the crossing. The 63rd Street crossing is a much larger bridge with a mid-span pier that appears to be sized very conservatively for flooding. The abutments on both sides of the crossing are heavily armored with grouted rip rap. Left Hand Creek approaches the structure at an angle, with the structure widening the channel considerably. The widening of the channel, coupled with the mid-span pier, induces deposition at that crossing, and as a result, sediment and debris accumulate. It is important to note that given the duration, magnitude, and sediment load of the September 2013 flood, the 63rd Street Bridge performed well. Crossings of any type are, fundamentally, weak points in the river under flood conditions. Removing them altogether is optimal, but clearly not practical. Downstream of this crossing, the channel has aggraded significantly, reducing capacity. At the break between reaches 3 and 4, just west of 63rd, a diversion structure diverts most or all of the water into the Williamson Ditch. The diversion is not constructed for fish passage or sediment transport and as a result, is rapidly aggrading, requiring frequent maintenance.

Treatments for this project involve stabilizing the banks and addressing the channel issues around the crossings. The large cutbanks through the section of channel along the golf course need to be cut back stabilized as they are in danger of being undercut and collapsing. The Crossing at Strath Street should be reviewed for flood capacity and sediment transport. In order to reduce the aggradation issues at the 63rd Street Bridge, opportunities to re-align the channel to a more direct approach should be considered. There appears to be room for channel re-alignment, pending cooperation from the landowner. Given the amount of sediment likely to pulse through the watershed, this bridge should be monitored as part of the larger watershed maintenance plan. The frequency at which the crossing will require maintenance is likely larger than an annual time scale and ultimately dependent upon the timing and magnitude of stream flows. Downstream of the bridge, channel capacity should be restored and possibly increased to lower the base flood elevations in the area. Finally, the diversion structure should be considered for retrofitting and/or replacement to account for aquatic organism passage and sediment transport.

5.4.3.5 Longmont Phase II Flood Control

The City of Longmont *Lefthand Creek Flood Control Project – Phase II* addresses flooding issues on Left Hand Creek from Pike Road to Main Street. The project has a design (work completed by Muller Engineering) and is awaiting funding. This section of Left Hand Creek has experienced some major bank failure which appears to be a product of mass wasting, fluvial and backwater flooding effects. Stream banks along Kanemoto Park were hit particularly hard. Currently, the reach is severely aggrading which is being (temporarily) exacerbated by repair work being performed by the City of Longmont. (Much of the fine sediment will flush out once repairs are complete.)

The channel work proposed as part of the Phase II project mainly involves riprap armoring the channel banks and capacity improvements achieved by laying the banks back to a 3:1 slope. The project will certainly increase channel capacity, lowering base flood elevations, but opportunities to increase ecosystem function and aesthetic value should be explored. This reach could benefit from an increase in channel complexity through the addition of habitat features and natural bank stabilization methods. These features can be used to facilitate the creation of a low flow channel which will improve habitat conditions and help maintain sediment transport, reducing aggradation. It should be noted that due to the increase in channel roughness proposed by the conceptual strategy for the Entrenched, Residential Channel River Style, the cross sections as detailed in the Longmont Phase II plans may need to be widened to achieve the desired capacity.

6 Next Steps

6.1 Master Plan Implementation

6.1.1 Coalition Leadership

Identifying a lead agency will help enable the Coalition to coordinate implementation activities. The LHCC already has several established agencies and watershed groups in its membership. One of these existing agencies could potentially “house” the LHCC. The LHCC will need to determine its organizational capacity, and members will need to affirm their commitment to collaboration.

6.1.2 Seeking Funding

One of the Coalition’s primary responsibilities will be pursuing funding to implement the projects identified in the LHCWMP. There are several grant and loan programs that fund watershed restoration and flood mitigation projects. It is important to monitor these funding sources for deadlines. Many of the sources described here award grants on an annual basis, but some funding is tied to specific disasters and has a smaller window of opportunity.

6.1.2.1 Funding Sources

Colorado Water Conservation Board
CWCB has several loan and grant programs related to watershed restoration. Some of these programs, including the Colorado Healthy Rivers Fund and Colorado Watershed Restoration Grant, are explained in further detail here. Please go to http://cwcb.state.co.us/LoansGrants/Pages/LoansGrantsHome.aspx for the complete list of CWCBs loan and grant programs.

Colorado Healthy Rivers Fund
The Colorado Healthy Rivers Fund was established by CWCB, the Water Quality Control Commission, and the Colorado Watershed Assembly. This grant can be used for projects such as erosion control, watershed restoration, water quality monitoring, flood protection, etc. Locally-based watershed protection groups are eligible to apply for a grant from this program. Grant applications are due April 30th of each year. Further details are available at http://cwcb.state.co.us/LoansGrants/colorado-healthy-rivers-fund-grants/Pages/main.aspx#ExampleProjects.

Colorado Watershed Restoration Grant
Money from the Colorado Watershed Restoration Grant program can be used to projects that involve, stream restoration, erosion control, restoration of riparian areas, flood hazard reduction, etc. CWCB will provide the application upon request. See http://cwcb.state.co.us/LoansGrants/colorado-watershed-restoration-grants/Pages/main.aspx for additional information.

Community Development Block Grant – Disaster Recovery
The Colorado Department of Local Affairs (DOLA) received grant dollars to fund flood recovery programs through the Community Development Block Grant – Disaster Recovery (CDBG-DR) program, administered by the U.S. Department of Housing and Urban Development (HUD). The first phase of CDBG-DR funding has already been allocated as of the writing of this document, but the Coalition can still pursue CDBG-DR

funding in the second and third phases. The State of Colorado was awarded $199,300,000 in the second phase. CDBG-DR funds can be used to help fund the long-term Coalition building effort. Some activities, such as grant writing, cannot be funded with CDBG-DR money. Further information on CDBG-DR can be found at http://dola.colorado.gov/cdbg-dr/.

Colorado Flood and Drought Response Fund
Colorado's Flood and Drought Response Fund was created in 2012 and is managed by the CWCB. The Fund can be used for flood and drought preparedness and for response and recovery activities following flood or drought events and disasters. Up to $300,000 is available through this fund on an annual basis.

Colorado Department of Public Health and Environment
CDPHE has a few grant programs that may be applicable to future LHCC projects, including the Water Pollution Control Revolving Fund and the Water Quality Improvement Fund. Additional details on these grant programs are available at https://www.colorado.gov/pacific/cdphe/wq-grants.

Colorado Watershed Assembly
The Colorado Watershed Assembly (CWA) is a support resource for watershed groups in Colorado. CWA also acts as an advocate for these groups to work with other stakeholders and raise public awareness of watershed issues. CWA lists several other private and government funding opportunities here: http://www.coloradowater.org/Funding%20Opportunities%20List.

FEMA Hazard Mitigation Grant Program
FEMA's Hazard Mitigation Grant Program (HMGP) is authorized under Section 404 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act. HMGP funds can be used by state, local, and tribal governments and private non-profit organizations to implement long-term mitigation projects after a presidential disaster declaration and during the immediate recovery phase of a disaster. Visit https://www.fema.gov/hazard-mitigation-grant-program for more information on HMGP, including frequently asked questions, a list of eligible activities, and the HMGP guidance documents.

Basin Roundtables
The Colorado Water for the 21st Century Act established nine basin roundtables that represent Colorado's watersheds. The South Platte Basin Roundtable planning area includes the Left Hand Creek watershed.

Red Lodge Clearinghouse
The Red Lodge Clearinghouse was founded in 2001 as a collaborative natural resources management website. The site includes brief overviews of natural resources management loan and grant programs and a list of agencies that can provide assistance on collaboration and stakeholder engagement. It has a searchable funding database at http://rlch.org/funding.

El Pomar Foundation
The El Pomar Foundation in Colorado Springs is a general purpose foundation that approves grants for a variety of projects. The San Miguel Watershed Coalition was awarded $20,000 in 2011 to develop the Dolores River Riparian Action Plan. General information on El Pomar Foundation grants can be found at http://www.elpomar.org/what-we-do/grants.

Other sources similar to the El Pomar Foundation may include the Bill and Melinda Gates Foundation (http://www.gatesfoundation.org/How-We-Work/General-Information/Grant-Opportunities) and the Adolph Coors Foundation (http://grants.coorsfoundation.org/login.html?return=%2F). These are also general purpose foundations that may approve grants for many different types of projects.

Additional State and Federal Sources

- Colorado Department of Agriculture
- Trout Unlimited
- EPA and CDPHE for Section 319
- Fishing is Fun through Colorado Parks and Wildlife
- National Fish and Wildlife Foundation
- USACE
- Colorado Parks and Wildlife Wetland program
- Colorado Department of Local Affairs

Glossary

Aggradation: The depositing of sediment within the channel bottom

Avulsion: The process by which significant erosion occurs at the downstream end of a Reach which results in a drastically different channel alignment

Degradation: The removal of sediment within the channel bottom

Deposition: The depositing of sediment within the channel bottom

Detention: The storage of flood water with a controlled release for the purposes of reducing flood-related impacts

Drop Structure: A structural provision installed within the channel to transition the channel from a higher elevation to a lower elevation in a short horizontal distance in an attempt to establish a stable channel slope

Ecology: The branch of biology dealing with the relations between organisms and their environment

Ecosystem: A system formed by the interaction of a community of organisms with their environment

Embankment: A bank, mound, or similar feature designed to hold back water, carry a roadway, etc.

Erosion: The removal of sediment within the channel bottom, from channel banks, or across various land surfaces

Floodplain: The land adjacent to the channel that becomes inundated with water during a flood event

Geomorphology: The study of the characteristics and development of channel features such as shape, slope, and layout

Hydraulics: The depth, width, and velocity of water within a channel and floodplain

Hydrology: Quantity of surface water runoff generated from a specific rainfall event

Infrastructure: Features such as roads, bridges, utilities, etc.

LiDAR: Technology utilizing plane-mounted laser apparatus to collect high resolution topographic information

Runoff/Stormwater: Surface water that is generated during a rainfall event and not absorbed by the ground or evaporated into the atmosphere

Turbidity: Measurement of the clarity of a liquid

Watershed: Area of land where all the water that is under it or drains off it goes to the same place ultimately

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Appendix A Project Prioritization

Appendix B Supporting Documentation for Risk Assessment Methodology

Table 15. LOMCs Processed within the Left Hand Creek Watershed (from FEMA MIP DB)

CASE NO.	EFFECTIVE DATE	TYPE	PANEL NO.	PANEL DATE	SUBDIVISION	OUTCOME	FLOOD ZONE
92-08-051P	25-Sep-92	102			CREEKSIDE SUBDIVISION, PIKE NEIGHBORHOOD	Open	
96-08-256R	15-Jul-96	CLOMR	288F	06/02/1995	LEFT HAND CREEK -- QUAIL RIDGE	Open	
97-08-0279A	3-Sep-97	LOMA	288F	6/2/1995	Southmoor Park	Structure	X
97-08-0394P	14-May-99	LOMR	269F	6/2/1995		Map revision	BFE
97-08-191A		LOMA	405F	06/02/1995	BRIGADOON GLEN, LOT 7		
97-08-393R	14-May-99	CLOMR	269F	06/02/1995	GATEWAY CENTER	Open	
97-08-394P	14-May-99	102	269F	06/02/1995	GATEWAY CENTER	Open	
99-08-0162A	20-Apr-99	LOMR-F	288F	6/2/1995	Creekside Rainbow Ridge	Map revision	X
99-08-0260P	5-Oct-99	LOMR	289F	6/2/1995		Map revision	BFE
99-08-260P	5-Oct-99	102	288F	06/02/1995	LEFT HAND CREEK	Open	
00-08-0382P	25-Apr-01	LOMR	288F	6/2/1995		Map revision	AE
01-08-0219A	18-May-01	LOMR-F	288F	6/2/1995	Creekside Business Park	Map revision	X
01-08-0267A	27-Jul-01	LOMA	288F	6/2/1995	Southmoor Park	Structure	X
02-08-0301A	29-May-02	LOMA	288F	6/2/1995	Creekside	Structure	X
02-08-0391A	17-Jul-02	LOMA	288F	6/2/1995	Creekside	Structure	X
02-08-0510A	13-Dec-02	LOMA	288F	6/2/1995	Melody Valley	Portion of property	X
03-08-0631A	24-Sep-03	LOMR-F	405F	6/2/1995	Brigadoon Glen	Map revision	X
04-08-0308A	20-Feb-04	LOMA	410F	6/2/1995		Structure	X
04-08-0368A	8-Apr-04	LOMA	245F	6/2/1995		Portion of property	X
04-08-0463P	16-Dec-04	LOMR	288F	6/2/1995		Map revision	AE
04-08-0541A	23-Jul-04	LOMA	288F	6/2/1995	Creekside	Structure	X
04-08-0718A	21-Dec-04	LOMA	288F	6/2/1995	Creekside	Structure	X
05-08-0072A	25-Feb-05	LOMA	385F	6/2/1995		Structure	AE
05-08-0189A	2-May-05	LOMA	288F	6/2/1995	Southmoor Park	Structure	AE
06-08-0102A	1-Dec-05	LOMA	288F	6/2/1995	Melody Valley	Structure	X
06-08-B026R	30-Jun-06	CLOMR	288F		HARVEST JUNCTION NORTH	Open	
06-08-B081A	26-Jan-06	LOMA	288F	6/2/1995	Southmoor Park	Portion of property	X
06-08-B240A	4-Apr-06	LOMA	288F	6/2/1995	Melody Valley	Structure	X
07-08-0275C		LOMR-F	245F		8283 NORTH 39TH STREET -- Sec 19, T2N, R70W, 6th P.M.	Map revision	
07-08-0795A	23-Aug-07	LOMA	288F	6/2/1995	Southmoor Park	Structure	X
07-08-0939A	25-Sep-07	LOMA	288F	6/2/1995	Southmoor Park	Structure	X
08-08-0370A	8-Apr-08	LOMR-F	245F	6/2/1995		Map revision	AE
08-08-0703A		LOMR-F	245F		SECTION 19, TOWNSHIP 2 NORTH, RANGE 70 WEST, 6th P.M. -- 8383 NORTH 39TH STREET	Map revision	
08-08-0704A		LOMR-F	245F		GUEST HOUSE -- 8383 NORTH 39TH STREET	Map revision	
09-08-0552R	16-Jun-09	CLOMR	405F		REPLACEMENT OF 63RD STREET BRIDGE OVER LEFT HAND CREEK	Open	
10-08-0187A		LOMA	410F		7914 NORTH 73RD STREET -- PORTION OF SECTION 24, T2N, R70W	Structure	
10-08-0353A		LOMA	245F		(70-NS) CRESTVIEW ESTATES, LOT 15C -- 361 LEFTHAND CANYON DRIVE	Structure	
10-08-0387R	10-Nov-10	CLOMR	288F		LEFT HAND CREEK FLOOD CONTROL PROJECT	Open	

CASE NO.	EFFECTIVE DATE	TYPE	PANEL NO.	PANEL DATE	SUBDIVISION	OUTCOME	FLOOD ZONE
12-08-0913A		LOMA	405F		BRIGADOON GLEN, FIRST ADDITION, LOT 24 -- 6472 ROBIN DRIVE	Structure	
13-08-0204A	2-Jan-13	LOMA	402J	12/18/2012	Brigadoon Glen	Structure	X
13-08-0209A		LOMA	402J	12/18/2012	BRIGADOON GLEN FIRST ADDITION, LOT 25 -- 6500 ROBIN DRIVE	Structure	
13-08-0246A		LOMA	402J	12/18/2012	OL- BRIGADOON GLEN, FIRST ADDITION, LOT 27 -- 6539 ROBIN DRIVE	Structure	
13-08-0265A	10-Jan-13	LOMA	402J	12/18/2012	Brigadoon Glen	Structure	X
13-08-0273P	2-Aug-13	LOMR	402J	12/18/2012	REPLACEMENT OF 63RD STREET BRIDGE OVER LEFT HAND CREEK	Map revision	
13-08-0336A	5-Feb-13	LOMA	402J	12/18/2012	Brigadoon Glen	Structure	X
13-08-0338A	21-Feb-13	LOMA	402J	12/18/2012	Brigadoon Glen	Structure	X
13-08-0356A		LOMA	402J	12/18/2012	BRIGADOON GLEN, FIRST ADDITION, LOT 25 -- 6500 ROBIN DRIVE	Structure	
13-08-0420A	26-Feb-13	LOMA	402J	12/18/2012	Brigadoon Glen	Structure	X
13-08-0423A	12-Mar-13	LOMA	402J	12/18/2012	Brigadoon Glen	Structure	X
13-08-0429A	26-Feb-13	LOMA	402J	12/18/2012	Brigadoon Glen	Structure	X
13-08-0518A		LOMA	402J	12/18/2012	BRIGADOON GLEN, FIRST ADDITION, LOT 30 -- 6455 ROBIN DRIVE	Structure	
13-08-0589A		LOMA	410J	12/18/2012	PORTION OF SECTION 19, T2N, R69W -- 7950 NORTH 81ST STREET	Structure	
13-08-0677A		LOMA	402J	12/18/2012	BRIGADOON GLEN, FIRST ADDITION, LOT 25 -- 6500 ROBIN DRIVE	Structure	
13-08-0787A	30-May-13	LOMA	402J	12/18/2012	Brigadoon Glen	Structure	X
13-08-0848A		LOMA	402J	12/18/2012	PORTION OF SECTION 27, T2N, R70W -- 7349 NORTH 63RD STREET	Structure	
13-08-0878A	18-Jun-13	LOMA	402J	12/18/2012	Brigadoon Glen	Structure	X
13-08-0878A		LOMA	402J	12/18/2012	BRIGADOON GLEN, FIRST ADDITION, LOT 18 -- 6491 BLUEBIRD AVENUE	Structure	
13-08-1075A		LOMR-F	402J	12/18/2012	OL-BRIGADOON GLEN FIRST ADDITION, LOT 25 -- 6500 ROBIN DRIVE	Map revision	
13-08-1185P	21-Aug-14	LOMR	288J	12/18/2012		Map revision	AE
13-08-1185P	21-Aug-14	LOMR	288J	12/18/2012	LEFT HAND CREEK FLOOD CONTROL PROJECT	Map revision	
13-08-1185P	4-Apr-14	LOMR	288J	12/18/2012		Map revision	AE
13-08-1340A	16-Jan-14	LOMA	288J	12/18/2012	Melody Valley	Structure	X
14-08-0675A	10-Apr-14	LOMA	288J	12/18/2012	Melody Valley	Structure	X
14-08-0987P	22-Oct-14	LOMR	288J	12/18/2012		Map revision	X
14-08-1275A	26-Aug-14	LOMA	402J	12/18/2012	Brigadoon Glen	Structure	AE

Table 16. SVAP2 Ecologic Stream Assessment – Ecosystem Elements

Element	Description	Scoring
1. Channel Condition	Evaluates the relative geomorphic stability of the channel. The shape of a stream channel changes constantly depending on the flow and sediment conditions in the channel. This element is a description of the geomorphic condition and the relative relationship between the channel and its floodplain.	**High Score:** The active channel and floodplain are connected throughout the reach, no signs of incision or aggradation. **Low Score:** Headcuts or massive incision present, no floodplain access, or severe lateral migration/avulsions.
2. Hydrologic Alteration	Hydrologic Alteration is the degree to which streamflow conditions differ from normal, unregulated conditions and patterns. Naturally occurring daily and annual flow variations provide ecological benefits to floodplain and riparian ecosystems. For example, variations in flow provide cues to fish for spawning, egg hatching, rearing, feeding locations, and migration (Junk, et al., 1989).	**High Score:** The river, creek, or stream has an unaltered hydrologic regime, there are no dams, impoundments, levees, withdrawals, diversions, or flow additions. **Low Score:** The river, creek, or stream has significantly less or more water during parts or all of the daily or annual cycle.
3. Bank Condition	Stable stream banks are essential to healthy stream systems. Failing banks provide an influx of fine sediments which have detrimental ecosystem, water quality, and economic consequences. As much as 85% of a stream's sediment load can come from failing banks. Healthy vegetation on streambanks promotes bank stability and reduces the impact of high flows.	**High Score:** Banks are stable, protected by vegetation, wood, or natural rock. **Low Score:** Banks are unstable with no protection, numerous active bank failures, and/or dominated by riprap or other fabricated structures.
4. Riparian Area Quantity	Riparian areas function as transitional areas between the stream and uplands. They may include wetlands or floodplains, depending on the valley form and stream corridor. They are important habitat and travel corridors for numerous plants, insects, amphibians, birds, and mammals.	**High Score:** Riparian corridor width is at least two bankfull widths or more than the active floodplain and is contiguous across and down the corridor. **Low Score:** Riparian corridor is less than 25% of the active floodplain or vegetation gaps exceed 30% of the property.
5. Riparian Area Quality	The quality of the riparian area increases with the width, complexity, and linear extent of the vegetation along the stream. A complex community consists of diverse plant species native to the area with varying age classes.	**High Score:** Natural and diverse vegetation with varied age classes. No invasive species. **Low Score:** Little to no native vegetation, invasive species widespread.
6. Canopy Cover	In forested riparian areas, shading of the stream is important as it helps maintain cool water temperatures. Loss of shading vegetation can cause a decline in certain species of fish (including trout), insects, and some aquatic plants. Additionally, cool water can hold more dissolved oxygen.	**High Score:** Greater than 75% of water surface shaded. **Low Score:** Less than 20% of water surface shaded.
7. Nutrient Enrichment	While nutrients are necessary for stream food webs, an excessive amount of algal and plant growth is detrimental to stream ecosystems.	**High Score:** Clear water along entire reach. **Low Score:** Pea green color present; thick algal mats dominate stream.
8. Manure or Septic Present	Manure or human waste increases nutrients and oxygen demand in streams. This alters food webs, nutrient cycling, algal growth, and could cause bacterial or viral contamination.	**High Score:** No livestock access and no leaking septics, sewers, and/or untreated waste discharges. **Low Score:** Livestock have unlimited access to stream and manure is noticeable and/or there is visible septic, sewer, or untreated wastewater discharges.
9. Pools	Pools are important resting, hiding, winter habitat and feeding locations for fish. Streams with a mix of shallow and deep pools offer diverse habitat for diverse species and age-classes of fish and other aquatic species.	**High Score:** More than three deep pools separated by riffles or boulders; shallow pools also present. **Low Score:** Pools absent.
10. Barriers to movement	Most aquatic organisms move around their habitat or take daily or seasonal migrations. Some species use headwater streams for spawning and move downstream to lakes and larger creeks for feeding as they mature. Barriers that block the movement of fish or other aquatic organisms interrupt these natural cycles.	**High Score:** No artificial barriers that prohibit movement during any time of the year. **Low Score:** Physical structures, water withdrawals, and or water quality prohibit movement.
11. Fish Habitat Complexity	Quality fish habitat is a mosaic of different types of habitat created by different combinations of water depth, velocity, wood, boulders, riparian vegetation, and species. Fish require these complex habitats and the dynamic nature of instream habitat features assures that fish are able to find suitable areas to rear, feed, grow, hide, and reproduce. The greater the variety of habitat features the more likely it is to support a diverse aquatic ecosystem.	**High Score:** Ten or more habitat features available, including logs or large wood, small wood accumulations, deep pools, shallow pools, overhanging vegetation, large boulders, small boulder clusters, riffles, undercut banks, and side channels or floodplains. **Low Score:** Less than four habitat features available.
12. Aquatic Invertebrate Complexity	In a healthy stream, substrates are varied, free of fine sediment, abundant, and in place long enough to allow for colonization of aquatic invertebrates. High stream velocities, high sediment loads, and frequent	**High Score:** Nine or more habitat features available, including logs or large wood, small wood accumulations, deep pools, shallow pools, overhanging vegetation, large boulders, small boulder clusters, riffles, undercut banks, and side

Element	Description	Scoring
	flooding may cause reaches to be unsuitable for these organisms. Wood and riffle areas with boulders and cobbles support the bulk of the invertebrate community. Reaches with wood tend to support a more diverse aquatic invertebrate community.	channels or floodplains, and must include at least one wood/riffle combination. **Low Score:** No habitat features available.

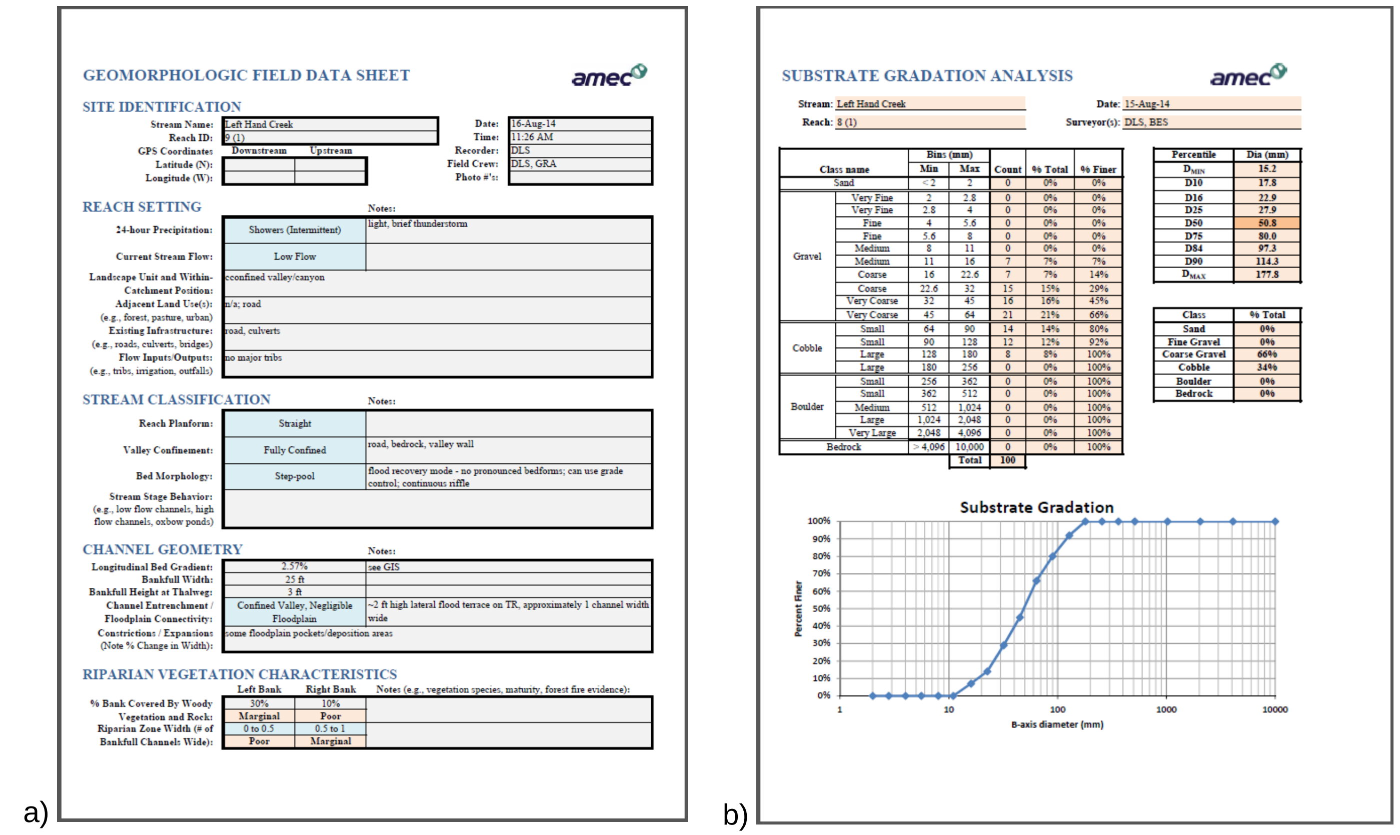


Figure 32. Field Data Sheets

a) Example field form used to classify each reach in the geomorphic risk assessment. b) Example grain size distribution and gradation analysis from pebble count data input into the spreadsheet.

Appendix C Left Hand Creek Coalition Contact List

Agency	First	Last
Boulder County - Program Manager	Julie	McKay
Boulder County - Parks and Open Space	Jesse	Rounds
City of Boulder	Mark	Gershman
City of Longmont	David	Hollingsworth
Colorado Parks and Wildife	Ben	Swigle
Colorado Parks and Wildlife	Larry	Rogstad
Colorado Parks and Wildife	Boyd	Wright
Colorado Department of Public Health and Environment - Project Manager Superfund / PA / SI	Mary	Boardman
CDPHE, Water Quality Control Division	Tammy	Allen
Colorado Dept. of Transportation	Dan	Marcucci
Colorado Division of Reclamation and Mine Safety	Julie	Annear
Colorado Water Conservation Board	Jeff	Crane
Colorado Water Conservation Board	Thuy	Patton
Colorado Water Conservation Board	Chris	Sturm
Colorado Water Conservation Board - State Recovery Liaison with the State OEM	Olivia	Stinson
Colorado Water Conservation Board - State Recovery Liaison with the State OEM	Don	Moore
Environmental Protection Agency - Region 8	Nat	Miullo
Environmental Protection Agency - Region 8	Peter	Ismert
FEMA - Infrastructure Systems, Recovery Support Function Coordination Specialist	Naren	Tayal
Jamestown, James Creek Watershed Initiative	Mark	Williams
Keep It Clean Partnership	Janice	Lopitz
Jamestown, Mayor	Tara	Schoedinger
Left Hand Ditch Company	Terry	Plummer
Left Hand Water District	Chris	Smith
Left Hand Water District	Darwin	Williams
Lefthand Water Oversight Group	Glenn	Patterson
Longmont and Boulder Valley Conservation Districts	Joni	Burr
St. Vrain and Left Hand Water Conservancy District	Sean	Cronin
St. Vrain and Left Hand Water Conservancy District	Doug	Lyle
USDA - Forest Service, Arapaho / Roosevelt Natl Forest	Dan	Cenderelli
USDA - Forest Service, Arapaho / Roosevelt Natl Forest	Sylvia	Clark
USDA - Forest Service, Arapaho / Roosevelt Natl Forest	Eric	Schroder
USDA - Natural Resources Conservation Service	Boyd	Byelich
USDA - Natural Resources Conservation Service	Sylvia	Hickenlooper

Appendix D Meeting Summaries and Public Outreach Documentation

Left Hand Creek Coalition Kick-Off Meeting – Meeting Summary

Date: June 27, 2014, 9-11:30am
Location: Rembrandt Room, 1301 Spruce St., Boulder, CO

WELCOME AND INTRODUCTIONS

Ryan Golten, CDR Associates, opened the meeting by facilitating a round of introductions. Graeme Aggett, AMEC, provided an overview of the meeting.

During introductions Left Hand Creek Coalition (LHCC) members were asked to state their objectives for the LHCC kick off meeting. Members' objectives included meeting other Coalition members, understanding the scope and objectives of the master plan, discussing the upcoming opportunity for CWCB funding for Left Hand stream restoration, and understanding the schedule and timeline of the master plan.

LEFT HAND MASTER PURPOSE AND GOALS

Luke Swan, AMEC, stated the AMEC team's understanding of the purpose and goals of the master plan. The project team developed a purpose statement, which reads "At the highest level, the purpose of the project is to use sound science and engineering to organize and process flood data into a form the Coalition can use to make informed recovery and planning decisions." The master plan is the first step in full recovery of the watershed.

Two outcomes of the plan will be to compile data and make planning recommendations. The project will compile data such as stream flow levels and hydraulics, and will gather previous input from the public and Left Hand Creek watershed stakeholders. Planning decisions will be made with the overriding goal of maximizing benefits and minimizing costs to stakeholders. Planning decisions will be based on priorities identified by the Coalition and public, and are likely to include reducing risk, defining flood plains, and protecting headgates. The master plan will prioritize projects in a way that streamlines the securing and allocation of funding.

The master planning process will maximize (1) stakeholder involvement and (2) use of existing information.

Key Elements of the Master Plan

- Facilitate an open and collaborative decision-making process
- Examine risk reduction strategies in both the short and long term
- Integrate and coordinate with planning efforts in adjacent watersheds
- Identify, assess, and mitigate for geomorphic hazards such as debris flows, channels, avulsions, and landslides
- Characterize the vulnerabilities and strengths of the riparian ecosystem
- Develop risk mitigation strategies around the system's natural assets and functions
- Ensure the agricultural community along the Left Hand is fully incorporated into the disaster planning effort

- Conduct outreach, education, and engagement of impacted residents and key stakeholders to share information and obtain input to be incorporated into the master plan process

Boulder County staff asked about what specific outcomes the project team anticipated from the master planning process. The project team stated that while floodplain modelling is not in the scope of the master plan, areas that require new mapping and recommendations on how to technically do so will be identified. Additionally recommendations on how to proceed in the recovery of the creek will be included. Those recommendations will be valuable in funding watershed projects.

Coalition members discussed the need to focus on what concrete benefits residents should expect from the master plan. They discussed referring to a flow chart developed after the flood in Jamestown that recommends to residents what process to follow for different types of recovery activities and needs. The group discussed the need for the master plan process to help residents understand how their property relates and fits into the whole watershed system and how the system impacts their property.

Mr. Aggett noted that certain lessons learned from the Jamestown recovery may be a helpful to other areas of the watershed and could inform components of this master plan. He also acknowledged that this master plan covers the entire watershed, and that issues and concerns there will differ significantly from other areas of the watershed, particularly the lower reaches on the plains. The group discussed how the master plan must be a watershed-wide effort that will coordinate closely with transportation, private property owners, and open space and will formalize these relationships to advance funding requests. One member noted that one way to demonstrate the watershed-wide nature of the master plan is through water quality, in that upper and lower reaches are directly connected over water quality issues.

The group agreed that it is important to clearly be able to articulate what the master plan is and its outcomes prior to conducting the first series of public meetings. Members noted the importance of this educational piece before asking landowners what they want to see in the master plan. E.g., What is a watershed? How does it behave? How did ours react in September? What's likely to happen in the future, and what can help mitigate future floods? Clearly different people and communities have different levels of, and needs for, understanding. Members agreed it's important to assess what's been presented and what communities understand so far.

Members were asked if the project team has captured their interests correctly. Members noted areas that were important to them, which included areas such as natural resources recovery, habitat recovery, and water quality.

MASTER PLAN SCHEDULE AND TIMELINE

Graeme Aggett informed the group on the master plan's schedule and timeline. The project team developed and distributed a graphic timeline chart and proposed work plan, which the group reviewed together.

Data Collection and Existing Plans: While fieldwork has been slightly delayed due to high stream flows, the project team is gathering existing studies and collecting data. The team is asking Coalition members to help identify gaps and additional data/studies. At the end of August/Early September the information from fieldwork, existing studies, and data collection will be rolled into a draft report, which will contain potential activity and funding options to share with Coalition members and the public and received feedback.

Public Meetings: Two public meetings will occur around late July (possibly July 31 for the lower watershed and August 5 for the upper watershed). The purpose of the meetings will be to educate stakeholders about the watershed as a system, including why the stream behaved as it did and what can be expected in the future; explain the scope of the master plan process; share input the Coalition and AMEC team has collected to date; and solicit input about priority focus areas for the watershed master plan.

Creek Corridor Assessment and Risk Evaluation: One deliverable on the project schedule is 100-Year Flood Maps. The Coalition discussed what the flood map would include. Mr. Aggett noted that in some areas the floodplain will not have changed. In other areas modelling can be done for an interim 100-year floodplain. The 100-year floodplain map of the master plan will note these areas and where current data exists, as well as data gaps. A balance must be considered for the floodplain between regulatory and risk mapping.

PROJECT WORK PLAN

The group discussed aspects of the master plan work plan.

- Currently the project team is conducting interviews with each coalition group
- The group agreed to meet approximately six times
- The project team is collecting input from the public through multiple channels (prior to the public meetings), including through Coalition member agencies and organizations of homeowners and residents, and through a dedicated phone and email for the project
- The project team is seeking to connect with private property owners, in order to get input and do field assessments. Coalition members can serve as conduit to private property owners
- The project team is developing basic operating protocols and will send them to Coalition members for feedback and agreement at the next meeting. Members would like LHCC meeting minutes and materials to be posted online and for the process to be as transparent as possible. Members agreed to have alternates for LHCC meetings, ensure their alternates are kept informed, keep their constituents informed about the master plan process, attend meetings and be spokespeople for the process with the media and the public. They will actively help with product review and will ensure their agencies are kept up to date and well informed, and will represent their agency interests/concerns on the Coalition.

The group discussed possible need to perform educational activities to assist the public in understanding this process and how it differs from other post-flood public processes, giving input, and providing their preferences. It was noted that Jamestown received significant education on creek recovery, which helped the post-flood Emergency Watershed Protection process. The master plan does not have nearly as much time to do education as happened in Jamestown, but there is agreement that this component of outreach should be prioritized.

Potential options for educational outreach include holding an educational pre-meeting or smaller neighborhood meetings, developing an educational presentation and sharing it on the website, developing a video for the website, and developing a series of PSA's relevant to all watershed master plans. Depending on what activity the Coalition decides can be used in educational outreach, they will think creatively on how to develop and fund the activities.

Colorado Water Conservation Board (CWCB) Grant

Bridgette McCarthy, Boulder County, discussed a CWCB grant opportunity for Left Hand creek restoration. Because the deadline of grant applications is July 1, Boulder County met with AMEC to identify a proposed project for the Coalition to consider supporting. Graeme Aggett discussed the project idea and asked for members' support. The creek restoration project was originally proposed to be located just below the confluence of James Creek and Left Hand Creek. Due to matching needs and limitations, Boulder County suggests a project of approximately $1M. One proposal was to locate the project in an area where private property residents reside, in order for the project to directly impact residents. Members also discussed locating the project just downstream from recovery work completed in Jamestown, with the hope that making improvements sequentially down the canyon, and extending the reach of recovery work, would help to create more of a 'pilot study' area for future monitoring and research for the entire watershed. The group discussed this proposal and supported it. Members also emphasized the importance of pilot restoration projects that can serve as models and research labs for the entire watershed. Coalition members agreed to support the project in whichever location it was ultimately proposed. Ms. McCarthy agreed to work with AMEC, in discussions with CWCB, to prepare the application. Boulder County and AMEC will share the final draft with the Coalition.

Left Hand Master Plan Website

There is an independent website for the master plan: http://lefthandcreekmasterplan.com/. This website will be the focal point for information, interactive maps, requests for feedback, and Left Hand Master Plan project updates. One member expressed interest in ensuring there are photos from both the lower and upper reaches, which the project team will include. The website will be active next week, by 7/3.

Next Steps & Action Items

- A Boulder County representative requested setting up technical engineering meetings between project team engineers and the Transportation Department. There will be a meeting with BoCo Transportation, CDOT and the project team on 7/3/14.
- Bridgette McCarthy, Boulder County, will prepare the grant application for the CWCB grant and share with the coalition prior to submitting.
- Ryan Golten, CDR Associates, will draft and distribute proposed LHCC operating protocol to members prior to the next LHCC meeting for members' review/feedback.
- Members agreed that LHCC meetings will held be bi-weekly on Mondays from 1:30 – 4:00pm. The next LHCC meeting will be July 14. The meetings will alternate locations between Longmont and Boulder. The project team will send out a meeting request.

- Diane Malone, Boulder County, will identify LHCC meeting locations and the project team will send meeting invitations to coalition members.
- Diane Malone will establish WebEx platform and secure a better microphone for calling in to future LHCC meetings.
- LHCC members will assist the project team to obtain right-of-entry forms from private property owners to conduct field assessments for the master plan.
- The project team will finalize and publicize the website.
- The project team will make the power point presentation from today's meeting available to LHCC members who could not attend the meeting. The presentation will be updated for the website.

MEETING ATTENDEES

	Name	Affiliation
1.	Graeme Aggett	AMEC
2.	Luke Swan	AMEC
3.	Ann Pagano	Boulder County
4.	Bridgette McCarthy	Boulder County
5.	Denise Grimm	Boulder County
6.	Diane Malone	Boulder County
7.	Jesse Rounds	Boulder County
8.	Varda Blum	Boulder County
9.	Wendy Blanchard	Boulder County
10.	Stacey Proctor	Boulder County
11.	Jeffrey Range	CDR Associates
12.	Ryan Golten	CDR Associates
13.	Jeff Crane (via phone)	Colorado Water Conservation Board
14.	Mark Williams	James Creek Watershed Initiative
15.	Darwin Williams	Left Hand Water District
16.	Glen Patterson (via phone)	Left Hand Water Oversight Group
17.	Boyd Byelich	NRCS
18.	Tara Schoedinger	Town of Jamestown
19.	Dan Cenderelli (via phone)	U.S. Forest Service

Left Hand Creek Coalition (LHCC) Meeting Summary

Date: July 14, 2014, 1:30-3:45pm
Location: BoCo POS Building, Prairie Room South (and by conference call)

WELCOME AND INTRODUCTIONS

LHCC and Project Team members re-introduced themselves and reviewed the proposed agenda. See below for list of meeting attendees.

STATUS UPDATES AND ANNOUNCEMENTS

The Project Team is on schedule with the Master Plan Work Plan distributed at the last LHCC meeting, except for field research which (as discussed and agreed last meeting) was delayed a month due to high Creek flows.

Interviews/community meetings. CDR/AMEC have conducted roughly 15 interviews with over 30 Coalition members and other key stakeholders. They have taken feedback from these interviews and discussions and assembled a “Themes” report discussed below, which will inform preliminary technical work as well as public outreach strategy. The Project Team is also meeting with interested community groups such as the Intermountain Alliance, Longmont and Boulder Valley Conservancy Districts, the Left Hand Fire Dept, Lower Left Hand Flood Recovery Inc., and others in the Watershed.

Technical data assembly. AMEC is collecting and assembling technical data from LHCC members, putting data into GIS, and will put maps on the project website by the end of July.

Public Meetings. The Team has been coordinating the first round of public meetings for July 31 and August 6, discussed in depth below.

Watershed Symposium on 7/18 in Loveland. This event designed to encourage more partnerships and collaboration across watersheds, discuss why watershed coalitions are important, and understand what is currently happening, what agencies have funding, and how to stay involved. It is not only for agencies/organizations but also HOAs and property owners. Julie McKay will be on the morning panel, as CWCB is funding three coalitions in Boulder County. She will discuss Left Hand in her presentation, which she’ll share with this group. Attendees were asked to report relevant information from the Symposium at the next LHCC meeting.

CWCB Grant for LH Watershed Restoration – no official decision yet, but should hear soon.

“THEMES” FROM INITIAL PROJECT INTERVIEWS

CDR/AMEC have conducted roughly 15 interviews with over 30 Coalition members and other key stakeholders, asking questions related to key Watershed issues, outreach strategy, and useful, accessible ways to discuss the Master Plan process and solicit meaningful input. The “Themes Report” from these interviews **was distributed by email before the meeting** on Monday 7/14 and will be corrected and updated based on today’s discussion.

The Project Team reviewed the major issues raised so far in the Themes Report. LHCC members discussed a number of specific issues in the context of that presentation.

Sustained watershed collaboration after the Master Plan process. Members discussed the MP process as ideally laying the groundwork for future collaboration in the Watershed for activities such as leveraging funds for Watershed projects (e.g., irrigation diversions) and getting Creek-related information to residents (e.g., who takes care of my ditch?; who's in charge of the river here?). There are 80 different citizen watershed groups around CO, with different structures and purposes based on what's important locally. It is a way for residents and others to identify projects and funding opportunities. This can be done through local conservancy districts, environmental NGOs, etc. James Creek Watershed Initiative is an example and may have useful resources. It was suggested this issue be put on future agendas and that a possible recommendation in the Plan could relate to a future role of the Coalition or offshoot that would be useful to residents in addressing local issues. The question of this role being assumed by some sort of taxing entity was discussed as a hypothetical option.

Map recommendations. Boulder County reiterated it will be important to have the Plan make recommendations about what flood maps continue to be valid or not, and what still needs to be done to help determine this.

Nutrient loading. Members discussed Left Hand as not having significant nutrient issues, though metal slurry from abandoned mines is a big issue in the upper Watershed.

Sediment loading in ditches, diversions and reservoirs. In Left Hand Valley Reservoir there are substantial sediment deposits. Some ponds are being dredged due to so much sediment. LH Water just rebuilt a diversion structure just west of Hwy 36 six weeks ago, and it is already clogged. There is a big question about where sediment and debris going. It was noted Denver Water has resources for this. Left Hand Ditch Co hasn't started cleaning its reservoirs but has cleaned its ditches four times since the flood.

Private land issues. We discussed the issue of residents putting structures in/along the Creek and ditches, including under/over-sized culverts, drop structures, tree revetments, etc. These can impact neighbors, aquatic habitat, stream alignment and the Watershed more broadly. They can also hinder the Ditch Company's ability to clean the ditches and encroach on its easement. People need to understand that the Creek may still move, which may impact these actions. Many people have received permits from USACE (which officially had more lenient standards for emergency permits following the flood) and Boulder County (which did not). Given that many permits were granted quickly following the flood without the luxury of close coordination, people may have been allowed to perform actions that may not be appropriate for the Creek long term.

In addition, Boulder County emphasized the need for the Plan to make stream alignment recommendations that will facilitate residents' decisions about 'how to get home', and to provide a road map of what more is needed. These recommendations will largely come from the Master Plan risk assessment process and will be important to landowners in the Watershed.

Preliminary recommendations. We discussed the potential recommendations that came up in the interviews and were outlined in the Themes Report. The Coalition added the following:

Homeowner education/resources. Related to the discussion immediately above, there was a suggestion to add, as a possible project recommendation from the Plan, guidance for private landowner stewardship of the Creek, maybe in the ultimate form of a pamphlet or FAQ sheet. The idea would be to help landowners place their stretch of the creek within the context of the broader system. One suggestion was a map for landowners so they can track debris that may come down the Creek, know where it's likely from, who's coming for it, whom to contact, etc. Jeff Crane will send examples from the Big Thompson and elsewhere to the Project Team. Mark Williams may have useful resources from James Creek Watershed Initiative. The Project Team is compiling a resource list, and will post useful resources on the website. Please send them to lefthandmasterplan@mediate.org.

Funding resources not identified so far in the Themes Report: Longmont Phase 2 funding; South Platte Roundtable Process (Water supply reserve account; CDBG block grants).

Potential collaboration on fish passages through ditch diversions. Trout Unlimited had partnered elsewhere to do this – a suggestion for Left Hand as well. Jeff Crane reported two ditches on the St. Vrain were just approved for irrigation diversions with fish passages through the Water supply reserve account. There are CDBG block grants available for Ditch companies.

Urban Drainage. The question of its involvement came up in the interviews. Apparently Left Hand Watershed used to be in Urban Drainage jurisdiction but is no longer. Some LHCC members indicated they'd like to explore getting Left Hand Watershed back in.

Laura and Ryan requested that everyone **PLEASE SEND EDITS/CORRECTIONS** to the Themes Report by end of the day on Monday, 7/21.

How the Interview "Themes" Inform the Master Plan Process

AMEC prepared a presentation, attached to this meeting summary, describing how the above issues might be addressed in the MP process. Luke explained how the Project Team is taking what it's heard and outlining an approach to these issues in the Master Plan. The following issues came up in the context of this presentation.

Informing Infrastructure & Design.

- Boulder County, in Left Hand Canyon, and CDOT, at the Highway 36 crossing and on the Diagonal, may use the Plan to inform transportation road design. There were questions about where the top soil will come from.
- Residents and others want to know about culverts; bank stabilization; in-channel energy dissipation; stream channel design.
- The County wants to have more specific conversations with AMEC about options for roadway design. They are still waiting to formalize 30% designs for James and Left Hand canyons. The County will draw from the Plan's assessment of public and private infrastructure, e.g., where do people feel culverts are undersized/oversized, when were things destroyed?
- The Master Plan will also give the County information for permitting, restoring and/or building private infrastructure.

Aquatic/riparian habitat: The Plan will look at mitigating some of the emergency watershed protection work, e.g., by increase channel complexity and restoring endangered species habitat.

Channel stabilization: Stream bank stabilization is tied to issues such as sediment loading and transport, ecosystem protection, erosion, and safety. The Master Plan will identify some reaches as "stable" in terms of geomorphic risk and other categories for regulators and residents.

Education. The Plan should be able to help residents understand what reaches are considered "stable" and which are most subject to change, by analyzing post-flood data and conducting field assessments on current conditions. This will be discussed in community meetings.

One key note about messaging: It has seemed useful so far for people to understand the MP as having three key purposes: (1) assessing the current/post-flood watershed; (2) planning for the system as whole around flood recovery, watershed protection, and future flood mitigation; and (3) increasing competitiveness for funding for projects in the Watershed.

PUBLIC MEETINGS & OUTREACH

Meetings. LHCC members agreed to the following locations/times/dates for public meetings:

- Lower Watershed, Thurs July 31st at the Altona Grange (for residents East of Hwy 36)
- Upper Watershed, Weds, Aug 6th at the Greenbriar Inn (for residents West of Hwy 36)

The purpose of the meetings will be to educate stakeholders about the watershed as a system, including why the stream behaved as it did and what can be expected in the future; explain the scope of the master plan process; share input the Coalition and AMEC team has collected to date; and solicit input about priority focus areas for the watershed master plan. LHCC members reiterated that education/information will be important at the public meetings before asking community members for input about Watershed priorities.

There will be also be a presentation/discussion at the regular Jamestown Community Meeting on Weds, August 5, to get input from Jamestown residents into the broader Watershed Plan.

Flyer. CDR will send Coalition members the public meeting flyer this week. Please distribute to your networks, post on your website and calendar, and share widely! The County will also send a postcard announcement to all residents of the Watershed late this week.

Outreach. CDR will conduct the following outreach regarding the public meetings:

- Work with the LHCC to finalize/circulate a **press release** early next week. Please see the County's list of media outlets attached to this summary and let the Project Team know if your jurisdiction has additional outlets, so these can be included.

- Send the public meeting flyer to assembled database for Left Hand Watershed – i.e., County contacts, people who attended the County's December flood recovery meeting, people who have been identified as key stakeholders.

- Ask that the flyer be posted on following **websites**, among others:
  - ❖ Left Hand Creek Master Plan
  - ❖ Boulder County Comprehensive Creek Recovery
  - ❖ Conservancy District
  - ❖ Left Hand Ditch

- Left Hand Water
- Jamestown
- Altona Grange

- The flyer will be posted on **quick topic boards** for Bar-K Ranch, Intermountain Alliance, Jamestown, Mountain Communities of BoCo, Lower Left Hand Flood Recovery Inc., etc. **Please let CDR know of any other stakeholder groups and contacts**!

The LHCC identified the following changes to the flyer, which the Project Team will incorporate:
- Highlight a key purpose is to get residents' *input* (that is in the text but easy to miss)
- Change language of what *caused* the flood to understanding more about the nature of the storm event and what factors contributed to the flooding

CDR proposed a preliminary general agenda for the public meetings:
- Relevant LHCC member(s) will welcome the public, endorse the process
- 1st hour: education (AMEC presentation) & Q/A about the Watershed and Master Plan
- 2nd hour: break into smaller groups by reach, likely using something close to the stream stretches that Boulder County used in the December flood recovery meetings. Each small group will have a facilitator, note-taker and technical resource person. Questions may include: What do you most value about the Creek? What is important to you about having the Creek here? What issues most important to you as far as how projects are prioritized? What type of projects would you like to see in this Watershed?

There was a discussion about the **messages** conveyed at public meetings. We want to make sure people know their input is important and understand how it will be used. We want to foster a sense of ownership. It will be important to listen carefully to people's values, with follow-up on how their values will be considered and incorporated. It is important to stress what landowners are doing and have done on their own. They are out ahead of this Plan in many ways.

LHCC members also discussed encouraging a social gathering following the meeting. Left Hand Brewery said they would support the process, but there are concerns about having alcohol, particularly related to an event sponsored by the County and other government agencies. LHCC members agreed not to include beer. We discussed having root beer, pizza and/or other food.

LHCC Operating Agreement

At the first LHCC meeting we discussed basic principles of members' roles and responsibilities, communications protocol, decision-making and project prioritization, and other aspects of the Coalition's mandate and how it will operate. The Project Team drafted a document based on that discussion and highlighted key points. It is attached with this meeting summary. They asked for members' review and edits by the end of the day Monday, 7/21. They will bring a final document for review at the next Coalition meeting.

Members discussed a concern about **ranking** projects by strict priority in the Master Plan. Longmont was just turned down for a large CDBG grant. The group discussed how this could happen under a strict priority system, where a project is not identified as a top priority for the Watershed as a whole. Members agreed there will be different funding sources for different types of projects, and the Plan should be attuned to these nuances, focusing on different types of criteria for ranking rather than going with straight ranking. The Plan should be able to characterize projects that are most suited to different types of funding sources.

This led to a discussion about **how funding would be pursued** for projects identified in the Plan, and **what role** the Coalition will play. LHCC members discussed how they would give letters of support for projects identified in the Plan and considered by the Plan to work toward good Watershed management, but different entities will pursue implementation depending on the project. Some projects will also happen independently of the Plan; for some projects, implementation will involve private lands. The process of **recommending projects** will require discussion, collaboration and negotiation regarding the elements and priorities of the final Plan.

Regarding **membership on the Coalition**, LHCC members said they welcome having others join, particularly groups representing landowners. There was discussion of ensuring any member can represent broad interests in the Watershed and/or in a stream reach. Membership should be solidified by the time the LHCC is considering elements of the Master Plan itself. The Coalition may also morph or lead into the creation of something else following Plan adoption.

NEXT STEPS & ACTION ITEMS

- Please post and circulate public meeting flyers
- Specific materials to provide to Project Team:
    - ❖ Jeff Crane will email landowner stewardship materials
    - ❖ AMEC follow up with Mark Williams - data/studies from James Creek Watershed
- Send edits to Themes Summary and Operating Protocol by end of day Monday 7/21
- Send Project Team any relevant education-related resources
- Send contacts you want to include on public outreach database for Master Plan
- Next meeting tentatively scheduled for **Monday, 7/28 at 1:30pm** in Boulder

MEETING ATTENDEES

	Name	Affiliation
1.	Luke Swan	AMEC
2.	Hillary King	AMEC
3.	Julie McKay	Boulder County
4.	Jesse Rounds	Boulder County
5.	Stacey Proctor	Boulder County
6.	Diane Malone	Boulder County
7.	Ryan Golten	CDR Associates
8.	Laura Sneeringer	CDR Associates
9.	David Hollingsworth	City of Longmont
10.	Larry Rogstad	CO Parks and Open Space
11.	Jeff Crane	CO Water Conservation Board
12.	Don Moore	CO Office of Emergency Mgmt. State Recovery Liason
13.	Mark Williams	James Creek Watershed Initiative
14.	Janice Lopitz	Keep It Clean Partnership

15.	Terry Plummer	Left Hand Ditch Company
16.	Darwin Williams	Left Hand Water District
17.	Joni Burr	Longmont and Boulder Valley Conservation Districts
18.	Nancy McIntire	Longmont and Boulder Valley Conservation Districts
19.	Boyd Byelich	NRCS
20.	Doug Lyle	St Vrain & Left Hand Conservancy District
21.	Dan Cenderelli (via phone)	U.S. Forest Service
22.	Sylvia Clark	U.S. Forest Service
23.	Katie Jagt	Walsh Environmental

Left Hand Creek Coalition (LHCC) Meeting Summary

Date: August 11, 2014, 1:30-3:30pm
Location: BoCo POS Building, Prairie Room South (and by conference call)

WELCOME AND INTRODUCTIONS

LHCC and Project Team members re-introduced themselves and reviewed the proposed agenda. See below for list of meeting attendees.

MEETING PURPOSE

The purpose of this meeting was to provide a project status update, debrief the Coalition on the public meetings, and refine the planning and outreach process for the next and remaining phases of the project.

STATUS UPDATES AND ANNOUNCEMENTS

Work Plan and Schedule. The AMEC team pointed out a long scheduling gap at the end of the project, after the initially-proposed final public meetings and before the plan must be completed and adopted. Because of this extra time, AMEC requested additional time to finish fieldwork (which is behind at this point), conduct analysis, and present the draft plan, provided that the ultimate end date for the final deliverable stays the same. The schedule for this assumes a draft plan which incorporates Coalition input before being shared at a public meeting for one last chance to identify any major gaps or flaws. The Coalition agreed to this plan. Revised dates will be provided in the attached Work Plan. [Can you attach the updated Work Plan to this meeting summary?]

Based on this revised schedule, we will push out, by 2 weeks, the schedule for the first draft recommendations to be circulated with the Coalition. The Coalition emphasized it is important to be clear on when AMEC will have first unveiling of candidate projects, and to do this incrementally on a rolling-out basis, so there are no huge surprises at the end.

The following steps need to happen in the next few weeks:

Aug 26th-Sept 15th:

- Email blasts to community, in general every 2 weeks
- Discussion about possible 'neighborhood meetings'
  - There may be ways that Coalition members can help with small group communication
  - It may not work to do a neighborhood meeting in one area and not another – we would need to be consistent across the watershed
  - We need to determine when we can put detailed maps in front of folks so they have a chance to give input about whether the maps are reasonable
  - AMEC will talk with landowners when doing field work on the stream
  - We need to provide landowners an opportunity to review project documents and give input by email during certain period of time for each reach

Sept 15th meeting:

- We are sharing a lot of info at this next meeting – a lot of info will be sent in advance, including results of field assessments
- The focus will be is to review and develop consensus on prioritization criteria
  - Prioritization Criteria will incorporate public input (reach-specific "values" and priorities from residents, shared in small groups during public meetings)
  - They also include considerations such as threats to human health/life; threats to property/infrastructure; low-hanging fruit (low cost, high impact); and other cost-benefit considerations

After Sept 15 – Coalition vetting of preliminary strategies and draft plan components

- Possibility of different members of Coalition looking at different sections of the draft plan
- Public Meetings on October 15th and 16th – the Coalition has a chance to ensure that the Plan is in a good place and also that it is not FINAL before going to the community

Field Work. AMEC is doing field work in coordination with Walsh. Though we are not doing all of the field work together, we are regularly checking in with each other. Luke and Katie did reconnaissance to identify sub-reaches based primarily on geomorphic breaks since energy influences them, but we're also trying to have generally consistent sizes and other standards for each sub-reach. The plan for conducting field work includes:

- Looking at the diversion from St. Vrain to James Creek
- Starting in the upper watershed and moving downstream
- Looking at pre-flood and post-flood DEM (digital elevation model), enabling us to see how the stream corridor has changed
- Property lines will be determined so we can ensure that we have all the necessary access forms
- We will generate map books that help ensure Katie, Luke and Graeme are in the right place when in the field
- A risk assessment form was developed using the RiverStyles approach. This approach allows us to bring more observational analysis in on specifics such as vulnerable infrastructure and high flood marks so the analysis is not purely geomorphic.

Based on the field work and analysis of other sources, AMEC will develop geomorphic risk assessment by reach. This will be color coded in a simple way so it's easy to grasp high/low risks. The ecological risk assessment Walsh is doing will also be incorporated. This will be presented first to the Coalition for review/refinement, and then to the public.

Data sources. An annotated bibliography is in development. Input has been solicited from the Coalition to identify any sources that should be included in the bibliography. This will be posted on the project website so others can reference the information and identify any key gaps.

Community Engagement. The website will serve as the primary method of interaction with the community. This will be updated with relevant information when updates become available. Blog posts with important updates will be added to the website. An e-mail blast is a critical component of next steps so people know to go to the website. We will send an email blast roughly every 2 weeks and update the website every 1-2 weeks.

We don't have the resources to meet with neighborhood groups at this point, although we will sometimes have the opportunity to meet with residents while we are in the field. We're happy to do this and will manage in a way that field work doesn't get slowed down too much.

After field work is done, there will be a very dynamic 1-2 week period in which AMEC will provide a reach by reach overview on the project website, and people will be encouraged by email to look closely at their reach, risk assessments, and list of potential projects.

As we transition from this watershed master planning process to long-term watershed organizing, we need to reframe how we talk about the last round of meetings for this process. It needs to be made clear that this is a long-term ongoing process even after the master plan itself is completed.

Long-term watershed organizing. Coalition members discussed the issue of how to move the Coalition-building process to the community, e.g., mission/vision statement, fiscal agent, members, etc for future watershed funding. A goal is to have this structure ready for CDBG funding. The State plans to focus on this model for future watershed funding. The County is supportive of this long-term watershed organizing, but acknowledged it is not within scope of this contract. Community engagement has to be carefully managed within this contract due to resources. Boulder County staff will help with this effort outside the master plan process.

In order to transfer the watershed organizing work to the community, the Plan can include a section on recommendations for how to implement this. A subgroup of the Coalition, led by Jeff Crane and Julie McKay, will meet to begin laying the foundation for these future efforts and coordinate as necessary with the consultant team, asking CDR for key community contacts/leaders as is useful. Neighborhoods may be a good source for community contacts and leaders. It needs to be determined if there are enough leaders in the different levels to have some representatives come to future Coalition meetings and act as liaisons for their communities. CDR has started to identify key leaders for Streamcrest, Nugget Hill, Oxford Lane, Brigadoon Glen, etc.

In terms of meeting attendance, all Coalition meetings are open to the public. It will be important to ensure people understand they are working Coalition meetings, rather than public-input meetings, and that there will be limited time for public input.

Key lessons learned from public meetings (see power point presentation). About 10 coalition members were present at each of the public meetings, on 7/31 and 8/6. The Lower Watershed meeting split into four facilitated groups, while the Upper Watershed meeting attendees split into three groups. The opening remarks at each meeting helped set the stage for the large groups and small group discussions. People provided feedback that they appreciated the facilitated groups and the focus on the whole watershed. Many people expressed interest in stewardship and want education on how they can help. Another key takeaway was that funding for projects identified by the master plan can theoretically be used for projects on private lands.

ISSUES AROUND COST AND REALISTICALLY FUNDING THE PLANS

Expense in relation to flood level. Naren Tayal with FEMA Region 8 stated that the Coal Creek Plan showed that designing projects to the 100 year floodplain was much more expensive than the 10 and 25 year ($42 million, $30 million vs. $10 million). The same issued was found in Jamestown. We may need to find a way to educate people about this so we are not setting unrealistic expectations. It's uncertain whether people understand how high true implementation costs can be. There is simply not enough money to build flood mitigation/resiliency projects to the level of protection that people want. In order to raise awareness about this, the State has an "unmet needs list" that can be shared (contact Olivia Stinson). It is best to be transparent with the public about the cost information.

Funding sources. The CDBG-DR implementation plan is open for public comment until the end of August. Boulder County will start an initial draft response and others can add to it. DOLA also provides money for individuals. Some people may want to do smaller applications. The CWCB has also awarded several grants for watershed restoration projects in the Left Hand Creek Watershed, including:

- $200,000 was awarded for restoration work for a 1.5 mile long stretch along James Creek. CDBG match funds will be pursued. It is also worth investigating if any road recovery efforts can be used as match.
- Lefthand Water was awarded $9,000
- Stephen Strand, a local landowner who has been involved in community efforts, also received CWCB award money.

Groups such as Wilderness Restoration Volunteers (WRV) and Trout Unlimited have substantial experience in restoration activities. Rocky Mountain Flycasters (the Loveland, Fort Collins, and Greeley chapter of Trout Unlimited), working closely with John Giordanengo with AloTerra Restoration Services and the Chair of the Big Thompson Restoration Coalition, secured a CWCB grant to do riparian restoration and plant propagation program in each of the flood impacted drainages, including Left Hand Creek. They would like to coordinate with this group about conducting restoration activities on Left Hand Creek. The Town of Lyons is also receiving several grants and outlining what funds can be used to match which grant awards.

Funding discussion in Plan. It's important to consider what should go into the Plan in terms of a funding source discussion, given that many of the current sources will be out of date or otherwise unavailable by the time the final deliverable is produced. The best option may be to provide links to information in the plan, without getting into a discussion of pitfalls, etc. The funding discussion should identify the types of programs that are out there. Basin Roundtables will be an important source, as well as CDPHE, a plethora of private foundations, Red Lodge Clearinghouse, Colorado Watershed Assembly, El Pomar, Gates, Coors, etc. Jeff Crane and other Coalition members will help AMEC identify relevant funding sources in the plan. This plan could also be a way to incorporate environmental issues into watershed master planning. The Plan will need to note what types of activities can be funded by each source. For example, CDBG cannot be used to fund grant-writing.

Important funding and implementation considerations to discuss in the plan include:

- Coalition development/ institution building (this could be added to the resource section)
- Training programs – e.g., a river network to set up training programs for the Coalition
- Key contacts, including Olivia Stinson, Don Moore, and Jeff Crane
- Carol Eukarius of the Coalition for the Upper South Platte has valuable information on best practices and should be contacted.
- UDFCD membership– the benefit of being within UDFCD's jurisdiction is that they have a lot of money. However, changing jurisdiction is very difficult.

Fiscal agent. An issue with some of these funding sources is the need to have a fiscal agent who can receive federal and state funding. Eligible entities can sometimes represent other stakeholders that would be ineligible on their own. Olivia Stinson is currently examining this issue with FEMA work. Important findings and lessons learned include the large capacity needed for absorbing and managing grants. For example, accountants are needed to review receipts, and some smaller communities don't have the workforce capacity for this. This process has a big learning curve, and we don't want to promote cumbersome funding that's hard to manage in front of a community that doesn't have a qualified fiscal agent to take on this endeavor. Currently available DOLA trainings, such as 101 Grant Writing, don't meet the level of expertise needed to manage state and federal grants.

Next Steps & Action Items

- AMEC will connect with Chris Taggert from Baker to determine what assumptions, modeling and hydrology are used for this watershed. Boulder County is having discussions internally to ensure consistency across watersheds (e.g., are the same assumptions being used for all 3 master plans; what does that mean as far as next steps with CWCB, modeling for road projects; is there consistency across watersheds and in program areas such as floodplain mgmt, private crossings, etc.). Chris Taggert from Baker is helping to resolve consistency issues.
- AMEC will send out summary of the field info collected this and next week. Input is needed from the Coalition to ensure we got everything that people think we need to be looking at.
- Next meeting scheduled for **September 15th at 1:30-4:00pm, BoCo Parks & Open Space, Parks Prairie Room South, 5201 St. Vrain Rd , Longmont**
- AMEC will update Work Plan with Coalition feedback and circulate for next meeting – including public meeting dates

Meeting Attendees

	Name	Affiliation
1.	Graeme Aggett	AMEC
2.	Luke Swan	AMEC
3.	Julie McKay	Boulder County
4.	Jesse Rounds	Boulder County
5.	Stacey Proctor	Boulder County
6.	Diane Malone	Boulder County
7.	Bridgette McCarthy	Boulder County
8.	Ryan Golten	CDR Associates
9.	Laura Sneeringer	CDR Associates
10.	Jeff Crane	CO Water Conservation Board
11.	Don Moore	CO Office of Emergency Mgmt. State Recovery Liason
12.	Olivia Stinson	CO Office of Emergency Mgmt. State Recovery Liason
13.	Naren Tayal	FEMA Region VIII
14.	Mark Williams	James Creek Watershed Initiative
15.	Joni Burr	Longmont and Boulder Valley Conservation Districts
16.	Boyd Byelich	NRCS

Left Hand Creek Coalition (LHCC) Meeting Summary

Date: September 15, 2014, 1:30-4:15pm
Location: BoCo POS Building, Prairie Room South (and by conference call)

WELCOME AND INTRODUCTIONS

LHCC and Project Team members re-introduced themselves and reviewed the proposed agenda. See below for list of meeting attendees.

MEETING PURPOSE

The purpose of this meeting was to provide a project status update, debrief the Coalition on field work and analysis completed to-date, and refine the planning and outreach process for the next and remaining phases of the project.

STATUS UPDATES: RISK ASSESSMENTS

Before going into detail on the Work Plan revisions, the AMEC team presented a status update on field work and risk assessments that had been completed since the August 11th Coalition meeting. The overall goal of the risk assessment is to determine flood hazard vulnerability and, based on that information, prioritize reaches for future projects. There are three major components of the risk assessment: flood (sorting out the regulatory floodplain status), geomorphology, and ecology.

Luke Swan first discussed the flood risk assessment. Field work and meetings with private property owners were key components of the flood risk assessment. The AMEC/Walsh team was able to meet with several property owners during field work and get firsthand accounts of what happened on individual properties during and after the September 2013 floods. A number of private property owners and Lefthand Ditch Company have implemented flood control projects since September. Some of the projects on private property are not safe; they were intended to be temporary emergency fixes, and in their current state these projects could potentially exacerbate flood impacts during future events. These projects must be taken into account when refining the risk assessments and developing recommendations for the Master Plan.

The GPS camera proved to be very useful during field work and the neighborhood meetings. GPS photos enabled AMEC to document the current state of the channel, identify locations that will be revisited during analysis and project development, and tie a specific location to individual property owners (shown in the photos). The GPS photos are organized in a database.

Other key components of the flood risk assessment are channel alignment and significant changes in geometry. Both channel alignment and stream geometry are closely tied to aggradation and scour. AMEC mapped scour and aggradation zones throughout the watershed. Another contributing factor to the level of flood risk in the watershed is the fact that many bridges and culverts are undersized. This issue, in combination with aggradation and channel realignment, has likely caused a rise in Base Flood Elevations (BFEs) in several locations. This means that some homes may now be located in the Special Flood Hazard Area when they previously were not. Identifying the areas that have new BFEs will help facilitate the floodplain development permit process.

The flood risk assessment will also be informed by existing studies such as Flood Insurance Studies, CDOT draft hydrology, and interim flood work. Doug Lyle mentioned that Lefthand Ditch Company had obtained a new hydraulic model from an engineer and submitted the model to Boulder County as part of a floodplain development permit application. AMEC will reach out to Boulder County to get this hydraulic model.

Next, Luke Swan and Graeme Aggett discussed what methodology was used to develop the geomorphic risk assessment. Field forms were used to evaluate the geomorphologic condition of each reach, using criteria such as valley confinement, bed morphology, pebble count, sediment dynamics, etc. This information was analyzed to help group reaches by properties and similar geomorphologic processes. This approach of organizing reaches by processes is known as River Styles. River Styles evaluates reaches with similar character, behavior, evolutionary traits, causes of change, and likely future. AMEC ended up with six different River Styles for the watershed using this methodology, and a list of geomorphic conditions was created for each of the six River Styles. Based on these conditions, AMEC can rank each reach as poor, fair, or good and make project recommendations that seek to improve these rankings.

The processes and conditions seen in each River Style can be used to estimate a future trajectory for the reach. Determining the future trajectory can help identify project priorities in reaches with particularly severe flood hazards. Identifying likely future trajectories also enables the AMEC team to design projects that work with the stream's evolutionary process rather than against it.

Debris flow and landslide channels were also identified during the risk assessment process. USGS has a post-flood landslide risk assessment; AMEC will reach out to USGS to obtain this information.

Katie Jagt spoke next and explained to the Coalition what criteria were used to develop the ecological risk assessment. The ecosystem risk assessment focuses on the physical structure and condition of a stream corridor, with healthy ecosystems displaying a complex and diverse set of features. The Stream Visual Assessment Protocol Version 2 (SVAP2) was used to evaluate the condition of the reaches based on five criteria: channel stability, water quantity, water quality, vegetation, and instream habitat. The criteria are based on several element scores, although salinity, nutrient enrichment, and water appearance were not included in the analysis due to the currently unstable, post-flood nature of Left Hand Creek.

Once the SVAP2 analysis was complete, reaches were classified into one of five categories from severely degraded to excellent. The SVAP2 evaluation was used to identify ecological deficiencies, as well as restoration goals and objectives. Katie provided preliminary recommendations and suggestions by reach for improving the ecological assessment score. The overall recommendation is to put in more holistic projects instead of temporary emergency fixes. One example provided was instating a minimum flow requirement for every reach, so that no part of the stream would run dry any time of the year. The Coalition discussed how to regulate this suggestion. Would it rely on the honor system, or would some kind of state oversight be needed?

These questions fed into a more general discussion about how to prioritize recommendations based on needs and values of the stakeholders in the Left Hand Creek watershed. For example, a minimum flow requirement might make certain stakeholders in the watershed happy while interfering with other stakeholders' interests. These potential conflicts of interest need to be taken into account when developing projects and recommendations.

The Coalition also emphasized the need to be conscientious of the language used for rankings. Terms such as poor, fair, and good can inadvertently put people on the defensive. The Coalition's review process will be vital to refining the language in the Master Plan.

Next the Coalition discussed the project ranking criteria. The Coalition will weigh in on the project ranking criteria, and then AMEC will continue to move forward with developing the projects. The Coalition determined that potential funding should not be used as a ranking criterion. However, the Master Plan should be written in a way that is tailored to going after funding. Safety will be used as one of the main criteria. Development of the criteria will take feedback from the first round of public meetings into account. The Coalition pointed out that people may prioritize values and projects that they personally find relatable.

AMEC's next step is to develop a list of projects based on the risk assessment, giving the Coalition something to react to. AMEC will take a two-tiered approach with the recommendations: projects AMEC is certain about and projects that need more input from the Coalition. Challenges, limitations, feasibility, and sustainability of projects need to be taken into account during the prioritization/ranking process.

STATUS UPDATES: WORK PLAN AND ANNOUNCEMENTS

Work Plan and Schedule. The AMEC team and the Coalition reviewed the Work Plan together and decided to push deadlines out one week. This will allow time for the AMEC team to develop a Draft Plan for the Coalition to review prior to the public meetings. Draft chapters will be submitted to the Coalition for review as they're completed, rather than having the Coalition review everything at once. Draft chapters will be sent in Word Document format to the Coalition so track changes can be used to record edits. Once the Coalition review is complete, AMEC will develop an Executive Summary for the public to review in lieu of making the entire draft available. The Executive Summary will list the recommended projects by reach. The public will also be able to review and comment on reach maps and recommendations on the project website.

The public meetings were pushed back one week to accommodate draft development and review. Although the previous plan was to use the Greenbriar Inn again, the Coalition determined that other venues may be better suited to the second round of public meetings. Suggested venues are provided in the attached Work Plan.

The following steps need to happen in the next few weeks. Please refer to the attached Work Plan as well.

- ***Week of September 15th – September 19th***
    - Coalition Meeting – Review results of field work; Plan outline; Final Meetings
    - Complete Risk Assessment mapping/pre-post flood conditions analysis
- ***Week of September 22nd – September 26th***
    - Identify project prioritization criteria and project options by reach
        - Review and refine prioritization criteria

        - Quantitative examples – e.g., $/damage (proxy for degree of impact); # of people impacted; estimated project costs
        - Qualitative – what's most important to people in specific reaches – e.g., safety – human/property; habitat/natural setting, debris, etc.
    - Explain impacts of applying project options to prioritization selections; get feedback and refine (email blast to Coalition and stakeholders to alert everyone to the information posted)
- Purpose:
    - Review potential project options (design examples, and examples of potential locations; assess cost effectiveness of options)
    - Run project options through proposed prioritization criteria – get feedback about possible project priorities by reach, including potential opportunities (e.g., project matches) or constraints (e.g., permitting)
    - 1-week period (09/23 – 09/29) to get reach-specific feedback on project priorities (includes Coalition meeting following Monday)
- Draft plan writing

- ***Week of September 29th – October 3rd***
    - Coalition meeting Monday 29th
    - Review feedback on prioritizations and project plan options and give reach-specific feedback on this via the website (email blast to Coalition and stakeholders to alert everyone to the information posted)
        - Update progress on web site – ensure project options are presented clearly and can be related back to prioritization criteria
    - Draft plan writing
    - Announce public meeting (to roll out final Plan and discuss implementation): send email blast

- ***Week of October 6th – October 10th***
    - Draft plan writing
    - AMEC submits Draft Plan to Coalition on October 10th

- ***Week of October 13th – October 17th***
    - Send out Public Meeting notice/email blast

- ***Week of October 20th – October 24th***
    - Coalition comments on Draft Plan due on October 20th
    - Send out Executive Summary for public review
    - FINAL PUBLIC MEETINGS
        - Suggested dates - Wednesday, October 22nd and Thursday, October 23rd
        - Upper Watershed meeting at Jamestown Town Hall?
            - Graeme to reach out to Tara Schoedinger about this
        - Lower Watershed meeting at BoCo Fairgrounds, Haystack, Side Links, St. Vrain School District or BoCo POS Building?
        - Have meeting with large group first and then break out into groups by reach
        - Focus is to <u>explain</u> the Plan and project recommendations, and discuss implementation/next steps
            - Gather input on who wants to be involved in future and how
            - Each reach will have a table for discussion and final comments after presentation

- Possibly have a long-term watershed Coalition sign-up table

- ***Week of October 27th – October 31st***
  - Public comments on Executive Summary due on October 31st
  - Incorporate edits into document

- ***Week of November 3rd – November 7th***
  - Incorporate final edits into document

- ***Week of November 10th – November 14th***
  - Final Coalition meeting on November 10th to discuss final edits to Plan and next steps
  - AMEC team submits Final Master Plan to Coalition on November 14th

Ongoing Community Engagement. The website and emails blasts will continue to serve as the primary method of interaction with the community. This will be updated with relevant information when updates become available. Details on the public meetings will be posted to the website when they are finalized.

AMEC will provide a reach by reach overview on the project website, and people will be encouraged by email to look closely at their reach, risk assessments, and list of potential projects.

Long-Term Watershed Organizing. Julie McKay gave a presentation on Boulder County's long-term watershed planning efforts. A major effort is the Comprehensive Creek Planning Initiative, which will determine where Boulder County goes with watershed organization after all the watershed master plans are complete. Considerations for post-master plan efforts include project implementation, funding, agency coordination, and Coalition expansion and structure. The County must determine its capacity for engaging in future creek recovery efforts. BoCo anticipates that there will be a high level of interest in having the County help with projects located on county-owned and managed lands, as well as projects located on private lands where a need for public safety is an issue. The County may take a leadership role or a supporting role depending on the project type. BoCo would like to use the Coalition structure to continue to facilitate collaboration with stakeholders to implement projects. The Coalitions can also help obtain state funding for watershed recovery, such as Community Development Block Grant-Disaster Recovery (CDBG-DR) Round 2 funds. The State of Colorado would also like the see the Coalitions continue to go after funding and implement projects identified in the master plans. Participating entities and organizational structure needs to be determined at the Coalition level, as each watershed is different. This will be discussed in further detail at the September 29th Coalition meeting.

NEXT STEPS & ACTION ITEMS

- Finalize public meeting venues
- Coalition to review Draft Outline and submit feedback
- AMEC to reach out to Boulder County and USGS to obtain existing studies
- AMEC team to finalize project prioritization criteria and rankings for Coalition review
- Next Coalition meeting scheduled for **September 29th at 1:30-4:00pm, Rembrandt Room, FRPIC basement, 1301 Spruce St., Boulder**

- AMEC will update Work Plan with Coalition feedback and circulate for next meeting – including public meeting dates
- AMEC will submit Draft Plan chapters to the Coalition for review as they are completed so the Coalition does not have to review hundreds of pages of information at once

Meeting Attendees

	Name	Affiliation
1.	Graeme Aggett	AMEC
2.	Luke Swan	AMEC
3.	Hillary King	AMEC
4.	Katie Jagt	Walsh Environmental
5.	Julie McKay	Boulder County
6.	Jesse Rounds	Boulder County
7.	Stacey Proctor	Boulder County
8.	Diane Malone	Boulder County
9.	Janice Lopitz	KLC Partnership
10.	Joni Burr	Longmont and Boulder Valley Conservation Districts
11.	Darwin Williams	Lefthand Water District
12.	Olivia Stinson	CO Office of Emergency Mgmt. State Recovery Liaison
13.	Naren Tayal	FEMA Region VIII
14.	Mark Williams	James Creek Watershed Initiative
15.	Doug Lyle	SVLHWC
16.	Sean Cronin	St. Vrain/Left Hand Water Conservation District
17.	Dan Cenderelli	Arapaho & Roosevelt National Forests (USFS)
18.	David Hollingsworth	City of Longmont

Left Hand Creek Coalition (LHCC) Meeting Summary

Date: September 29, 2014, 1:30-3:30pm
Location: Rembrandt Building, 1301 Spruce St., Boulder

WELCOME AND INTRODUCTIONS

LHCC and Project Team members reviewed the proposed agenda. See below for list of meeting attendees.

MEETING PURPOSE

The purposes of this meeting were to provide a project status update, review and refine project criteria and prioritizations, discuss ongoing efforts for long-term Coalition building, and refine the planning and outreach process for the next and remaining phases of the project.

REVIEW AND REFINE PROJECT CRITERIA AND PRIORITIZATIONS

Luke Swan, Graeme Aggett and Katie Jagt presented their technical work update to the Coalition. This update included a discussion of project development, project prioritization, and an overview of the spreadsheet tool developed to help organize and rank proposed projects. The projects were developed using a combination of input from the Coalition and the public, as well as the fieldwork and risk assessment results. Brigadoon Glen and Oriole Estates were used as examples to help explain how the suggested projects were developed. Some of the private property owners in these reaches have also implemented their own projects (perhaps not legally) that need to be taken into consideration. The high-level treatment plan for these reaches is to realign small segments of the channel to create more direct crossings, and possibly floodproof at-risk structures. Issues that need to be addressed in the Upper Watershed include emergency, temporary berms created by property owners that may not be safe.

In general, the projects to address flood risk include increasing channel capacity and lowering the base flood elevations (BFEs). Projects for mitigating geomorphic risk include managing erosive power and addressing bank stability issues in sediment source zones. Projects to improve ecosystem health involve improving channel complexity, adding large woody material, creating benches, and establishing low-flow channels. AMEC may also provide property acquisition recommendations. Boulder County and Jamestown have already applied to the Hazard Mitigation Grant Program (HMGP) to acquire several properties, so AMEC will check these lists to determine if they would have proposed acquiring any of the same properties. The AMEC team reiterated that these projects are preliminary and will be refined with input from the Coalition and the public. The Coalition suggested tying projects to existing plans, policies and regulations. AMEC will also meet with AECOM to tie projects into the roadway design effort. A third consulting, working for Boulder County, will look at the projects and designs in the finished Master Plan along with the road designs to ensure that ecosystem health is integrated.

The PowerPoint presentation contained a few hand-drawn sketches of the proposed projects. The AMEC team asked the Coalition if they would like to see the hand-drawn designs or computer-aided designs (CAD) in the final plan, or a combination of both. An advantage of the hand-drawn designs is their accessibility to lay people who are less familiar with engineering schematics. This makes the hand-drawn designs more inviting for community input on projects.

Next the AMEC team walked the Coalition through the prioritization spreadsheet tool. The tool currently uses a fair/better/best ranking system to evaluate how projects mitigate flood/geomorphic/ecological risk, as well as how those projects meet the values and priorities identified by the Coalition and the public. In order to optimize project prioritization, several factors need to be examined including implementation timing, cost, impacts, resiliency, feasibility, and benefits. The Coalition members debated about using cost as a criterion. It was ultimately determined that preliminary costs are useful, but it may not be the ultimate deciding factor when the Coalition pursues funding to implement projects. The Coalition also asked for clarification on what fair, better and best mean exactly, and suggested using different criteria such as low/medium/high rankings, a color coded system, or a numerical ranking. Using a numerical prioritization system was a topic of some debate. It is difficult to quantitatively rank projects, especially across reaches. Also, if the ultimate objective is to implement all projects identified in the master plan (or at least as many as possible), then the priority order may not matter. Furthermore, strictly following a ranking system may not be the most advantageous approach either; there is some benefit to pursuing projects that are “low-hanging fruit” for the purpose of demonstrating success and building support. However, some projects create interdependencies with cascading effects on other reaches. In these cases, prioritization and order of implementation *does* matter because these projects must be executed first.

AMEC’s next step is to take this feedback and give the Coalition a list of projects to react to. The list should include suggested priorities based on the criteria discussed during the meeting, focusing on projects that can realistically be funded, address risk/safety needs, and meet constituent needs. AMEC will also identify interdependencies, such as when an upstream project will affect downstream projects. This list will be posted to the project website by the end of the week, along with maps. High level feedback from the Coalition is needed by Tuesday (October 7th). The Coalition should focus on identifying projects that need more info or create concerns.

The Master Plan will also capture other projects that are underway or planned.

STATUS UPDATES: WORK PLAN AND ANNOUNCEMENTS

Work Plan and Schedule. The AMEC team and the Coalition reviewed the Work Plan together. Most of the deadlines remain the same from the previous revisions. The draft plan will be shared with the Coalition on October 10th. The primary difference is that the Coalition’s initial comments on the draft plan and the Executive Summary are now due on October 17th to allow time to incorporate comments into the Executive Summary prior to the public meetings. The Executive Summary will be sent to the public in advance of the meetings so they can get an initial understanding of what information and findings are included in the draft plan. The draft plan itself will be made available for public review on October 27th. Comments on the public review draft will be due on October 31st. The public will also be able to review and comment on reach maps and recommendations on the project website.

The public meetings are scheduled for Wednesday, October 22nd at the Jamestown Town Hall and Thursday, October 23rd at the Boulder County Parks and Open Space Building in the Prairie Room. Both meetings are scheduled from 6:00pm until 8:30pm.

The following steps need to happen in the next few weeks. Please refer to the attached Work Plan as well.

Week of September 29th – October 3rd

- Coalition Meeting, September 29
    - Review feedback on prioritizations – finalize with Coalition
- Review project options and request reach-specific feedback on this via the website (email blast to Coalition and stakeholders to alert everyone to the information posted)
    - Update progress on web site – ensure project options are presented clearly and can be related back to prioritization criteria
- Draft plan writing
- Announce public meeting (to roll out draft Plan and discuss implementation): send email blast

Week of October 6th – October 10th

- Draft plan writing
- October 7th – Coalition comments on proposed projects due (projects posted to website)
- AMEC submits Draft Plan to Coalition on October 10th

Week of October 13th – October 17th

- Send out Public Meeting notice/email blast
- Distribute Executive Summary to Coalition for review
- Coalition comments due on Executive Summary on October 17th
- Initial Coalition comments due on Draft Plan on October 17th (high level review pointing out any red flags)

Week of October 20th – October 24th

- Coalition meeting, October 20th (location TBD)
    - Review of Draft Plan recommendations
- Release Executive Summary to public on October 21st prior to public meetings
- PUBLIC MEETINGS
    - Wednesday, October 22nd at the Jamestown Town Hall and Thursday, October 23rd at the BoCo POS Building, Prairie Room
        - Both meetings from 6:00pm – 8:30pm
    - Have meeting with large group first and then break out into groups by reach
    - Focus is to explain the Draft Plan and discuss implementation/next steps
        - Gather input on who wants to be involved in future and how
        - Each reach will have a table for discussion and final comments after presentation
        - Have a long-term watershed Coalition sign-up table

Week of October 27th – October 31st

- Public review draft plan goes out on 27th
- Public comments on Executive Summary and Draft Plan due on October 31st
- Coalition written comments on Draft Master Plan due 10/31
- Incorporate comments, feedback into document, address concerns and reconcile differences

Week of November 3rd – November 7th

- Incorporate final edits into draft document

Week of November 10th – November 14th

- Final Coalition meeting (DATE TBD WITH DOODLE POLL) to discuss Public and Coalition feedback, modifications to draft, final edits to Plan and next steps – consider

distributing Final Plan, with changes from draft, to Coalition before this meeting so members can bring any changes to the 11/10 meeting
- AMEC team submits Final Master Plan to Coalition on November 14th

Conferences. The Colorado Watershed Assembly is hosting the 2014 Sustaining Colorado Watersheds Conference in Avon from October 7-9, 2014. Julie McKay is attending this conference and invited other members of the Coalition to attend as well.

Ongoing Community Engagement. The website and emails blasts will continue to serve as the primary method of interaction with the community. This will be updated with relevant information when updates become available. Details on the public meetings will be posted to the website when they are finalized.

AMEC will provide a reach by reach overview on the project website, and people will be encouraged by email to look closely at their reach, risk assessments, and list of potential projects.

Long-Term Watershed Organizing. Julie McKay summarized the presentation she gave at the September 15th Coalition meeting on the Comprehensive Creek Planning Initiative (CCPI). Julie and Sean Cronin described some of the organizational efforts implemented by the St. Vrain Creek Coalition that could apply to Left Hand, such as inviting private citizens to a meeting to discuss public participation in long-term watershed organization. Several of the citizens showed interest in being involved in this process during the St. Vrain Coalition meeting. The St. Vrain Coalition determined that future Coalition structure should center around a steering committee composed of agency representatives and members of the public. Something similar may work for the Left Hand Creek Coalition, which already has several established agencies and watershed groups in its membership. One of these existing agencies could potentially “house” the Left Hand Creek Coalition. Julie stated that Boulder County can convene a discussion with the Coalition about how to move forward with this effort. The Coalition decided that they would meet during the week of October 13th. Chris Sturm from CWCB will be invited to participate. The Left Hand Creek Coalition will need to determine its organizational capacity, and members will need to affirm their commitment to collaboration.

Chris Sturm may be able to give additional insight on how Community Development Block Grant-Disaster Recovery (CDBG-DR) funds will be used to help fund the long-term Coalition building effort. CWCB is considering releasing the funds in phases, with initial funds being used for coordinating and formalizing the Coalitions. A second phase of funds would be used for implementing the projects identified in the watershed master plans. This plan is only preliminary and is subject to change. Chris Sturm may be able to provide new information at the meeting during the week of October 13th.

In order to receive funding, the Coalition must have a fiscal agent. Coalition members discussed possibly having a steering committee could advise the fiscal agent. Another important issue in organizing the Coalition for the long-term is establishing its mission and scope. This will also be discussed at the internal Coalition meeting in mid-October.

NEXT STEPS & ACTION ITEMS

- Develop public meeting materials
- Ongoing draft development

- AMEC team to organize list of project recommendations for Coalition to review
- Next Coalition meeting scheduled for **October 20th at 1:30-4:00pm (location TBA)**
- AMEC will submit Draft Plan chapters to the Coalition for review as they are completed so the Coalition does not have to review hundreds of pages of information at once
- AMEC to send Doodle Poll to schedule November Coalition meeting (November 10th conflicts with Sean's district board meeting so several people may not be able to attend a Coalition meeting that day)

MEETING ATTENDEES

	Name	Affiliation
1.	Graeme Aggett	AMEC
2.	Luke Swan	AMEC
3.	Hillary King	AMEC
4.	Katie Jagt	Walsh Environmental
5.	Julie McKay	Boulder County
6.	Jesse Rounds	Boulder County
7.	Stacey Proctor	Boulder County
8.	Diane Malone	Boulder County
9.	Janice Lopitz	KLC Partnership
10.	Peter Ismert	USEPA Watershed Team
11.	Darwin Williams	Lefthand Water District
12.	Olivia Stinson	DHSEM State Recovery Liaison
13.	Naren Tayal	FEMA Region VIII
14.	Mark Williams	James Creek Watershed Initiative
15.	Doug Lyle	SVLHWC
16.	Sean Cronin	St. Vrain/Left Hand Water Conservation District
17.	Nat Miallo	USEPA Disaster Recovery
18.	David Hollingsworth	City of Longmont
19.	Don Moore	DHSEM
20.	Eric Schroder	USFS
21.	Mark Gershman	City of Boulder
22.	Bridgette McCarthy	Boulder County

Left Hand Creek Watershed Master Plan
Themes Report (As of 8/8/14)

The following themes are based on preliminary conversations with over 30 Left Hand Coalition members (which are primarily agency and local government representatives) and other key Watershed stakeholders about the Left Hand Watershed Master Plan and what they hope to see from it. This summary is by no means exhaustive. It serves primarily to help frame some of the issues and questions for public outreach and input during the Master Planning process. It does not incorporate feedback from the landowners and other key stakeholders collected during the July 31st and August 6 public meetings (see separate meeting summaries). Much of the input at the public meetings was consistent with these themes.

Scope and Expected Outcomes

Purpose
The Left Hand Creek Watershed Plan is an opportunity to:

- Conduct coordinated, long-term planning for the entire Watershed as a system. This will include consideration of hazards that impact flooding, such as wildfires.
- Study the post-flood Watershed and recommend and prioritize long-term flood recovery and resiliency, Watershed restoration, and future flood mitigation projects.
- Increase the Watershed's opportunities and competitiveness for federal and state funding. The planning process does not include funding for implementation.

Expected Outcomes

- Flood, geomorphic, and ecosystem risk assessments performed at the reach scale.
- Clarity on what flood map and data sources (e.g., FEMA maps) exist for particular stream sections and identification of needs for future studies.
- A list of guiding principles or prioritization criteria to utilize for future planning (e.g., safety, cost effectiveness and multiple benefits).
- Recommendations on Creek alignment, which will provide guidance for public road alignment and other public and private infrastructure restoration.
- Recommendations on priority projects for long-term flood recovery and resiliency, Watershed restoration and future flood mitigation, and associated funding needs. Examples of projects may include rebuilding stream banks, conducting Watershed restoration, enhancing water quality, reducing sedimentation and protecting diversion structures.
- Identification of available funding resources, including associated requirements and timelines.
- A discussion of implementation strategies – e.g., approaches to pursuing funding; potential role for a Watershed-wide group to coordinate future Watershed efforts.

The Plan will Not

- Change local policies and procedures related to project implementation.
- Override existing Management Plans.
- Be implemented until project funding becomes available.
- Update FEMA maps and affect flood insurance.
- Be a forum for addressing immediate, individual property needs. For residents of unincorporated Boulder County, these questions will continue to be directed to the Boulder County Flood Rebuilding & Permit Information Center (FRPIC) and other appropriate agencies.

Considerations for Master Plan Approach/ Process

Key Considerations
This Master Planning process involves a balancing of:

- Recognizing the Master Plan should include the values and vision of the residents who live in the Watershed and are the long-term individual stakeholders in this process.
- Learning about site-specific stream impacts and principles/values of property owners in order to better understand the functioning of the Watershed and possible options for future recovery, while keeping a system-wide focus.
- Providing landowners with information to help develop knowledge of Watershed-level considerations before asking them about reach-scale planning; ensuring the initial focus of the Master Plan public meetings is educational.
- Recognizing the "meeting fatigue" of residents who were severely impacted by the flood under a year ago, making it particularly challenging to ask residents to engage in long-term planning that will require future fundraising efforts before implementation can occur.
- Using a Coalition of agencies and jurisdictions to steer the process while keeping a focus on engagement of individual residents and neighborhoods (especially given the limitations described above).
- Recognizing the significantly accelerated master planning schedule and time limitations.

Information and Messaging
Our conversations identified the following additional issues to incorporate into public information and messaging. Some information may be provided by compiling available resources and adding them to the project website.

- There is a need to increase understanding of the stream response to the September flooding by describing hydrology basics, what happened during the flood (e.g., significant impacts of debris flow), issues that may have affected the impacts (e.g., Overland Fire and land use issues), and what to expect in the future.
- The Watershed has experienced a significant disturbance event to which it will be adjusting for years.
- The purpose of the Master Plan is to make the Watershed more resilient over time.
- It would be useful to provide guidance for private landowner stewardship of the Creek. To some extent the Master Plan process can address this, including information about impacts on neighbors and the entire Watershed system from private structures in and along the Creek and ditches. This could also include information about floodplain management, permitting requirements, and whom to contact with specific Creek-related issues. A more extensive landowner resource guide could also be a project that comes out of Master Plan.

Implementation Approach
There is a need to clarify how the Plan will be implemented after it is developed, whether the Coalition will have a continued role or presence, and what that role could be. The Coalition could continue to work together to implement the Master Plan, or a specific entity could be designated or formed for this purpose. Likewise, this process could be an opportunity for Watershed residents and stakeholders to coalesce for the purpose of future flood recovery and Watershed protection.

Master Plan Focus Areas

The following Plan focus areas were discussed.

Reduce sediment transport and deposition: Sediment transport has significant impacts by clogging ditches and making it difficult to transport water to users, and impacting aquatic habitat. A focus area will be to recommend strategies for reducing, coping with, and managing the sediment loads likely to be seen in the future.

Recommend woody debris related actions: Woody debris in the Creeks can be helpful from an ecological restoration standpoint, but it also can have negative impacts such as clogging ditches, damaging infrastructure and being deposited downstream. The planning process can help determine an appropriate balance by recommending areas appropriate for the use of large woody debris as a channel stabilizing feature.

Provide irrigation water: The Plan must ensure there is enough flow coming into the ditch headgates to enable allocated irrigation. Existing water rights should not be impacted.

Protect infrastructure and inform design/construction activities: The planning process should focus on protecting infrastructure, such as roads, bridges, the Left Hand water treatment facility, and irrigation ditches against future flood impacts. The planning process will inform the design of current infrastructure projects. For example, Boulder County is not making final decisions on roadway design until after the channel alignment zones are refined, the Watershed assessment may inform the replacement structure that CDOT is designing at the base of the canyon on Highway 36, and the risk assessment will inform requirements for private crossings and access.

Restore aquatic habitat/fisheries and riparian habitat: There have been considerable impacts to fisheries from channelization and the removal of woody materials during emergency flood restoration. The planning process should focus on re-establishing ecosystem function. Woody vegetation (e.g., root wads) should be used where possible to stabilize the channel and promote the re-generation of in-stream habitat. Strategic placement of structures can protect banks, uplands, and infrastructure. As the Creek exits the canyon, it becomes a transition stream with habitat for a number of state threatened and endangered species, e.g., Prebles Meadows Jumping Mouse.

Recommend stream channel design: The planning process can help address issues including erosion of stream banks, property damage and safety issues. The master plan will recommend conceptual-level strategies for stabilizing the channel. Many people emphasized a preference for natural channel design strategies.

Protect and enhance drinking water quality: Some associated considerations include the following:

- **Mine wastes:** There is potential release of low quality water from abandoned mines in the Watershed. There may be opportunities to re-stabilize mines to prevent future impacts.
- **Water quality concerns** associated with spent ammunition from shooting areas, Off-Highway Vehicle (OHV) use and roadway runoff.

Consider key impacts:

- **Safety concerns**
- **Removal of top soil** during the flood had major impacts on land use and associated costs.
- **Weed transport** through sediment/silt (e.g., sheet grass, foxtail and thistle).

Provide information on the benefits and consequences of public and private land management activities, including floodplain management and permitting requirements: Future floods may be mitigated through improved land maintenance such as encouraging an open forest with understory vegetation to better hold soil. Some private property owners have put structures in/along the Creek and ditches. If permits and projects are not reviewed and coordinated closely, there can be undesired consequences on the Watershed system as projects can impact surrounding neighbors or property owners downstream. These can also prevent ditch companies from being able to clean ditches when needed and encroaches on ditch easements. There are many properties in which projects are planned for the fall/winter. Without access to these specific plans, it is challenging to do a comprehensive Watershed assessment. Landowners should understand the benefits and impacts of specific land management activities, including the fact that channel alignment may change significantly, as the Watershed is adjusting from the flood. It would be useful to encourage property owners to hold off on new structures where possible until the Watershed assessment is completed.

Provide input for policy, programmatic, and regulatory issues: The Plan will help address some regulatory questions, including:

- Floodplain Management: The plan should determine which FEMA maps are still relevant for specific stream stretches for obtaining rebuilding floodplain development and other permits, insurance, etc. It should also identify which maps need to be updated, what are the priority areas for remapping, what data is required to meet FEMA's standards and criteria for remapping, and what the timeline/cost is to update the county's FEMA maps.
- Hazard Areas: The plan should identify hazard areas and provide suggestions for how the county might explore new approaches to planning for and regulating development in hazard areas.

Potential Recommendations

Our conversations highlighted several preliminary ideas and recommendations for implementation.

Funding and Partnership Opportunities:

- A CWCB Stream Restoration Grant has been awarded for the Left Hand Creek Watershed.
- CWCB will be managing HUD Community Development Block Grant Disaster Recovery (CDBG-DR) funding.
- NRCS may be able to provide Emergency Watershed Protection Phase II funding.
- The Forest Service may be able to fund projects on non-Forest Service land through the Wyden Amendment if projects support their mission (e.g., fish passage connectivity).
- The Master Plan could help facilitate innovative partnerships – e.g., Trout Unlimited may be willing to research grants to fund fish diversion structures around headgates.
- The state held a Colorado Recovery Funding Workshop last spring that provided information about different funding programs that may be relevant to projects identified in the Master Plan. The Website is: https://sites.google.com/a/state.co.us/coloradounited/get-help-1/financial-and-insurance-assistance
- Utilize volunteers through groups such as the Wildland Restoration Volunteers.

Other Potential Projects/Opportunities (not yet vetted):

- Coordination and integration with other ongoing flood recovery programs and activities (e.g. road reconstruction, development reviews, public and private projects, etc.) For example, Boulder County will be designing Left Hand Road, James Road, and other public transportation facilities. Master Plan recommendations should be incorporated into the design.
- CDOT will be designing a replacement structure at the Highway 36 crossing. Master Plan recommendations could be incorporated into the design.
- After the flood, the Left Hand Ditch reconstructed a headgate in a way in which a fish-passage diversion structure could be incorporated later. There may be other locations in which fish-passage diversion structures could be added.
- Urban Drainage could be designated as a formal entity to coordinate future Creek recovery, functioning and resilience planning through a mill levy. It could identify problem areas, maintain the channel, review permits, etc.
- Currently, much of the cost of sediment removal is being shouldered by ditch companies, Left Hand Water District and private property owners. The Plan may want to consider policy recommendations that identify how to share the cost of sediment removal more broadly since sediment removal benefits the whole community.
- Longmont has developed proposed improvements for the Main Street to Pike Road Phase II project.
- Develop refined guidance for private landowner stewardship of the Creek, possibly in a pamphlet or FAQ sheet format. The idea would be to help the landowner see his/her stretch of the Creek within the context of the broader system. One suggestion was to develop a map for landowners so they can track debris that may come down the Watershed, know where it's likely from, who's coming for it, whom to contact, etc.

LEFT HAND CREEK WATERSHED MASTER PLAN

Purpose of the Watershed Plan

The Left Hand Creek Coalition has launched a process to develop a long-term Master Plan to enhance the resilience of the Left Hand Creek Watershed. This is an opportunity to:

- Conduct coordinated, long-term planning for the entire watershed as a system
- Study the post-flood Watershed and recommend and prioritize long-term flood recovery, watershed restoration and future flood mitigation projects
- Increase competitiveness for federal and state funding

Community Kickoff Meetings

We invite you to attend a meeting to:

- Increase your understanding of the nature of the September 2013 flood event and what to expect in the future
- Learn more about the Master Plan process and how your property fits into broader Watershed planning
- Provide input on focus areas for the Plan
- Learn how you can be involved

Lower Watershed Meeting (East of Hwy 36): Thurs July 31st, 6-8 PM
Altona Grange, 9386 N 39th Street, Longmont, CO

Upper Watershed Meeting (West of Hwy 36): Weds, Aug 6th, 6-8 PM
Greenbriar Inn, 8735 N. Foothills Highway, Boulder, CO

There will be a half-hour open house after the meetings.
The Plan will also be discussed at the Aug 5th Jamestown Community Meeting.

Contact information

For more information, please visit the Left Hand Creek Watershed Master Plan website at: **lefthandcreekmasterplan.com**
Contact the Project Team at: **720-407-4788** or **lefthandmasterplan@mediate.org**

Left Hand Creek Coalition Members

Lefthand Water Oversight Group
Lefthand Ditch Company
City of Jamestown, Colorado

Left Hand Creek Watershed Master Plan
Community Kick-Off Meeting

August 6, 2014 6-8pm, with Open House from 8-8:30pm
Greenbriar Inn, Boulder, CO

LEFT HAND CREEK WATERSHED MASTER PLAN COMMUNITY MEETING

The purpose of the Left Hand Creek Watershed Master Plan kick off community meeting was to announce the beginning of the master planning process, to inform the public on what flood recovery issues will be addressed by the master plan and to let the public know how they can provide input. 58 community members attended the meeting, in addition to nine members of the Left Hand Creek Watershed Coalition, which is overseeing the development of the master plan.

Format: Welcome from the Left Hand Coalition (LHCC); Presentation with large group question and answer; Small group break-out discussions by neighborhood/stream section, which focused on values/vision for the Creek and key focus areas for the master plan (see below).

LARGE GROUP DISCUSSION QUESTIONS

Elements going into the master plan

- Huge debris flow areas – will that be addressed? *Yes, within watershed. Clearly impacted by land management up slope where debris originated.*
- Coordination - USFS role in the process? How OHV area affected? Any time schedules for implementation? *USFS –in data gathering phase, then will plan in winter with environmental analysis.*
- Sizing of culverts on side creeks – many are plugged, may need new ones or resized. *Plan will address "hot spot" culvert issues – where need to be resized, where more needed.*

Possible outcomes of plan

- Managing sediment – deposited during flood, or current / future sediment. *These issues and sources are interrelated. Plan will address "risk" areas for heavy sediment and debris flows.*
- LH Canyon still going to be a bicycle route? *Yes.*

General Qs about Plan

- 1-10y unfunded plan described here – what's funded short-term, especially roads? When will LH Road repairs be completed so residents can re-establish bridges? Are the August and 2015 Boulder County road repairs funded? What's being done about road erosion now and in the future? Where's snow removal in the winter with broken roads? *LH road, from confluence up, will be repaired next year. BoCo is paying and will seek partial reimbursement from FEMA and FWHA. There will be snow removal this winter.*
- Anyone at this meeting from CDOT to address Middlefork Rd plans for bridge or culvert. *CDOT working on bridge design, coordinating with master plan process. Not here tonight.*
- Coordination - MP won't change floodplain maps - how will we get FEMA involved so there's no re-work later? *FEMA is plugged into the master plan process; a rep sits on the Coalition.*

Concerns

- Any testing of water to determine if heavy metals or contamination? Did LWOG monitor Slide Mine area (downstream from Lick Skillet Rd)? How will test results be distributed?

Glenn Paterson from LH Watershed Oversight Group gave an update. Please see http://www.lwog.org

REACH-SPECIFIC SMALL GROUP MEETINGS

The small groups were organized by stream section, or 'reach.' The purpose of the small groups were to (1) hear from residents in that section what values and vision they have for their section and the Creek as a whole; (2) identify which issues are most important to residents in each reach; and (3) hear how residents want to be involved in the master plan and the watershed in the future.

1) What do you most value about the Creek, as you think of a long-term vision for the watershed?

Reach 6 (confluence of James/Left Hand Creek to Streamcrest)

- The vegetation, fish and landscape
- Wildlife and the diversity of it
- Flowers
- Quietness in the canyon
- Privacy
- Seeing nature - natural setting
- Recreation
- Incredible biodiversity
- Historical value – of the buildings and the communities

Reach 7 (middle Left Hand Canyon, upstream of confluence with James Creek)

- Swimming holes
- Trout pools / ponds
- Riparian habitat (bears swimming, deer watering holes)
- Water quality
- Natural setting
- Recreation
- Creek-bank vegetation (deciduous trees, bushes)
- Not 'cement city living'
- Privacy vegetation, from the road – tranquility, less noise

Reach 8 (James Creek watershed) & 9 (Upper Left Hand canyon, above mile marker 11)

- Privacy— vegetation needs to be replaced
- Aesthetics and property value
- Want to maintain access to creek
- Natural environment
- Fish habitat
- Prefer to let nature take its course when it comes to sediment
- Natural habitat around the creek—birds, insects, animals, trees, etc.
- re-vegetation
- The more natural look is preferred

2) What issues are most important for us to focus on as we study the Watershed and develop recommendations?

Issues identified in the reach-specific, small group meetings included:

Reach 6

- Protection of property
- Flood mitigation
- Emergency preparedness and communication

Reach 7

- Access, expedite bridge building
- Re-establish foot paths (washed out)
- Safety - clearing bike lanes; consider separating from road, e.g. Boulder Creek
- Property lines confirmed – have they been changed by creek moves?
- Work on private property done by govt. – doesn't feel collaborative
- Upstream impacts downstream, e.g. blown septic impact on water quality
- ROE – revisit allowing access for plan projects, liability language, usage
- Don't want the plan to undo all the work already done
- Large, boulder / debris fields on USFS property (up from Glendale Gulch NRCS project)
- Floodplain decisions
- Strong communication plan to adopt watershed wide vision among residents
- Voice of residents in developing the plan
- Utilities coming into canyon – not very sound (Xcel, Century Link)

Reach 8 (James Creek watershed) & 9 (Upper Left Hand canyon, above mile marker 11)

- Concern about funding
- Desire for collaboration of agencies and landowners/ residents
- Desire to provide regular input
- Concerns about competing interests between Coalition, agencies and residents
- Decision making process and regulation constraints
- Connecting road plan to creek plan
- Not widening the stream so people don't lose property
- Stream alignment
- Woody debris is good if it is done in a way that makes sense
- Flood mitigation is important
- Balance between aesthetics with protection of property
- Private access issues

3) Other Issues identified in the reach-specific, small group meetings included:

Reach 7

- MP Website very informative please keep updated
- Must be multi-channel
- Neighborhood meetings for more input
- Email communication
- Neighborhood websites / listserv are a great resource – please keep updated

SURVEY RESULTS

22 residents also filled out survey forms to answer the above questions. The results of those and the online survey (addressing the same 2 questions) will be posted on the project website by August 13, 2014.

Left Hand Creek Watershed Master Plan
Community Kick-Off Meeting

July 31, 2014 6-8pm, with Open House from 8-8:30pm
Altona Grange, Longmont, CO

Left hand Creek Watershed Master Plan Community Meeting

The purpose of the Left Hand Creek Watershed Master Plan kick off community meeting was to announce the beginning of the master planning process, to inform the public on what flood recovery issues will be addressed by the master plan and to let the public know how they can provide input. 52 community members attended the meeting, in addition to ten members of the Left Hand Creek Watershed Coalition, which is overseeing the development of the master plan.

Format: Welcome from the Left Hand Coalition (LHCC); Presentation with large group question and answer; Small group break-out discussions by neighborhood/stream section, which focused on values/vision for the Creek and key focus areas for the master plan (see below).

Large Group Discussion Questions

Elements going into the master plan

- What data is being considered? Does it include geologic, hydrologic, climatological data, e.g., where Creek was historically, future climate projections? *Yes, this data being inventoried and will be posted on project website; please share anything you see missing*.
- When the plan considers sediment issues, does it include gravel, boulders? Does 'debris' include organic matter and human materials/trash? *Yes – all of the above.*
- Is the Plan considering that the flood included 'surges,' due to dam and culvert blockages, rather than progressing linearly? Is the Plan also considering that floods don't happen strictly incrementally but that different events are triggered at particular benchmarks and scales? *Yes, this is all being analyzed in the study.*

Possible outcomes of plan

- Most of the creek flows through private property. Will the plan consider funding for private property owners to do certain projects, as opposed to just public agencies or the Coalition? *This will be an issue in implementing recommendations in the plan. There will be projects for which agencies/others will have to seek funding that do apply to private lands.*
- Can the plan consider options for long-term monitoring of watershed, including private and public properties – e.g., cleaning of culverts and stream banks, cleaning out dead trees at risk of being pulled into the creek during flood? It's an issue when residents pursue their own actions, causing problems for neighbors. *The plan can recommend strategies/projects that could enhance stewardship and watershed improvement, including on private lands.*

General Qs about Plan

- How much will it cost? How long will it take? Where will money come from? *This depends on which of the plan's recommendations are pursued, by whom, and from what sources.*
- Concerns about saying the 'Plan won't conflict with current Management policies?' *This doesn't mean there won't be new practices/projects based on what's important to residents and what funding can be obtained for these.*

Concerns/comments

- Would like to see possible focus on stewardship, for landowners whose actions cause problems for neighbors.
- County should consider buying up parts of the floodplain vs. funding remedial actions.
- What guarantees that plan will work? Month before flood, received note re 63st bridge replacement improving floodplain (100y flood design) – didn't work, caused home loss.
- Plan for future events that may or may not happen – there are real situations now that need fixed (bankruptcy, damage, etc.). Concerns that the plan doesn't address the short term.
- There are remaining debris piles/dumpsters that haven't been picked up by the County.
- We would like there to be a chance to take stock of how flood was handled by the County and improvements that could be made for the future.

REACH-SPECIFIC SMALL GROUP MEETINGS

The small groups were organized by stream section, or 'reach.' The purpose of the small groups were to (1) hear from residents in that section what values and vision they have for their section and the Creek as a whole; (2) identify which issues are most important to residents in each reach; and (3) hear how residents want to be involved in the master plan and the watershed in the future.

1) What do you most value about the Creek, as you think of a long-term vision for the watershed?

Reach 1 (East of 95th) & Reach 3 (55th to 63rd)

- Stewardship
- Maintaining/restoring the integrity of the natural setting, which contributes greatly to residents' quality of life
- Sense of interrelatedness of watershed

Reach 2 (63rd to 95th)

- Sense of being consulted and involved in Creek/land use decisions; joing approaches to solutions between the County and residents
- Open/transparent communication

Reach 4 (39th to 55th)

- Legacy and heritage associated with farming/irrigation
- Riparian zone/pasture
- Maintaining a flowing river
- Financial and historical importance of water rights
- Quality of life from a creek running through land
- Wildlife habitat and natural ecosystem
- Importance of natural setting
- Quality of life and ecosystem benefits from open space

Reach 5 (Streamcrest east to 39th)

- Maintaining/restoring natural setting
- Contribution of the Creek and riparian zone to residents' quality of life
- Farming/irrigation

- Assurance of safety
- Protecting water quality and reducing sediment
- Open, two-way communication with County regarding County regulations

2) What issues are most important for us to focus on as we study the Watershed and develop recommendations?

Issues identified in the small groups included:

Reach 1 (East of 95th) & Reach 3 (55th to 63rd)

- Protection of property
- Flood mitigation
- Emergency preparedness and communication
- Maintaining and properly designing culverts/bridges

Reach 2 (63rd to 95th) - enhancing (citizen and other) oversight and management of the watershed on private lands; reducing sediment and debris that comes from upstream; maintaining and properly designing culverts/bridges

Reach 4 (39th to 55th)

- Water quality
- Reducing sediment for irrigation purposes (sand clogs irrigation filters; water too alkaline)
- Reducing debris flows from upstream
- Stewardship/watershed management (concerns about illegal pumping from river, placing structures in Creek with impacts on neighbors and downstream); maintaining culverts on private property and County culverts (e.g., 41st st); cleaning trees/willows from creek banks (e.g., 49th st)
- Tie master plan study to road design (e.g., 41st st), especially where slowing down flows
- Need to plan for climate change (seem to be receiving more rain this time of year)

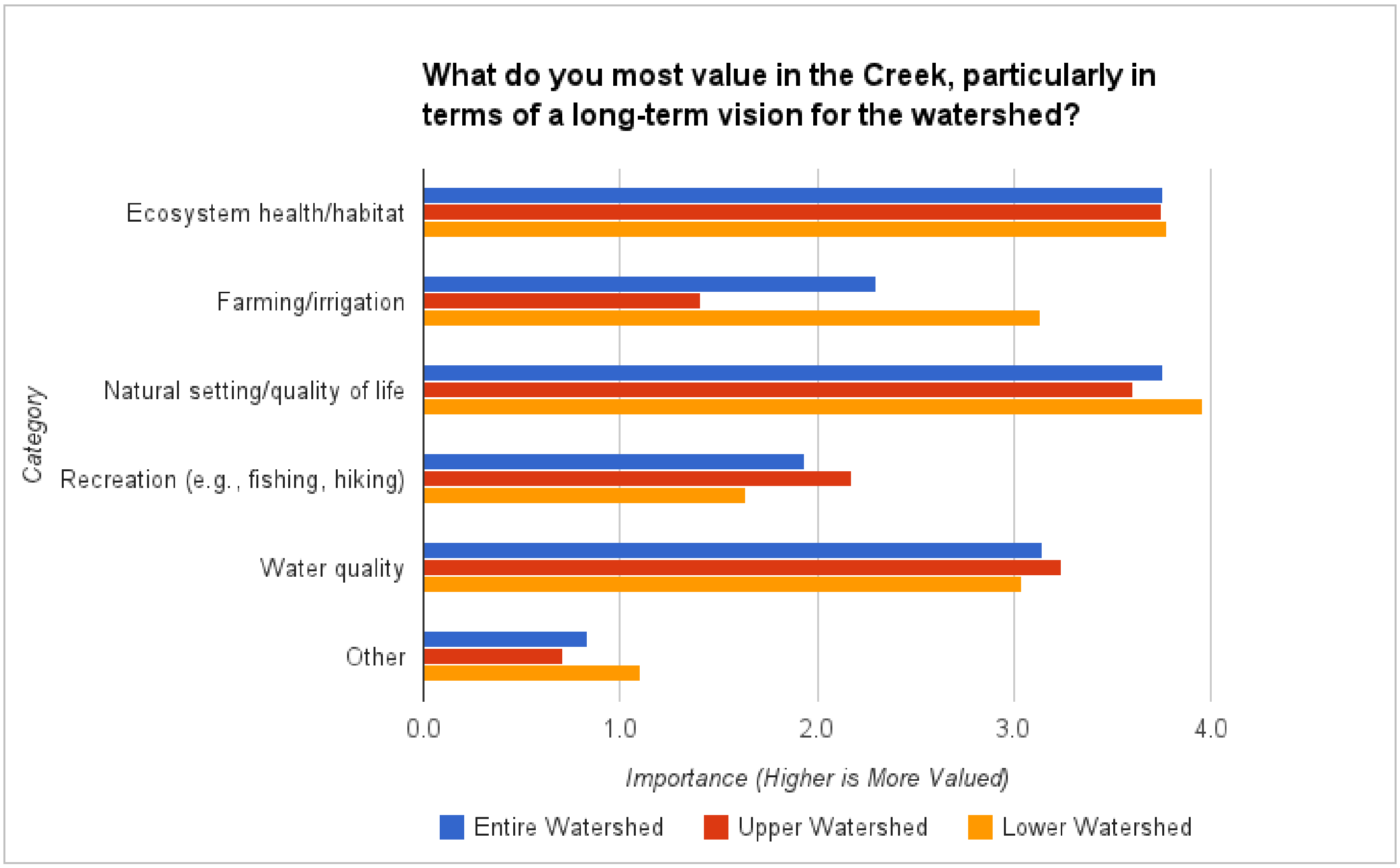
Reach 5 (Streamcrest east to 39th) - mitigating debris; reducing sediment; mitigating impacts to private property from future flood; stewardship/enhancing oversight of the watershed (citizen and other); emergency preparedness

SURVEY RESULTS

26 residents also filled out survey forms to answer the above questions. The results of those and the online survey (addressing the same 2 questions) will be posted on the project website by August 13, 2014.

2) What do you most value in the Creek, particularly in terms of a long-term vision for the watershed? (Higher means more valued)

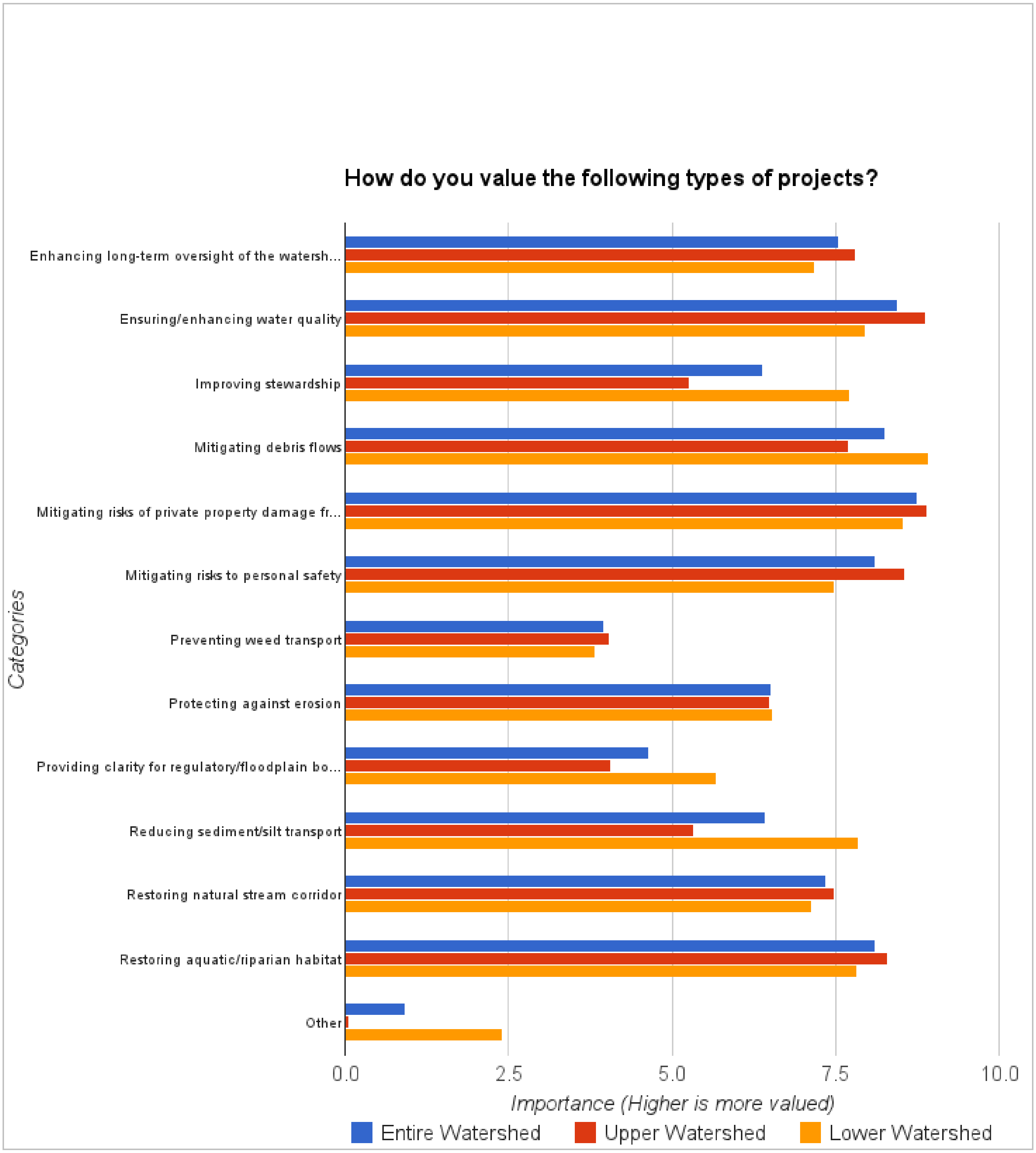
	Entire Watershed	Upper Watershed	Lower Watershed
Ecosystem health/habitat	3.8	3.8	3.8
Farming/irrigation	2.3	1.4	3.1
Natural setting/quality of life	3.8	3.6	4.0
Recreation (e.g., fishing, hiking)	1.9	2.2	1.6
Water quality	3.2	3.2	3.0
Other	0.8	0.7	1.1



3) One goal of the plan is to identify and prioritize long-term recovery projects. Examples include flood recovery projects, flood mitigation measures and ecological restoration. How do you value the following types of projects? (Higher means more valued)

	Entire Watershed	Upper Watershed	Lower Watershed
Enhancing long-term oversight of the watershed	7.5	7.8	7.2
Ensuring/enhancing water quality	8.5	8.9	8.0
Improving stewardship	6.4	5.3	7.7
Mitigating debris flows	8.3	7.7	8.9
Mitigating risks of private property damage from future floodi	8.7	8.9	8.5
Mitigating risks to personal safety	8.1	8.6	7.5

Preventing weed transport	4.0	4.0	3.8
Protecting against erosion	6.5	6.5	6.5
Providing clarity for regulatory/floodplain boundaries	4.6	4.1	5.7
Reducing sediment/silt transport	6.4	5.3	7.9
Restoring natural stream corridor	7.3	7.5	7.2
Restoring aquatic/riparian habitat	8.1	8.3	7.8
Other	0.9	0.1	2.4



LEFT HAND CREEK WATERSHED MASTER PLAN

Purpose and Status of the Watershed Plan

The Left Hand Creek Coalition is overseeing a process to develop a long-term Master Plan to enhance the resilience of the Left Hand Creek watershed. This is an opportunity to:

- Conduct coordinated long-term planning for the entire watershed as a system
- Study the post-flood watershed and recommend and prioritize long-term flood recovery, watershed restoration and future flood mitigation projects
- Increase competitiveness for federal and state funding

Community Meetings

We invite you to attend a meeting to:

- Learn about project recommendations for the watershed, including the process and methods used, and how input from the July and August community meetings was incorporated
- Discuss reach-specific project recommendations and share input before the Plan is finalized in mid-November

Upper Watershed Meeting (West of Hwy 36): Weds, October 22nd, 6-8 PM
Jamestown Town Hall, 118 Main Street, Jamestown, CO

Lower Watershed Meeting (East of Hwy 36): Thurs, October 23rd, 6-8 PM
Boulder County Parks and Open Space, 5201 St. Vrain Road, Longmont, CO

A draft Executive Summary with project recommendations for the Master Plan will be posted on the project website on October 21st. The draft Plan will be posted on the website following the community meetings. Comments may be submitted through November 3rd.

For more information, please visit the Left Hand Creek Watershed Master Plan website at: **lefthandcreekmasterplan.com**
Contact the Project Team at: **720-407-4788** or **lefthandmasterplan@mediate.org**

Left Hand Creek Coalition Members

Boulder County, Forest Service, St. Vrain & Left Hand Water Conservancy District, Colorado Division of Reclamation Mining & Safety, NRCS Natural Resources Conservation Service, United States Environmental Protection Agency, Colorado Water Conservation Board, Colorado Parks & Wildlife, Keep It Clean Partnership, FEMA, Jamestown Colorado, City of Boulder, City of Longmont, Colorado Department of Public Health and Environment, DOT Department of Transportation, Left Hand Water District, Lefthand Water Oversight Group, Lefthand Ditch Company, City of CO CDPS, Colorado Division of Homeland Security & Emergency Management, Longmont & Boulder Valley Conservation Districts

Left Hand Creek Watershed Master Plan
Second Round of Public Meetings

October 22nd, 2014 6-8pm at Jamestown Town Hall, Jamestown, CO
October 23rd, 2014 6-8pm at Boulder County Parks and Open Space Building, Prairie Room, Longmont, CO

LEFT HAND CREEK WATERSHED MASTER PLAN COMMUNITY MEETING

The second set of public meetings was held on October 22nd at the Jamestown Town Hall and October 23rd at the Boulder County Parks and Open Space Building Prairie Room. The purpose of these meetings was to share the AMEC team's risk assessment and high-level project recommendations for each reach. Thirty community members attended the Upper Watershed meeting on October 22nd. The project team delivered a PowerPoint presentation to the group to explain how projects were developed and how to use the LHCWMP. At the end of the presentation, the project team organized two breakout groups based on the attendees' locations in the watershed and gave a hands-on demonstration of how to interpret the maps and conceptual drawings in the LHCWMP. Five members of the public attended the Lower Watershed meeting on October 23rd. Due to the smaller number of people at this meeting, the project team spoke with the attendees in one group for the entirety of the meeting rather than using breakout groups.

The public provided feedback by marking up maps and making notes on comment cards. Comments included project recommendations at specific sites, such as installing a sediment retention basin, installing a culvert, and removing debris to mitigate flooding and protect infrastructure. The comment cards are included in Appendix D of the Left Hand Creek Watershed Master Plan. Comments were also recorded in a spreadsheet to keep track of everything that was sent to the project team. Most comments were addressed directly in the Master Plan. A few comments were related to Boulder County's flood recovery efforts, and those comments were forwarded to the appropriate County personnel.

Many of the people who attended the Upper Watershed meeting were curious about the implementation process and next steps for the projects identified in the plan. The project team and attending Coalition members explained the need for funding and identified potential funding sources. The Coalition's role in the future was explained to the extent possible, as finer details are still being determined. Upper Watershed residents asked the project team about specific project recommendations and methodologies, such as restoring soil and organic material, projects that have social/recreational aspects, how gulches and debris flow paths were taken into account, early warning systems, and flow rates. Residents also wanted to know how the Master Plan would impact the floodplain development permitting process. The Master Plan does not have the level of detail needed to issue new permits, but it does provide guidance on where Boulder County should request FEMA mapping updates.

At the Lower Watershed meeting, residents recounted what they experienced during the 2013 floods and pointed out areas that still displayed the impacts of the floods (e.g., sedimentation and debris). The meeting attendees also pointed out other issues, such as the large trees in the channel that contribute to the large debris flow problem during floods. The Lower Watershed residents asked the project team about specific flood restoration methodologies, such as how to stabilize the stream banks, what the purpose of stabilizing a low-flow channel is, etc. The attendees voiced questions about water rights in the watershed, and whether those water rights stakeholders were included in the planning process. Left Hand Ditch Company owns most of the water, and given their membership in the Left Hand Creek Coalition, they will be able to consider taking concerns into account regarding fish habitat, etc.

Left Hand Creek Watershed Master Plan
Comment Form

Address or Reach number (see Left Hand Watershed map)

13 @around SX-4

Comments

Please use specific location information where possible. Use other side, as needed.

- *Do the recommended projects address your concerns? If not, what have we missed?*
- *Do they reflect the future you envision for your watershed?*
- *What remaining questions do you have?*
- *Other comments?*

at mp 7.0 to ± 7.5, flow comes down Nugget Hill and collects in side of road until it hits knee just above Glendale Firehouse (sta 4). The flow moves to ~~along~~ on road and floods firehouse, leaving deep silt, affecting ability to move equipment. Culvert at about mp 7.4 would help

How did you hear about us?

☐ **Email list**

Which one? nuggethillrd@gmail.com

☐ **Media**

☐ **Website**

Which one?

☐ **Other**

Comments can be submitted through November 3, 2014 by e-mailing lefthandmasterplan@mediate.org

THANK YOU FOR YOUR INPUT!

Left Hand Creek Watershed Master Plan
Comment Form

Address or Reach number (see Left Hand Watershed map)

LHCM_15_26

Comments

Please use specific location information where possible. Use other side, as needed.

- *Do the recommended projects address your concerns? If not, what have we missed?*
- *Do they reflect the future you envision for your watershed?*
- *What remaining questions do you have?*
- *Other comments?*

Please add a sediment retention basin to catch sediment coming down the tributary along Lickskillet Rd, to keep this sediment out of Left Hand Cr.

—Glenn Patterson

How did you hear about us?

☐ **Email list**

Which one?

☐ **Media**

☐ **Website**

Which one?

☑ **Other**

Member of Coal.

Comments can be submitted through November 3, 2014 by e-mailing lefthandmasterplan@mediate.org

THANK YOU FOR YOUR INPUT!

Left Hand Creek Watershed Master Plan
Comment Form

Address or Reach number (see Left Hand Watershed map)
54

Comments
Please use specific location information where possible. Use other side, as needed.

- *Do the recommended projects address your concerns? If not, what have we missed?*
- *Do they reflect the future you envision for your watershed?*
- *What remaining questions do you have?*
- *Other comments?*

JUST EAST OF THE EDGE OF JAMESTOWN IS A NARROW THROAT THAT BACKED UP ALL THE WAY TO OUR HOUSE DURING THE FLOOD! BEFORE THE SURGE ABOVE TOWN - THIS NEEDS TO HAVE DEBRIS REMOVED & THE CHANNEL OPENED UP - IS THE AREA BETWEEN 2160 & 2199 JAMES CANYON DRIVE - WAS NOT ADDRESSED IN THE EWP WORK
THANK YOU NANCY, ROGER LOVING

Comments can be submitted through November 3, 2014 by e-mailing lefthandmasterplan@mediate.org

THANK YOU FOR YOUR INPUT!

How did you hear about us?

☑ **Email list**
Which one? ______

☐ **Media**

☐ **Website**
Which one? ______

☐ **Other** ______

Is the reach label wrong on Sheet 18 - should it be Reach 4?

Appendix E Other Projects in the Left Hand Creek Watershed

CWCB Stream Restoration Projects

A number of other watershed restoration projects are underway or planned in the planning area. The CWCB awarded several grants for Left Hand Creek Watershed restoration projects, including:

- $200,000 was awarded for restoration work for a 1.5 mile long stretch along James Creek. Community Development Block Grant (CDBG) match funds will be pursued. It is also worth investigating if any road recovery efforts can be used as match.
- Left Hand Water District was awarded $9,000 for post-flood sediment removal from the raw water intake. The District is providing matching funds, for a total project amount of $18,060. An excavator will remove and haul away approximately 250 cubic yards of sediment that has accumulated in the intake. Removing the sediment will significantly improve the District's water supply delivery system. This project will not alter the stream channel, riparian vegetation, or aquatic habitat.
- Stephen Strand, a local landowner who has been involved in community efforts, also received CWCB award money in the amount of $20,000. The purpose of this project is to stabilize the stream bank and repair the riparian habitat along 300-500 feet of Left Hand Creek that runs through Mr. Strand's private property. Vegetation will be planted to help anchor soil and restore the riparian corridor.

Emergency Watershed Protection Program Projects

Table 17 summarizes the active NRCS projects in the watershed, funded by the Emergency Watershed Protection (EWP) program:

Table 17. Active NRCS Projects in the Left Hand Creek Watershed

Stream/ Creek	Grantee	Site Name	GPS	GPS	Elevation (ft)	Description	Town
James Cr	Jamestown	2199 James Canyon Rd	40.112372	-105.378563	6,836	Create swale to channel runoff into James Creek; regrade left (north) bank of stream to increase capacity. Trench 150 ft with a 1:2 slope until it enters James Creek; create swale approximately 10 ft wide. If swale depth at stream is greater than 3 ft, recommend installing a 4 ft culvert and backfilling over top. Re-slope approx 100 LF of streambank.	**Jamestown**
James Cr	Jamestown	#12 12th St	40.113431	-105.383803	6,881	Recommend approximately 180 cy of riprap along the bank, house side for protection.	**Jamestown**
James Cr	Jamestown	20 - 4 Main St	40.115675	-105.387084	6,914	Recommend returning the stream to its original channel. This involves approximately 350 lF of dozer work. The stream re-channel will start just downstream of 20 Main St and end at 4 Main Street.	**Jamestown**
James Cr	Jamestown	20 Main St	40.115675	-105.387084	6,914	A low area approximately 80 ft in length put the home danger of flooding during high flows. Recommend: 1. Debris removal (approximately 45 cy); 2. Armoring with riprap (approximately 160 cy).	**Jamestown**
James Cr	Jamestown	34 Main St	40.115675	-105.387084	6,914	Debris removal is needed (35 cy). Recommend gabions (70 cy) to prevent damage at high flow. Side note: there is considerable seepage from an unknown source coming down the upstream side of the house.	**Jamestown**
James Cr	Jamestown	85 & 91 Main St	40.115675	-105.387084	6,914	Team site confirmed condition and need to remove deposition. Stream bed is raised 5 feet	**Jamestown**

Stream/ Creek	Grantee	Site Name	GPS	GPS	Elevation (ft)	Description	Town
						due to deposition. Remove deposition for a distance of 200' behind homes. This is estimated at 450cy of excavation.	
James Cr	Jamestown	105, 99, 91, 85, 73 and 67 Main St	40.115675	-105.387084	6,914	Slope is now unstable at an angle of ~80 deg. Spring runoff will undercut the near vertical slope (approximately 90 ft wide by 50 ft high) resulting in a massive cut slope failure. Stream blockage will flood nos. 105, 99, 91, 85, 73 and 67 Main St. Armor slope with large stone, d 36" or larger.	**Jamestown**
James Cr	Jamestown	167 Main St	40.115675	-105.387084	6,914	This house was completely destroyed & swept away by the Sep 2013 flood event. Spring runoff flows will threaten the highway/Main St. Street bank should be back filled to a 1 to 1 slope & stone armored. **This Phase II project should be done concurrent w/ Phase I.** This is house with scaffolding holding up east portion of the structure. Scope is to protect remaining west portion from further damage. Possible protective measure could be 8' high berm placed	**Jamestown**

Stream/ Creek	Grantee	Site Name	GPS	GPS	Elevation (ft)	Description	Town
						between stream and the dwelling. Estimate an 8 foot high training berm 200' long would take 650cy of materials. If local material cannot be used an option would be to use gabions or rip rap.	
James Cr	Jamestown	17 Ward St	40.115848	-105.391589	6,970	Recommend pushing rock back toward house; give stream more capacity; provide more protection for runoff	**Jamestown**
James Cr	Jamestown	21 Ward St, Jamestown	40.115757	-105.391800	6,977	Stream deposition has raised stream invert approximately 5ft, increasing risk that spring runoff will flood house. Recommend removing deposited material. Spoil site required.	**Jamestown**
James Cr	Jamestown	51 Ward St, Jamestown	40.11527	-105.393515	7,006	Temporary road/culverts installed on site of original stream bed at very sharp angle (approx 60 deg). Spring runoff will likely cause James Creek to jump channel & flood Ward St again. Recommend reorientation of road/stream intersection plus armoring. 1) Armor outside corner of turn at inlet with rock taken from inside corner (35 cy); 2)	**Jamestown**

Stream/ Creek	Grantee	Site Name	GPS	GPS	Elevation (ft)	Description	Town
						Replace existing culverts with two 48" culverts (approx 75 LF ea) just west of two pine trees, oriented parallel to stream flow; 3) Armor left bank at culvert outlet	
James Cr	Jamestown	55 Ward St, Jamestown	40.115258	-105.393762	7,009	Temp roadway installed at creek avulsion over 2-60 in culverts. To prevent creek over-topping road and endangering house number 55, roadway must be elevated 3 to 5 ft tying into right streambank @ house numbers 55 & 59 Ward St. to create failure, point over culverts vs. down Ward St. The avulsion caused creek and road to switch places. Quantity approx 700 CY of fill.	**Jamestown**
James Cr	Jamestown	65 Ward St	40.115211	-105.394476	7,026	Owner is named Adam. Property has been eroded leaving serious ditches in the yard between the house and stream. The stream invert has lowered to the point where his Sandpoint well is dry and the property has much woody debris on the upstream side. EPA contractor is removing woody debris from the property and adjacent stream.	**Jamestown**
James Cr	Jamestown	69 Ward St, Jamestown	40.115507	-105.394502	7,026	Considerable debris at the upstream side washed out Bridge providing access to 69 Ward St. Remove debris (70cy) and push rock (approx 100cy of sand and cobble to East side of channel diverting stream Westward back to its original location, to protect structures. Steep bank in danger of further erosion, putting structures above at risk. Armor bank with riprap; pull down trees at edge of bank (left in photo). Estimated 100 cy of riprap needed	**Jamestown**
James Cr	Upper James	9 Ward St	40.115844	-105.391080	6,970	Debris flow upstream likely to compromise treatments.	**Boulder Co.**
James Cr	Upper James	26 Ward St	40.115511	-105.392026	6,990	Debris flow upstream likely to compromise treatments.	**Boulder Co.**
James Cr	Upper James	59 Ward St	40.11506	-105.393986	7,710	Debris flow upstream likely to compromise treatments.	**Boulder Co.**
James Cr	Upper James	67 Ward St	40.115122	-105.395873	7,030	Debris flow upstream likely to compromise treatments.	**Boulder Co.**
Left Hand Cr (330/1100)	LH Streamcrest	8795 Streamcrest	40.130722	-105.285566	5,569	Left Hand Creek. Remove about 1,800 cy of mostly woody debris from creek to power poles on north bank. Marked point is at downstream	**Boulder Co.**

Stream/ Creek	Grantee	Site Name	GPS	GPS	Elevation (ft)	Description	Town
						end; debris continues about 400 ft upstream.	
Left Hand Cr (330/1100)	LH Streamcrest	8785 Streamcrest	40.1328139	-105.288486	5,621	Debris removal and restore pre-flood channel.	**Boulder Co.**
Left Hand Cr (330/1100)	LH Streamcrest	8725 Streamcrest	40.1328139	-105.288486	5,605	Debris removal and restore pre-flood channel.	**Boulder Co.**
Left Hand Cr (330/1100)	LH Streamcrest	2877 Middle Fork	40.1294472	-105.282519	5,579	Debris removal and restore pre-flood channel.	**Boulder Co.**
Left Hand Cr (330/1100)	LH Streamcrest	3027 Middle Fork	40.1295306	-105.282836	5,585	Debris removal and restore pre-flood channel.	**Boulder Co.**
Left Hand Cr (330/1100)	LH Streamcrest	8531 Foothills	40.13147	-105.282875	5,579	Debris removal and restore pre-flood channel.	**Boulder Co.**
Left Hand Cr (330/1100)	LH Streamcrest	8765 Streamcrest	40.132457	-105.288285	5,602	Debris removal and restore pre-flood channel.	**Boulder Co.**
Left Hand Cr (330/1100)	LH Streamcrest	361 Lefthand Canyon Dr	40.133173	-105.287060	5,606	Suggest removing 10 cy woody debris. Place local rock at eroded area adjacent to bridge on the south downstream side.	**Boulder Co.**
Left Hand Cr (150/800)	LH Canyon Dr.	**LHC-9** 7164 Lefthand Canyon Dr	40.083596	-105.365125	6,767	Home at 7164 Lefthand Canyon Drive in danger from stream breakout. Consider placing rock gabions & geotextile immediately adjacent to the north bank of stream. Build about 4 ft high, 4 ft wide and 100 ft long, with upstream end	**Boulder Co.**
						starting at utility pole. 7164 Lefthand Canyon Drive. Consider removing 60 cy of mostly woody debris. Note, the remains of wood planks from a destroyed privately owned bridge are intertwined with the woody debris.	