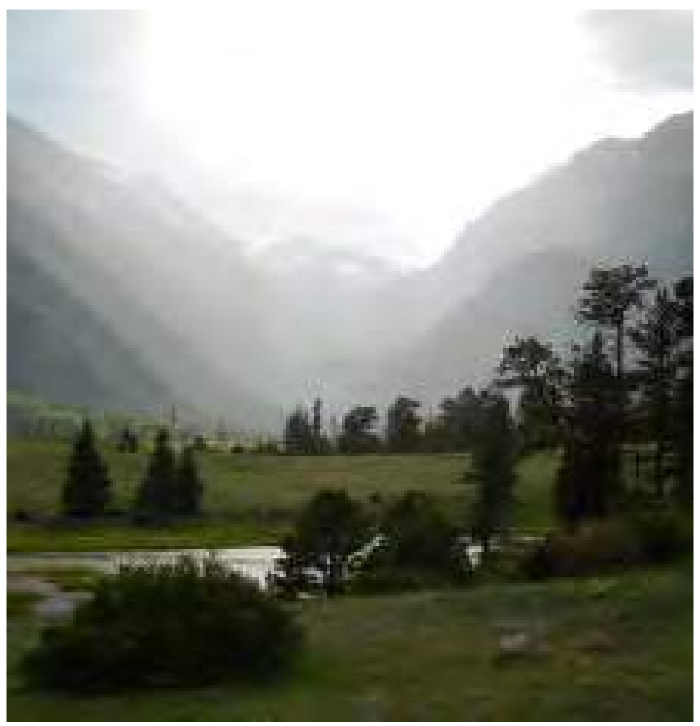
Town of Estes Park, Colorado

# Fish Creek Corridor Plan for Resiliency

Fish Creek Coalition



DRAFT January 2015

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Town of Estes Park

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Anderson Consulting Engineers, Inc.
Civil • Water Resources • Environmental

Great Outdoors Consultants

Round River Design

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Fish Creek Whispering Pines Dr. Home Damage

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## Introduction

With its tight link to Rocky Mountain National Park, the Estes Valley is a treasure of our state, drawing over 3 million visitors annually. The Fish Creek Corridor runs along the southeast end of Town, conveying flows from Twin Sisters Mountain and Lily Lake in the upper watershed, delivering to Lake Estes at the Town's down-valley limits. Although Mary's Lake will drain to the Fish Creek Watershed in a severe dam breach event, for our planning purposes, Mary's Lake will be treated as a part of the Big Thompson watershed as it has no surface connections to Fish Creek. The Fish Creek Corridor is critically important to and well-loved by the many people who live, work, and play along it. With so much development located in the river corridor, reducing flood risk and improving stream health is essential for successful coexistence with the river.

Fish Creek is a unique river system, with a challenging combination of steep gradients, a predominance of highly mobile sands in its upper soil layers, and extensive development along the creek and throughout the watershed. Stability in Fish Creek depends on intact native vegetation, with dense root matrices as "glue" for finer soils, as well as healthy beaver dam complexes that serve as regular "checks" along the channel to help hold the grade and dissipate energy during flood events.

In September 2013, Fish Creek experienced an extreme flood, with peak flow estimates at almost 2,000 cubic feet per second (cfs), which is larger than the peak flow predicted for the 500-year recurrence interval flood (1,400 cfs) (CDOT, 2014). Further, Fish Creek endured localized pulses resulting from numerous dam and culvert failures along the channel's length. It is likely the largest pulse of flow and sediment came from the dam break at Scott Ponds, though, additional pulses were caused when every culvert failed on Fish Creek during the September flood, the majority of these being undersized public and private crossings. Pre-flood beaver dams were also breached during the flood, but likely made the smallest contribution to larger pulse flows. Estimates of the larger pulses experienced locally are as high as 6,900 cfs (NRCS, 2013).

Without a doubt, the flood of 2013 and subsequent scientific and planning efforts showed that we still have much work to do in Fish Creek to achieve a healthy, resilient river system that protects both life and property during both large and small flood events.

With funding and technical support from the Colorado Water Conservation Board (CWCB) and the Office of Emergency Management (OEM), flood-affected communities were guided to create watershed coalitions and develop collaborative stream corridor master plans as the first critical step towards resiliency for our river systems, our economies, and our communities. The directive of the funding is to guide communities towards prioritization and implementation of flood recovery and stream restoration projects that protect life and property from hazards, while enhancing riparian ecosystems for wildlife and recreation.

In Estes Park, the **Fish Creek Corridor Plan for Resiliency** is the fruition of this directive and the first step in a decades-long journey of recovery and preparedness. The Plan is both a technical reference serving as a basis for final design, construction, and monitoring as well as a funding tool to support the grant writing process for flood recovery implementation funding.

The Fish Creek Plan is based on three base philosophies:

- Resiliency requires understanding the river and working with river processes, rather than forcing it into a mold of what we think it ought to be;

- A risk-based approach to planning is the only way to fully accommodate the complexities of river systems and inter-relationships with our roads, homes, and infrastructure; and
- With so many people impacted by the September flood, resiliency planning can only be successful by engaging a broad range of public, private, and non-profit stakeholders and through widespread outreach and education to garner public support.

The Plan defines the vision for resiliency and identifies stepping stones to achieve the vision. Through education and outreach to date and critical ongoing education and outreach, the Plan fosters consensus driven and technically sound resiliency solutions that will be the foundation for project funding and implementation in both the short- and long-term.

Measures of success of the Fish Creek Plan include reduction of high risk areas for both flood and geomorphic hazards, community understanding of the river corridor and associated risks, increased resiliency for long-term support of recreational, educational, and correlated economic opportunities, and healthy and functional fish and wildlife communities and native riparian plant communities.

With this Plan and the formation of the Fish Creek Coalition, which is transitioning to the broader and permanent Estes Valley Watershed Coalition, the Estes Park community embarks on the critical next step in flood recovery *to build permanent recovery work on a foundation of strong science and engineering, vetted through the communities it will impact.*

We are on the path to resiliency for our river system, our economy, and our community.

Fish Creek Breaching Fish Creek Road

Trail and Culvert Damage

# 2 Introduction

## 2.1 Project Scope

The Master Plan report serves as a guide for future recovery and restoration planning, both in the short-term (1 to 2 years) and the long-term (decades). The plan is built on a foundation of science and engineering and vetted through the community. The objectives of the Fall River Corridor Master Plan effort are to:

- Create a short-term (1-2 years) and long-term (decades) implantable vision for recovery and restoration of identified priority areas on Fall River.
- Incorporate public input and guidance into the vision
- Focus on resilient solutions that consider hazards and stream health, including natural restoration, not just hard engineering
- Utilize qualitative and quantitative risk assessment tools that inform the short- and long-term planning decisions, considering flood and geomorphic risk
- Maximize funding opportunities through defensible prioritization of recovery and restoration projects and programs
- The Fall River Corridor Master Plan effort is collaborative in nature, drawing on the expertise of engineers, fluvial geomorphologists, ecologists, fisheries biologists, and risk experts and informed by input from the community, including impacted home and business owners.

The physical scope of the master plan is the Fall River Corridor from its headwaters to the confluence with the Big Thompson River in Estes Park, CO, and extending laterally into the channel migration zone. The technical scope addressed by the master plan is broad rather than detailed, and serves to best direct further work and funding on the Fall River to meet the community and stakeholder objectives. The ecological, geomorphic, and flood risk assessments were also large scale and were performed based on field assessments, existing data, and existing model analysis. Cut-sheets were produced for the prioritized projects that provide an overview of objectives, benefits, implementation strategy, permitting requirements, cost estimates, and funding strategies. The cut-sheets do not provide detailed designs for construction implementation.

## 2.2 Community Process Approach

A watershed approach to restore the Fish Creek Corridor was used in this Master Plan, which addressed the problems in a holistic manner and ensured that the stakeholders in the watershed were actively involved in selecting the management strategies that will be implemented to solve the problems. The purpose of this approach was to improve awareness through educating stakeholders on the issues affecting their watershed's health and encouraged participation. It coordinated community actions through the development of a common vision. Local participation was used to put the planning process in the hands of local communities and ensure their concerns are fully integrated. By involving a broad representation of stakeholders, diverse interests were incorporated (including interests of NGOs and individuals) which worked to build participation and acceptance. The plan was meant to target resources, focusing on manpower and funding to address the important issues identified by the community. The partnerships formed established working relationships, improved communication, and allowed information to be shared. Furthermore, these partnerships minimized conflict and promoted cooperation, while leveraging resources. Talents, expertise, funding, and time were combined among many individuals, organizations, and agencies, collectively supporting achievement of large-scale goals.

## 2.3 Risk Assessment Approach

Utilizing a risk  based analysis is the best method to synthesize the massive extent of data, problems, and opportunities into scientifically defensible priority lists for funding and implementation. A risk-based approach has been utilized by the Dutch for over 30 years under their "Make Room for the River" program, as well as the states of Vermont and New York when dealing with post-hurricane recovery. Risk (R) is simply the probability (P) of occurrence multiplied by the consequence (C). For example, the National Flood Insurance Program (NFIP) maps floodplain boundaries for the 100-year and 500-year floods (which represents 1% and 0.2% probabilities (P) of occurrence), but risk (R) is not evaluated in this mapping because the consequences (C) of flood inundation in a given area are not considered.

Furthermore, the flood mapping is based on one channel alignment and geomorphic hazards (e.g., mudslides, channel avulsions [channel takes new path]) are not considered. The damage incurred in the flood-affected corridors during the September 2013 flood has been approximated as greater than 60% of the damaged area occurred outside of the mapped 100-year floodplain boundaries. Therefore, the risk-based analysis adopted for this Master Plan effort addresses geomorphic risk along with flood risk.

A successful risk reduction approach does not have a single answer. Multiple risk reduction goals are necessary to address myriad river conditions and land uses. Although there is always a residual risk, acquisition of high hazard properties is the closest to reducing risk to zero. Successful risk reduction also considers an acceptable percent of reduction. Changing from 2 pedestrian bridges to 1, for example, cuts the risk of debris jam in half locally.

Fish Creek Road and Creek Flood Damage

Fish Creek Road Damage

Estes Park Golf Course Damage

Fish Creek - East Fork

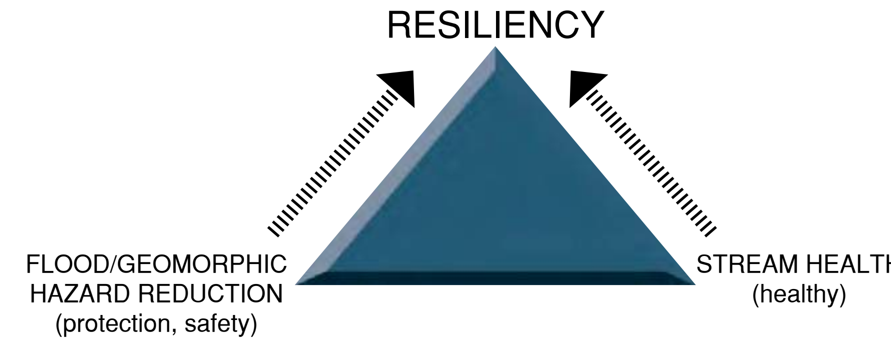
## 2.4 Resilient Solution Approach

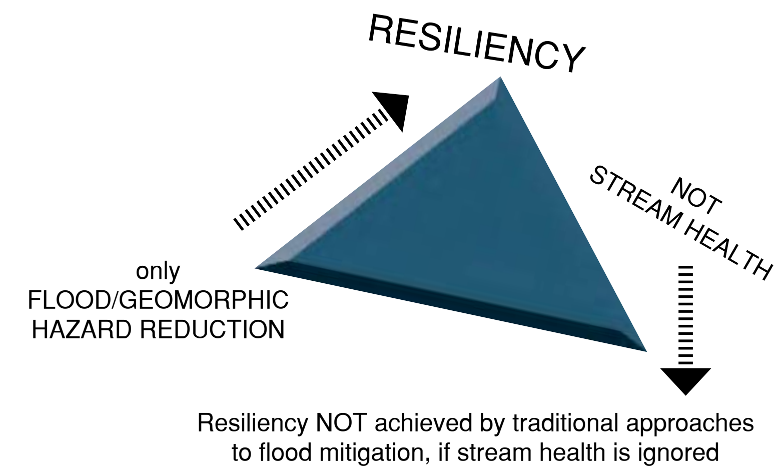
The Fish Creek Corridor Plan for Resiliency approach considers both hazard reduction and stream health to identify truly resilient solutions. Resiliency is not synonymous with safe or healthy or sustainable, it requires both hazard reduction for protection & safety and healthy streams for the flexibility of the system to bounce back from the flood impacts.

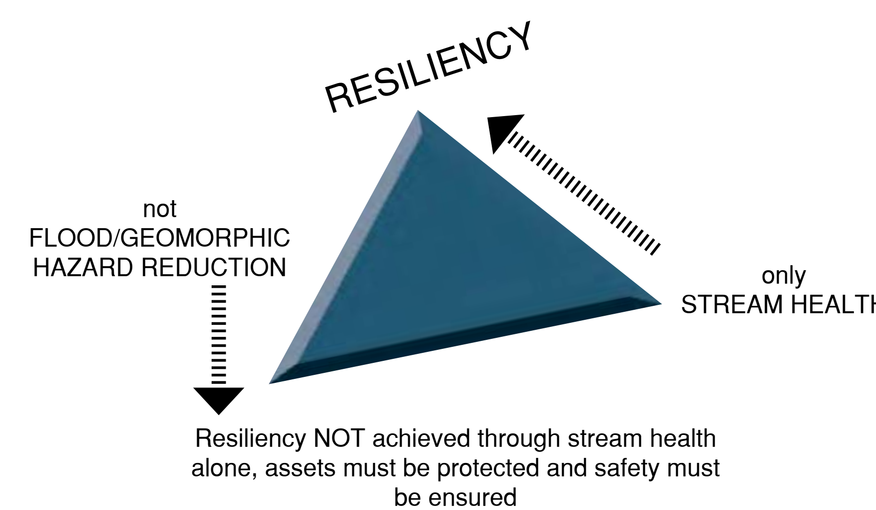
Traditional flood mitigation approaches select a target streamflow (often 100  year), then design hard structures to resist the hydraulics of the target flow. This approach focuses only on safety – and only on conditions occurring for the few days the river is in flood stage.

This design may be seen as successful at or below the target flow, but there is always a potential for a bigger flow, and with no flexibility, the stream is not able to adjust itself and catastrophic failure is a typical result of these larger flows. Moreover, this approach also sacrifices stream health (physical river processes of moving sediment and water, as well as the ecological complexity of the stream system) every day the river is not in flood stage.

Conversely, resiliency is not achieved by focusing only on stream health.  When we have assets (homes, businesses, bridges, etc.) located along our stream corridors, protecting them and ensuring safety is a necessary part of resiliency.



## Master Plan Goals

The Master Plan report will serve as a guide for future recovery and restoration planning, both in the short-term (1 to 2 years) and the long-term (decades).

*Built on a foundation of strong science and engineering and vetted through the community.*

**It will create strategies** to reduce the impact of future flooding and geomorphic hazards AND **create strategies** to restore ecological health, including wildlife habitat, fish passage, and wetland, riparian, and river improvements.

**Maximize funding** opportunities through defensible prioritization and project cut sheets.

## Resilient Solutions

**1st Tier:** potential acquisition to remove an asset from a high hazard area should be considered first for maximum risk reduction.

**2nd Tier:** when acquisition is not an option, the owner makes an informed decision to stay.

**3rd Tier:** now engineering solutions, local scale and system-wide, can be considered to best protect the asset, the community, and to improve stream health for true resiliency.

*Visit fishcreekcoalition.org for examples of resilient versus static solutions.*

**New Master Plan Timelines**

**Work with your RAC Captain in August and watch for the draft master plan report in September and the final report in October**

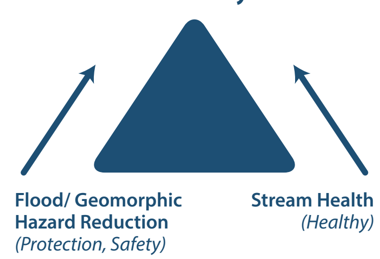
Fish Creek Coalition

## Fish Creek Corridor Master Plan

### River Master Planning for Resiliency

**re•sil•ience**

1. the ability of a substance or object to spring back into shape; elasticity.
2. the capacity to recover quickly from difficulties; toughness.




### What is Fluvial Geomorphology?

The scientific study of landform development and change under processes associated with running water.

### Why is it so important?

To make sound decisions for flood recovery and restoration, we must fully understand the geomorphic processes that drive stream behavior. Understanding river processes allows us to predict response to treatments and to work with Fish Creek, not accidentally against it, for solutions that will stand the test of time.

**Contact Information**

Website **fishcreekcoalition.org**
Facebook **facebook.com/FishCreekCoalition**
Email **fishcreek@estes.org**

Fish Creek Coalition

# Fish Creek Corridor Master Plan

## Fish Creek Corridor Master Plan

*Our vision for resiliency is to work w… and the public to plan for safe, hea… resilient stream corridors*

## Be Involved!

Information on project dates, tec… educational resources is available…

- through your **River Advisory C… Captain** (see inside!)
- **website:** *fishcreekcoalition.org*
- **Facebook:** *facebook.com/FishC…*
- **email:** *fishcreek@estes.org*

Fish Creek Coalition flyers served as an overview reference on the RACs themselves, as well as what is driving the master planning work, why change is needed, and how we can go about making that change together. They also served as a quick reference to the coalition website and Facebook pages,.

The flyers were distributed door to door by Mountain Outreach and the RAC captains to keep the residents informed of the plan for resiliency activities.

fishcreekcoalition.org

## What are we Doing that's New?

### Master Planning for Resiliency

The master plan considers both hazard reduction and stream health to identify truly resilient solutions, rather than static treatments that only harden the river.

### Risk, R = P x C

*Probability of occurrence X consequence.*

We are taking a risk-based approach to planning and this is new in the U.S. The Dutch have 30 years under their "Make Room for the River" program. Post Hurricanes Sandy and Irene, VT and NY have started…and now Colorado.

### Flood and Geomorphic Risk

Most of the damage caused by the September 2013 flooding occurred outside of our mapped 100-year floodplain areas. We were harmed by channel avulsions (new channel paths) and landslides. These are geomorphic hazards.

**We need to plan based on both flood and geomorphic risk!**

## What is Successful Risk Reduction?

**Not just one answer.** We will need multiple risk reduction goals to address myriad river conditions and land uses.

**Reduce Risk to Zero.** Although there is always residual risk, acquisition of high hazard properties is the closest to reducing to zero.

**Reduce Risk by an Acceptable Percent.** Changing from 2 pedestrian bridges to 1, for example, cuts the risk of debris jam in half locally.

**Simply ensure safe access for all in next flood.**

facebook.com/FishCreekCoalition

## What is the River Advisory Committee?

*The RAC is the heart of the master planning process.*

**A workgroup** of citizens, the Town, and agencies that work directly with the master plan technical team to:

- define issues;
- evaluate projects and management strategies;
- foster ownership of the planning process; and
- provide input on the master plan.

### System for 2-way communications:

- deliver information from the technical team to the community; and
- bring community issues and input to the team.

*Tell your RAC captain what level of involvement is right for you for the remainder of the master planning process.*

**Fish Creek RAC Neighborhood Captains**

| Stream Reach | Description | Neighborhood Captain |
|---|---|---|
| Upper Reach | Upstream of confluence at Little Valley Rd | ***Donna Hasman*** *planning@estes.org* |
| Middle Reach | Confluence at Little Valley downstream to Scott Ave | ***Chuck Bonza*** *cbonza1@aol.com* |
| Lower Reach | Downstream of Scott Ave to Lake Estes | ***Steve Deats*** *grayugly1@gmail.com* |

fishcreek@estes.org

## Technical and Educational Resources

*Field assessments are complete and results are available at fishcreekcoalition.org:*

**Ecological Assessment:** provides an initial evaluation of the overall condition of Fish Creek, its riparian zones and instream habitats, to understand trends in stream and riparian conditions through time.

**Flood Risk Assessment:** identifies assets (buildings, infrastructure) at risk of damage during flood event.

**Geomorphic Risk Assessment:** enables understanding of river processes to support appropriate solutions that will work with the river to provide the best long-term protection. Planning-level Channel Migration Zone (pCMZ) maps have been created to identify highest hazard areas where the channel may re-occupy historic areas that were not previously on our radar.

*Also visit fishcreekcoalition.org for past presentations and reporting, native revegetation guidance, and more.*

### Did you know?

*With required permits, landowners may complete channel work on their property to protect it. The purpose of permits is to ensure no adverse effects. Please coordinate with the RAC and technical team for assistance.*

**We want to hear from you!**
*Values and Evaluation Criteria Ranking Form enclosed.*

Please complete and return **BY AUGUST 22** to your RAC Captain or to

**Estes Park Community Development**
**P.O. Box 1200, Estes Park, CO 80517**
**or *planning@estes.org***

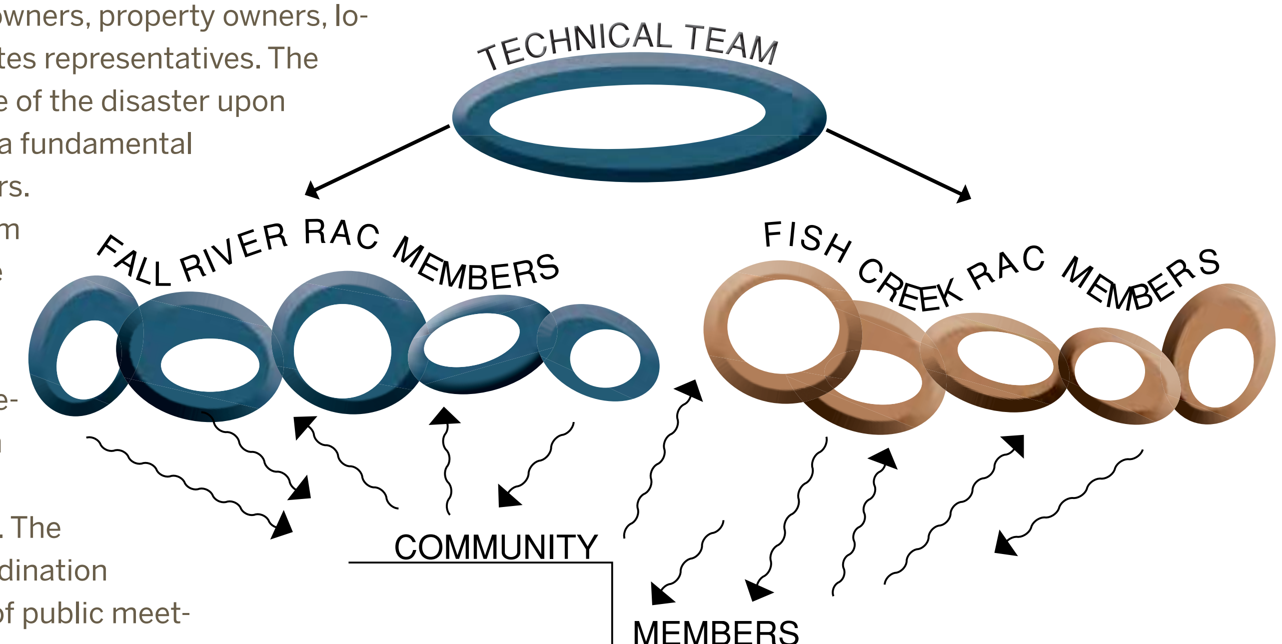

Estes Park Flood Expo August 2014

Larimer County Flood Open House March 2014

# 3 Community Outreach and Involvement

## 3.1 Objective

The preeminent objective guiding the development of the master plan was to set forth recommendations that were developed and vetted through a consensus based community process. To best accommodate the many different parties with interests in the Fish Creek corridor, the Town of Estes Park helped to assemble the Fish Creek Coalition to coordinate interested parties and most effectively advocate for health and resiliency of the stream corridors and the Town. The Fish Creek Coalition is comprised of representative community members including residents, business owners, property owners, local government agencies and Town of Estes representatives. The Fish Creek Coalition was built in the wake of the disaster upon the belief that the path forward requires a fundamental shift in how we view and plan for our rivers. While many think of the river as a problem that must be fixed, the Coalition sees the river as the linchpin in the solution.




To conduct flood recovery work a comprehensive approach, restoration of the Fish Creek corridor, will begin with the river corridor master plan development effort. The Master Plan was developed in close coordination with the Fish Creek Coalition in a series of public meetings, workshops, outreach, educational seminars and meetings, facilitated by the Master Plan Team and the Town of Estes Park.

A watershed approach defines, analyzes, and addresses river and creek problems in a holistic manner and ensures that the stakeholders in the watershed are actively involved in selecting the management strategies that fit with their local and cultural values. This approach was used to shape the Fish Creek Corridor Master Plan, turning the focus of the plan away from localized problems and solutions and towards projects that fit within the context of the greater river system—both physical and social. One of the primary purposes of this approach was to improve resident and land owner awareness through education on the issues affecting their river and watershed's resilience as well as the risks their property is exposed to.
Through the development of a common vision and over-arching goals for the river systems, the plan has suggestions for sequential and coordinated community actions in the years to come resulting from independent technical review and analysis and by involving a broad representation of stakeholders in the formation of the River Advisory Committee (RAC). Diverse interests were incorporated (including interests of NGOs and individuals) which worked to build participation and acceptance.

Fish Creek Public Meeting #1

Fish Creek Public Meeting #2

The partnerships formed in the development of the master plan established working relationships, improved communication, and allowed information to be shared all of which will allow the formation of the greater Estes Valley Coalition to succeed into the future. Furthermore, these partnerships encouraged conflict resolution, and promoted cooperation, while leveraging the talent and expertise, of the local individuals, organizations, and agencies, all of which collectively supports achievement of large-scale goals.

## 3.2 Master Plan Team

3.2.1 Formation and member entities Includes:

- Fish Creek Coalition
- Town of Estes Park – Community Development Department
- Technical Team
- River Advisory Committee

The technical team for the Plan for Resiliency is composed of professionals in multiple disciplines including engineering, fluvial geomorphology, risk analysis, ecology, landscape architecture and fisheries. The technical team includes Walsh Environmental, Robert Peccia & Associates (RPA), Crane Associates, Anderson Consulting Engineers (ACE), Round River Design and FlyWater.

The heart of the Fish Creek master planning process is the River Advisory Committee (RAC) which is a means to foster ownership of the planning process in the community, create a constant stream of public engagement, promote understanding of the issues and process, and expedite the acceptance and implementation of a final plan. The RAC held monthly meetings (or conference calls) which informed and guided the planning process. It is a forum in which invested individuals and organizations have the opportunity to help define values and vision, define issues, proposing projects and management strategies, and provide input on the final plans. Having representatives from every reach of the river, and from all sectors of the community, encourages all members and the planning team to consider Fish Creek as system-keys for the plan's success.

## 3.3 Public engagement process

A number of public outreach activities were conducted to assist in the planning process. This section describes the various public engagement techniques that were conducted during the development of the Fish Creek Corridor Plan for Resiliency.

### 3.3.1 Stakeholders

Stakeholders and agencies helped direct the development of the Fish Creek Corridor Plan for Resiliency, and provided input via meetings, work sessions, and a Fish Creek coalition web-site and Facebook page comment tool. Monthly meetings with representatives from Estes Park, the Technical Team and the RAC's were conducted at various location in Estes Park throughout the duration of the project to share information.

The stakeholders included:

- Town of Estes Park – Public Works Department
- Estes Valley Recreation and Park Development
- Estes Valley Land Trust
- Larimer County
- Home and Business Owners
- Rocky Mountain National Park
- the Estes Area Lodging Association
- Upper Thompson Sanitation District
- Estes Valley Recreation and Parks District

### 3.3.2 Public Meetings

A series of public meetings were conducted for the for the Fish Creek plan. The meetings were intended to inform the public of Plan activities and solicit input for the project.

Public meeting dates;
March 14, 2014 Fish Creek - Public Meeting #1
April 21. 2014 Fish Creek Public Meeting #2
November 12, 2014 - Draft Master Plan Open House

### 3.3.3 River Advisory Committee (RAC)

The heart of The Fish Creek Plan for Resiliency planning processes was to create a River Advisory Committee (RAC) for the corridor. The RAC was a means to foster ownership of the planning process in the community, create a constant stream of public engagement, promote understanding of the issues and process, and expedite the acceptance and implementation of a final plan.

The RAC held monthly meetings which informed and guided the planning process. It was a forum in which invested individuals and organizations had the opportunity to help define values and vision, define issues, proposing projects and management strategies, and provide input on the Plan for Resiliency.

In addition RAC neighborhood captains were assigned to designated reaches of Fish Creek. These neighborhood captains helped the planning team facilitate contact and discussions with all property owners as well as hold organized individual meetings with specific homeowners.

RAC meeting dates;
Fish Creek RAC meeting #2 - Wednesday July 30, 2014
Fish Creek RAC meeting #3 - August 14, 2014
Fish Creek RAC Meeting #4 - August 27, 2014
Fish Creek RAC meeting #5 - September 23, 2014

**Fish Creek RAC neighborhood captains**

| Stream Reach | Description | Neighborhood Captain |
|---|---|---|
| Upper Reach | Upstream of confluence at Little Valley Road | Kim Slininger & Donna Hasman |
| Middle Reach | Confluence at Little Valley downstream to Scott Ave | Chuck Bonza |
| Lower Reach | Downstream of Scott Ave to Lake Estes | Steve Deats |

**FALL RIVER and/or FISH CREEK** please circle for which corridor you are completing this form

**PART 1: PERSONAL VALUES**

*What do you and your family value in the Fall River and Fish Creek Corridors? Please check all that apply:*

- ☐ Soothing natural aesthetic
- ☐ Important for wildlife habitat
- ☐ Bird watching, wildlife viewing
- ☐ Supports healthy, native plant communities
- ☐ Socializing, source of community pride (e.g., the annual duck race)
- ☐ Other:
- ☐ Important draw for business
- ☐ Hike along it, fish it, wade in it, skip rocks, build sandcastles, and more
- ☐ Important for water quality, air quality groundwater replenishment, soil stabilization
- ☐ Protection/ expect it to not threaten my property

**PART 2: Evaluation Criteria**

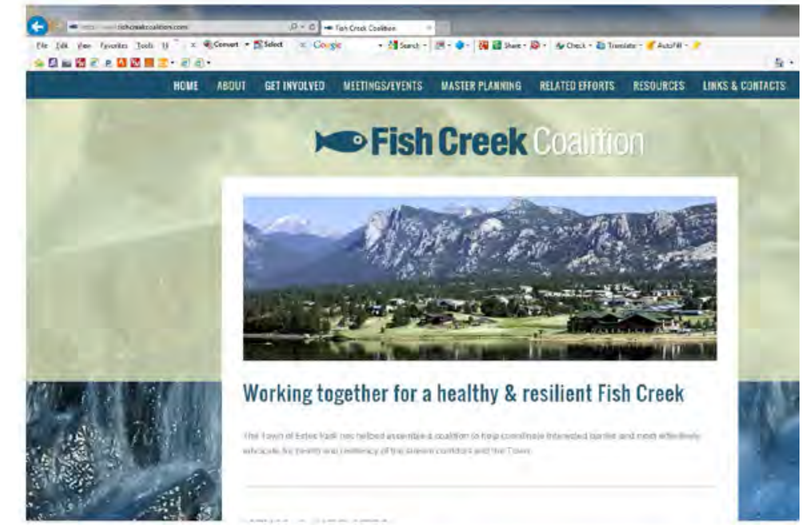
The Fish Creek and Fall River Corridor Master Plans rely on many criteria to evaluate, rank, and prioritize potential flood recovery and restoration projects. Listed below you will find a list of many of the characteristics, goals, objectives, and benefits of potential projects. **Please rank on a scale of 0 to 5, with 5 being the highest score possible, how important each of these statements is to you with regard to Fall River and Fish Creek recovery and restoration.**

— Address safety of the public and residents
— Restore public access and utility service without restricting access to private properties
— Provide access to recreational amenities, schools, and businesses
— Allow continued utility service during construction
— Reduces flood and geomorphic hazards to reduce future damage
— Increases river stability, reduces future erosion
— Improves stream health
— Complete projects in the shortest time possible
— Complete the reconstruction while lowering risk to permanent infrastructure and the public
— Create infrastructure investments that are reasonable to construct
— Projects with best value for their life cycle
— Meet Federal and Local standards for design
— Effectively uses undamaged infrastructure
— Incorporates new flood flow/ rainfall information
— Is innovative
— Provides neighborhood and reach scale solutions requiring multiple land owners to come to consensus
— Enhance tourist destinations
— Enhances access to tourist destinations
— Enhances access to community facilities, and neighborhoods
— Enhances access to neighborhoods
— Other:
— Enhances *local* natural outdoor recreational opportunities such as trails (hiking ,biking, and equestrian) and fishing
— Enhances *regional* natural outdoor recreational opportunities
— Enhances community supported recreation opportunities such as golf, camping and water based activities (canoeing, kayaking, stand up paddleboarding, motorboats, waterskiing etc.)
— Enhance neighborhood & community livability
— Enhance neighborhood & community aesthetics
— Preserve neighborhood & community culture & history
— Incorporate input from property owners
— Incorporate input from the community
— Incorporate input from conservation and environmental organizations
— Incorporate input from businesses and business leaders
— Protect and enhance fish habitat
— Protect and enhance avian habitat
— Protect and enhance beaver habitat
— Protect and enhance stream corridor vegetation
— Enhances water quality
— Provides the corridor with multiple benefits (e.g. flood mitigation, habitat enhancements, recreation and public access)
— Limits maintenance costs
— Uses locally available materials
— Uses environmentally friendly processes

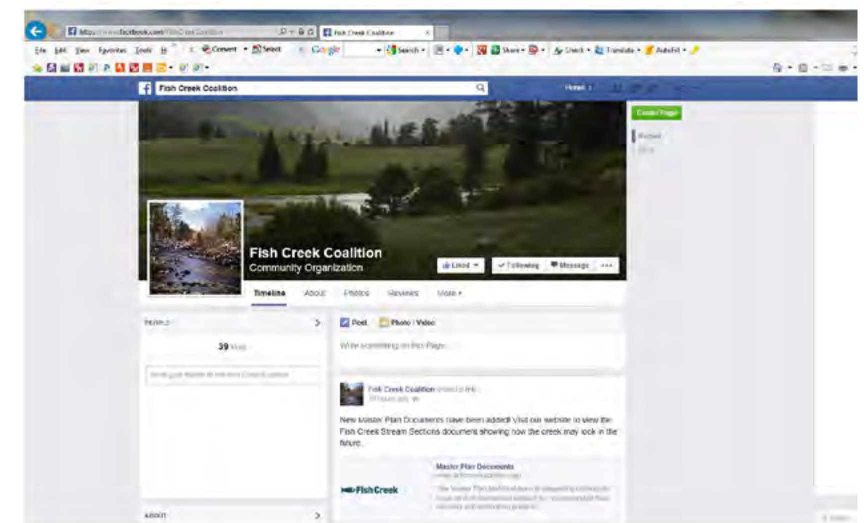
Please return completed form by Oct 20, 2014 to the Town of Estes Park Community Development Department at planning@estes.org or PO Box 1200, Estes Park, CO 80517.

### 3.3.4 Values & Evaluation Criteria Survey

The Fish Creek Plan for Resiliency relies on many criteria to evaluate, rank, and prioritize potential flood recovery and restoration projects. A survey was created to evaluate and help define characteristics, goals, objectives, and benefits of potential projects for the Plan for Resiliency. They were ranked on a scale of 0 to 5, with 5 being the highest score possible, of importance the statements are to the residents for Fish Creek recovery and restoration.




Fish Creek Coalition Website




Fish Creek Coalition Facebook Page

### 3.3.5 Project Website and Facebook Page

A project website was created to assist in keeping the Fish Creek residents up to date on project milestones and progress. The website was a portal for information about Meetings/events, comments, related efforts, flood resources, and weekly updates.

The Facebook page was used for meeting notifications, public comments, and notifications of other planning efforts.

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Before and After Baldplate Inn

## 4.0 Watershed Background and Description

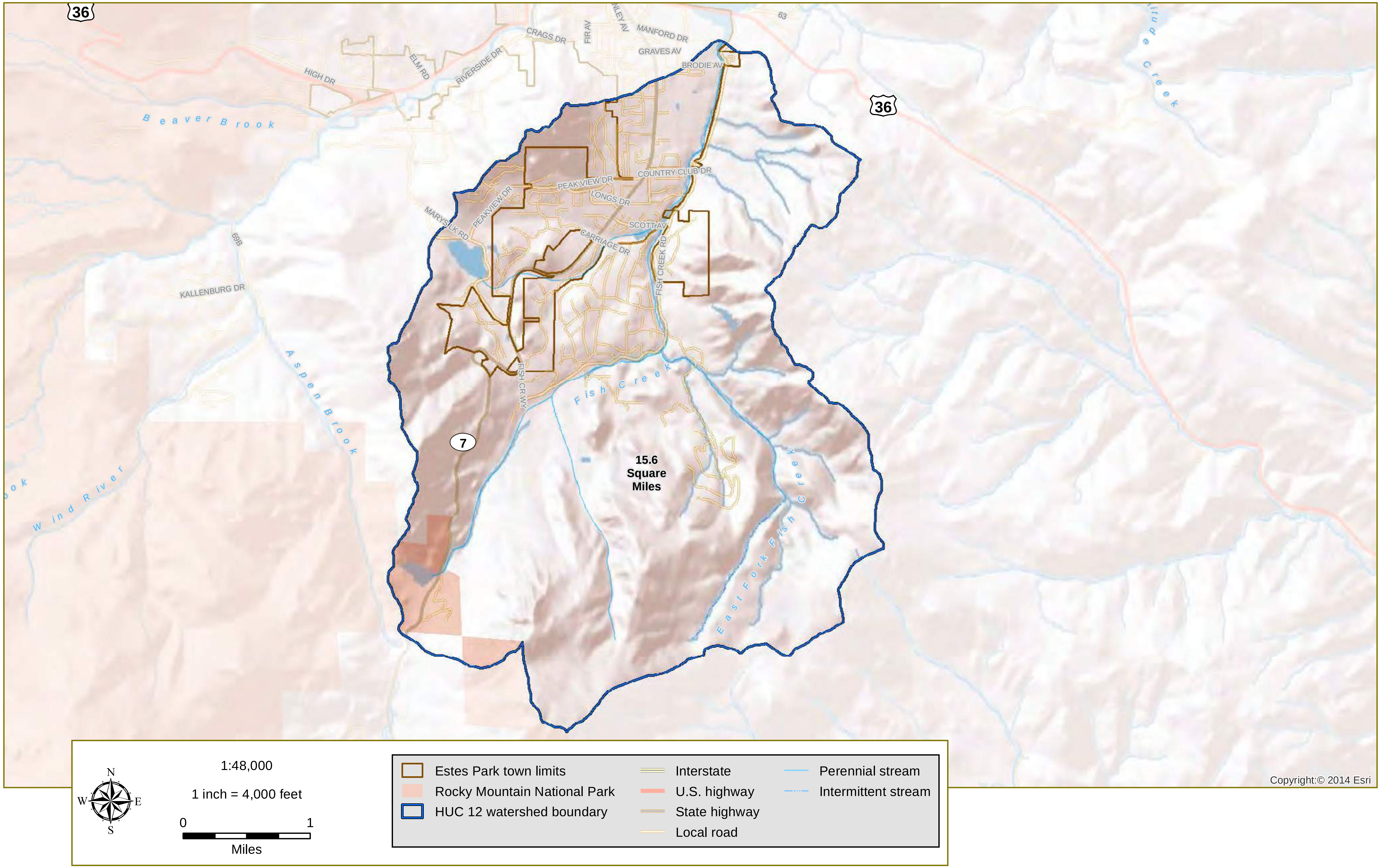
### 4.1 Location

The Fish Creek Watershed is approximately 15.6 square miles located in north central Colorado. The main stem of Fish creek is approximately 5 miles long, and an additional mile on the east fork of Fish Creek was also considered in this plan. The Fish Creek drainage extends to the south and west as far as Lily Lake and Mary Lake. The headwaters are in Arapaho & Roosevelt Nation Forest southeast of Estes Park. Fish Creek is a tributary of the Big Thompson River and the confluence is at Lake Estes, east of Estes Park.

The elevation in the watershed ranges from 11,418 feet at Twin Sisters Peak and 7,485 feet at the confluence with Lake Estes. The climate is defined by cold winters and warm summers with average temperature in Estes Park of 44 degrees F. In the past decade, Estes Park received an average of 13 inches of precipitation a year.

The main fork of Fish Creek runs along Fish Creek Road, and the east fork runs along Little Valley Road and Jacob Road. The upper portion of Fish Creek watershed is a lightly developed residential region that includes Lilly Lake and Marys Lake. The lower four miles of Fish Creek flows through a medium density residentially developed zone, which structures near to the river's edge in some places. The residential population along Fish Creek is primarily composed of permanent residents in single family homes, with some short-term accommodations. A golf course and Estes Parks schools are located on the west side of Fish Creek in the last mile before the confluence at Lake Estes.

Fish Creek is an important aesthetic draw for local residents. It provides access to areas for wildlife viewing and bird watching. The trail along Fish Creek and fish Creek road connects the residential areas to Lake Estes and the schools. The drainage from Marys Lake to Fish Creek is also an important trail connection. Fish Creek is not a strong fishing destination.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Beaver Brook
Aspen Brook
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Fish Creek
East Fork Fish Creek
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CRAGS DR
ELM RD
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MANFORD DR
GRAVES AV
BRODIE AV
COUNTRY CLUB DR
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Interstate
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State highway
Local road
Perennial stream
Intermittent stream

## 4.1 Flood History

### 4.2.1 Historic

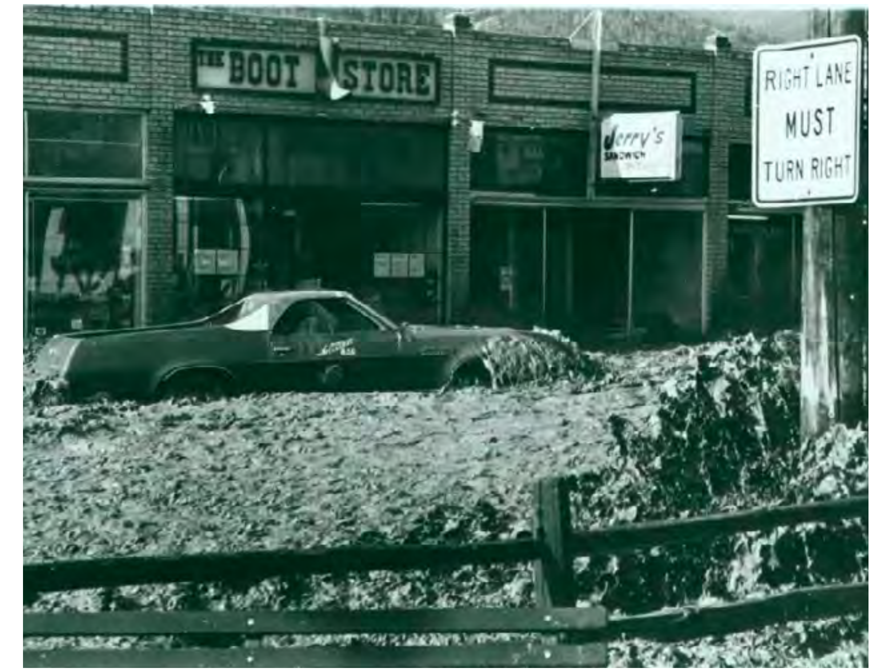
### 4.2.2 September 2013 Flood

In Fish Creek, the floodwaters of the September 2013 storm event so greatly exceeded flow volumes typically carried by the small tributary, that the dominant post-flood condition in Fish Creek is extensive scouring of channel bed and banks, leaving the channel orders of magnitude deeper and wider. The floodwaters also delivered substantial volumes of fine grained sediments to Fish Creek. In some areas, the fine sediment supply was in excess of the transport capacity to convey the material, resulting in significant deposition areas. As in Fall River and Big Thompson River, these deposited materials are now available for transport during the spring runoff, which will not likely flush it entirely from the system. Rather, sediments will move episodically downstream and redeposit, eventually moving through over the course of several runoff events.

The Brook Court to Country Club Reach was identified after the 2013 flood as a 'high threat' area in post-flood spring runoff. This site received extensive sand deposition estimated at 4 feet in depth over 800 feet in length and over 100 feet in width during the September flooding. The threat at this site is tied to the potential for backwatering upstream from the sand deposition before spring flows begin to transport the fine sediments and carve a larger path through the depositional area.

With the impending high flows of annual spring runoff, this location of substantial aggradation poses an imminent threat to homes and infrastructure in the immediate vicinity due to higher water surface elevations. A primary threat is damage to the temporary sewer line, which has been recently installed following the September flooding. The temporary line is extremely vulnerable, with sections crossing the main channel

1982 Flood waters through Estes Park During the Lawn Lake Flood. Photo Courtesy of the Estes Park Museum.




Rushing water on Elkhorn Ave. during the 1989 Lawn Lake Flood. Photo Courtesy of the Estes Park Museum.


Elkhorn Ave. during the 1989 Lawn Lake Flood . Photo Courtesy of the Estes Park Museum.

1982 Lawn Lake Flood at Ponderosa Lodge on Fall River. Photo Courtesy of the Estes Park Museum.

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# 5 Data Collection

## 5.1 GIS Data and Mapping

GIS data and mapping was employed in the risk analysis and project recommendation phases of the master plan. The data employed includes publicly available data and GIS data generated by the technical team in the process of various risk assessment tasks. The following table summarizes the public data utilized in the master planning effort

In the process of completing the risk assessments GIS boundaries were developed for the ecosystem quality, planning-level Channel Migration Zone, and floodplain extents for the post-flood condition.

| Data Type | Source | Date |
|---|---|---|
| Post-flood Aerial imagery | Larimer Emergency Telephone Authority (LETA)/Digital Globe | 2013 |
| Pre-flood Aerial imagery | Bing/ESRI | 2011 |
| Pre-September 2013 River Alignment | LiDAR - NEON/NSF Grant No. DBI-0752017 | 2011 |
| Post-September 2013 River Alignment | Preliminary LiDAR - FEMA/Photo Science Geospatial Solutions | Feb 2014 |
| Parcels | Larimer County | July 10, 2014 |
| Utilities (Potable water and Sanitary Sewer) | Town of Estes Park | June 3, 2014 |
| Pre-September 2013 Trail Alignment | Town of Estes Park | Mar 2013 |
| Estes Park Town Limits | Town of Estes Park | No metadata |
| Rocky Mountain NP Limits | Town of Estes Park | No metadata |
| Road Alignments | Town of Estes Park | Mar 2013 |
| Floodplains (FIRM) | FEMA | Mar 2013 |
| Post-Awareness Floodplains | Anderson Consulting Engineers | Sep 2014 |


GIS Mapping

## 5.2 Identified Reaches

As a first step in the rapid geomorphic assessment, Walsh scientists and engineers identified geomorphic reaches, or sections of the Fall River, with roughly homogenous physical and dynamic characteristics. The purpose of delineating reaches is to "break down" river networks into physically homogenous sections for planning purposes. These reach characteristics can then be used to "build-up" an understanding of the systemic interactions within the watershed. Geomorphic reaches were identified based on one or more of the following criteria:

- Changes in gradient (proportional to sediment transport capacity)
- Changes in valley width and channel confinement
- Tributary junctions (changes in the ratio of sediment transport capacity to sediment supply)
- Changes in channel pattern (sinuosity)
- Changes in infrastructure that control lateral erosion and migration
- Changes in geology/ erodibility of adjacent valley slopes
- Changes in land use

In total, 17 geomorphic reaches were identified within the Fall River study area

Biological assessment protocols (SVAP2) call for ecological "reaches" that are frequently shorter than the geomorphic reaches described above. The rapid ecological assessment of the Fall River corridor conducted by Walsh scientists identified 22 reaches during the ecological assessment. The additional reaches identified were frequently a subdivision of the geomorphic reaches based on changes in streamside development or vegetation.

## 5.3 Field Work

Fish Creek field work consisted of a Rapid Geomorphic and Rapid Ecological assessment. The field technical team conducted this work in March and April of 2014 by observing Fish Creek at strategic access points along the entire corridor. Aerial photographs printed at large scale were used as base

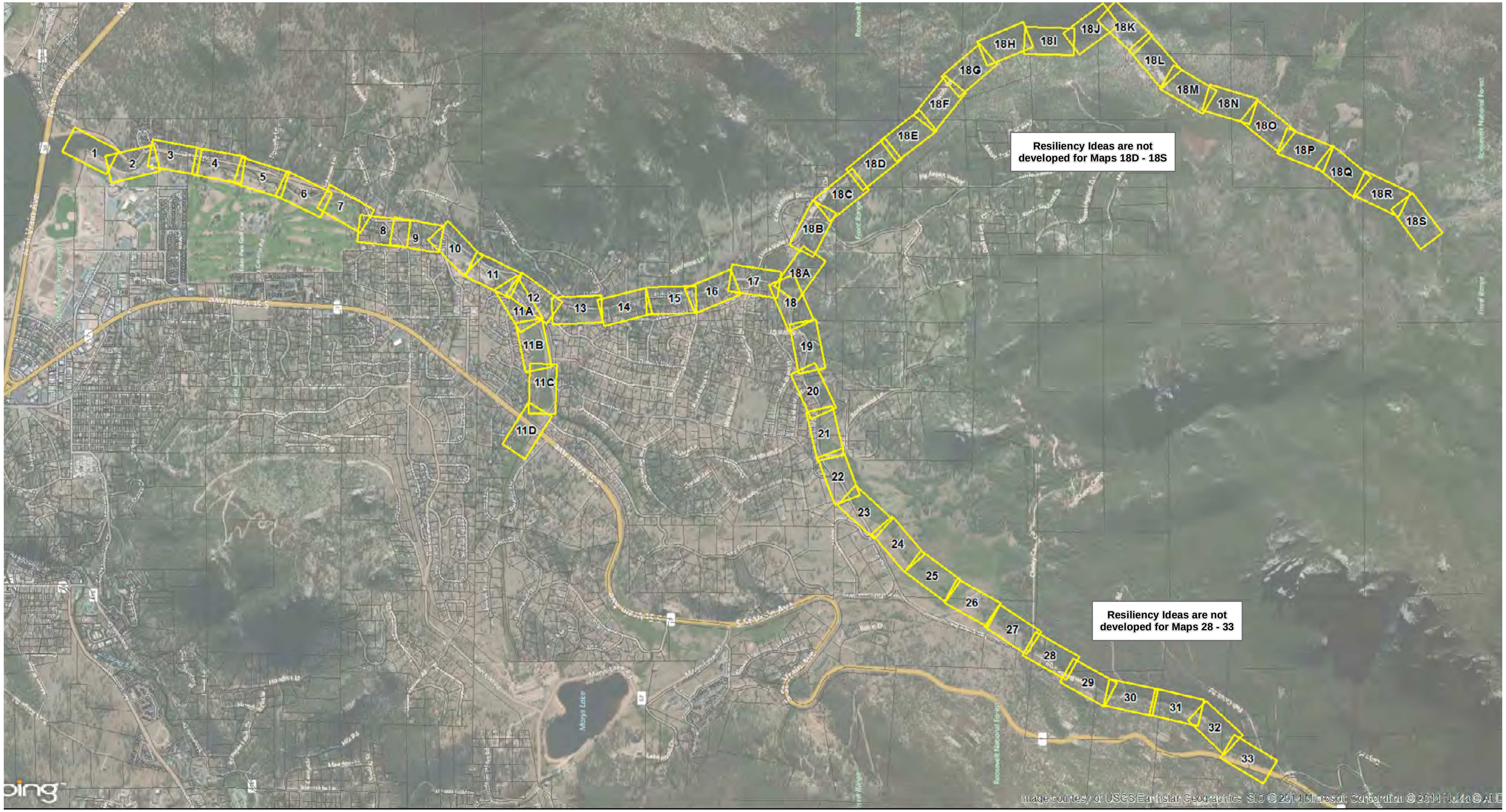
Table XX: Geomorphic reach descriptions for the Fish Creek Study

| Stream | Reach # | Upstream Start (approx.) | Downstream End (approx.) |
|---|---|---|---|
| Fish Creek | 9 | Lily Lake Outlet | Cheley Camps Access Road |
| Fish Creek | 8 | Cheley Camps Access Road | Rockwood Lane Crossing |
| Fish Creek | 7 | Rockwood Lane Crossing | East Fork Fish Creek Confluence |
| Fish Creek | 6 | East Fork Fish Creek Confluence | Brook Lane Crossing |
| Fish Creek | 5 | Brook Lane Crossing | Scott Avenue Crossing |
| Fish Creek | 4 | Scott Avenue Crossing | Brook Drive Crossing |
| Fish Creek | 3 | Brook Drive Crossing | Golf Course Hole #17 |
| Fish Creek | 2 | Golf Course Hole #17 | Estes Park High School |
| Fish Creek | 1 | Estes Park High School | Lake Estes |
| East Fork Fish Creek | 3-E | Headwaters | Little Valley Road Ponds |
| East Fork Fish Creek | 2-E | Little Valley Road Ponds | Jacob Road Crossing |
| East Fork Fish Creek | 1-E | Jacob Road Crossing | Fish Creek Confluence |

maps and were marked up with notes during the assessment. Photographs were taken at each reach to document existing conditions. Sites of particular geomorphic or biologic interest were also photographed – specifically as project development ideas were being discussed. The team completed the SVAP2 field data sheets collectively and discussed geomorphic conditions, processes, and stressors. Follow up field visits were conducted in June and July to confirm existing, reference, and potential geomorphic conditions.

Technical Team Conducting Corridor Evaluations

Fish Creek Key Map

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## 5.4 Values & Evaluation Criteria Survey

A public survey of personal values and evaluation criteria was

A public survey of personal values and evaluation criteria was used to guide and compare the recommended projects. To improve continuity with other organizations working on flood recovery, the survey used for the Plan for Resiliency was the same as NRCS and CDOT. The survey asked the participant to mark which of nine values they personally held for the river, and then to give each of 39 evaluation criteria a rank between 0 and 5 for importance to them. Both the personal values and evaluation criteria sections had spots to write-in other responses. Public surveys were distributed at the public meetings, through the coalition website, through the coalition's facebook account, by email, and by US mail to local residents. A total of 29 survey responses were received, and the results of the survey are summarized below.

## 5.5 Related Plans and Documents

Numerous other studies and planning efforts were used to support the development of the Fall River Corridor Master Plan. These documents provide scientific, social, and political basis for this plan.

- Fall River Corridor Master Plan (November 2014)
- Estes Valley Comprehensive Plan (December 16, 1996, revised 2014)
- Big Thompson River Master Plan
- Left Hand Creek Watershed Master Plan
- 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
- Exceedance of Probability Analysis for the Colorado Flood Event, September 9-16, 2013
- CDOT/CWCB Hydrology Investigation Phase One – 2013 Flood Peak Flow Determinations

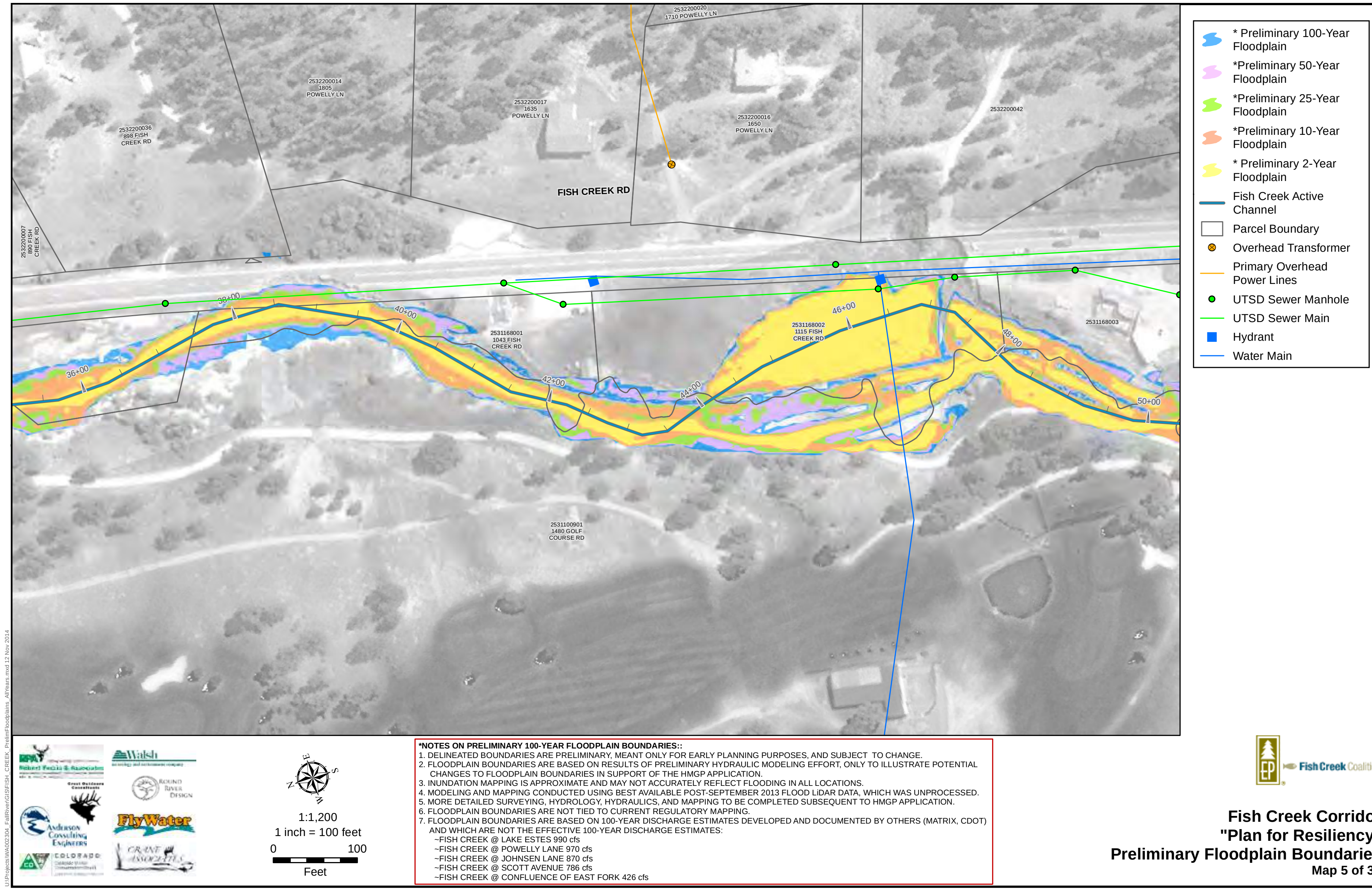
| ID | PERSONAL VALUES *Ranked from survey response* | Ranking |
|---|---|---|
| 2 | Important for wildlife habitat | 8 |
| 1 | Soothing natural aesthetic | 7 |
| 4 | Supports healthy, native plant communities | 7 |
| 8 | Important for water quality, air quality, groundwater replenishment, soil stabilization | 7 |
| 3 | Bird watching, wildlife viewing | 6 |
| 9 | Protection/ expect it to not threaten my property | 6 |
| 7 | Hike along it, fish it, wade in it, skip rocks, build sandcastles, and more | 4 |
| 5 | Socializing, source of community pride | 1 |
| 10 | Other: *Road access to Fish Creek Road/ Use of the bike path* | 1 |
| 11 | Other: *It's home* | 1 |
| 6 | Important draw for business | 0 |
| **ID** | **EVALUATION CRITERIA** *Ranked from survey response* | **Ranking** |
| 4 | Allow continued utility service during construction | 135 |
| 6 | Increases river stability, reduces future erosion | 129 |
| 5 | Reduces flood and geomorphic hazards to reduce future damage | 127 |
| 2 | Restore public access and utility service without restricting access to private properties | 123 |
| 27 | Incorporate input from property owners | 119 |
| 1 | Address safety of the public and residents | 114 |
| 7 | Improve stream health | 113 |
| 9 | Complete the reconstruction while lowering risk to permanent infrastructure and the public | 102 |
| 24 | Enhance neighborhood & community livability | 99 |
| 8 | Complete projects in the shortest time possible | 98 |
| 37 | Limits maintenance costs | 90 |
| 21 | Enhances *local* natural outdoor recreational opportunities such as trails (hiking ,biking, and equestrian) and fishing | 88 |
| 36 | Provides the corridor with multiple benefits (e.g. flood mitigation, habitat enhancements, recreation and public access) | 87 |
| 14 | Incorporates new flood flow/ rainfall information | 85 |
| 20 | Enhances access to neighborhoods | 85 |
| 25 | Enhance neighborhood & community aesthetics | 84 |
| 10 | Create infrastructure investments that are reasonable to construct | 83 |
| 12 | Meet Federal and Local standards for design | 83 |
| 11 | Projects with the best value for their life cycle | 82 |
| 13 | Effectively uses undamaged infrastructure | 81 |
| 34 | Protect and enhance stream corridor vegetation | 80 |
| 35 | Enhances water quality | 80 |
| 28 | Incorporate input from the community | 77 |
| 39 | Uses environmentally friendly processes | 77 |
| 3 | Provide access to recreational amenities, schools, and businesses | 76 |
| 31 | Protect and enhance fish habitat | 71 |
| 19 | Enhances access to community facilities, and neighborhoods | 67 |
| 32 | Protect and enhance avian habitat | 67 |
| 16 | Provides neighborhood and reach scale solutions requiring multiple land owners to come to consensus | 66 |
| 38 | Uses locally available materials | 63 |
| 29 | Incorporate input from conservation and environmental organizations | 61 |
| 22 | Enhances *regional* natural outdoor recreational opportunities | 59 |
| 15 | Is innovative | 53 |
| 26 | Preserve neighborhood & community culture & history | 52 |
| 23 | Enhances community supported recreation opportunities such as golf, camping and water based activities (canoeing, kayaking, stand up paddleboarding, motorboats, waterskiing etc.) | 48 |
| 33 | Protect and enhance beaver habitat | 37 |
| 30 | Incorporate input from businesses and business leaders | 36 |
| 18 | Enhances access to tourist destinations | 30 |
| 17 | Enhance tourist destinations | 28 |
| 41 | Other: Maintain current property boundaries | 20 |
| 42 | Other: No eminent domain acquisitions | 20 |
| 40 | Other: Preserve or build property values | 10 |
| 43 | Other: Restore Fish Creek Hiking Trail | 5 |

Future planning and development efforts should refer to these documents in their own efforts. Coordinating with other coalitions and planning efforts could be advantageous for funding opportunities and long-term success of the projects. Further references for these documents are provided in the References section.

Fish Creek Flood Damage

## 5.6 Regulatory Floodplains

FEMA 100-yr regulatory floodplain maps were collected by the technical team for the master planning; however they were not prioritized in the master planning risk assessments. The current regulatory floodplain extents are known to be under-estimated on account of an unrealistically low 100-year discharge being employed in the analysis. Additionally, changes in the local topography as a result of the September 2013 floods render the current maps inaccurate. As a result, the technical team focused on updating the flood discharge estimates to more realistic values, and incorporated the new topography and changes in river crossings to best represent the current state of floodplain extents. This work is summarized with more detail in Section 6.4.




Fish Creek Post Flood Conditions

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# 6 River Corridor Risk Assessment

## 6.1 Overview

A solid understanding of the river corridor underpins the risk-based planning process. Flood mitigation, safety, hydrologic and structural function, biology and environment, and resiliency were assessed using semi-quantitative methods in order to evaluate relative risk throughout the Fish Creek corridor. The following assessments were used to rank stream reaches and specific community assets for potential of flood and/or geomorphic damage.

1. Hydrologic data
2. Community asset inventory
3. Ecologic assessment using the SVAP2 protocol
4. Geomorphic risk assessment, including an assessment of sediment transport
5. Erosion hazard assessment, including reach-wide geomorphic hazards of debris flows, slope failures and bank erosion, alluvial fans, headcuts, and avulsions
6. Flood risk assessment, including updating existing hydrologic data, development of hydraulic model for 2-, 10-, 50-, 100-, and 500-year flows (calibration to recent flows), and floodplain mapping (2- to 100-year).

Structures and infrastructure at risk were noted during the SVAP2 field assessments.

## 6.2 Ecosystem Risk Assessment

A healthy, resilient stream ecosystem is one that maintains key ecological and physical functions though varied hydrologic conditions, though 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.

As part of the Fish Creek Corridor Master Planning effort, scientists and engineers from Walsh Environmental completed a rapid ecologic stream assessment of Fish 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

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an overall understanding of the vulnerabilities that certain key species may have in the Fish Creek and assist with focusing appropriate restoration strategies.

The application of the SVAP2 protocol includes the evaluation of features in the stream system 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 1: SVAP2 Ecologic Stream Assessment – Ecosystem Elements. 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.

### 6.2.1 Methodology

The first task in the ecologic stream assessment was to divide Fish Creek into reaches of similar geomorphic form. Aerial imagery and high-resolution topography were evaluated to identify changes in geomorphic conditions (gradient, channel form, tributary confluences, etc.) which dictated locations of reach breaks. The reach breaks were adjusted, if necessary, during the initial field investigation. Ultimately, Fish Creek was divided into 15 ecosystem reaches (Table 2a) and East Fork Fish Creek was divided into 10 ecosystem reaches (Table 2b). Each reach was evaluated using the SVAP2 protocol. Table 1 describes the elements assessed as part of the SVAP2 protocol. Each element is scored with a value of zero to 10, where a higher score indicates a more healthy system. An overall score was assigned to each reach, based on the average of the scores for the 12 elements.

### 6.2.2 Results (Figure Maps in Appendix)

The resulting SVAP2 scores are presented in Table 3 and the overall score is mapped by reach in Figure 1. 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

Nearly the entire lower reach downstream of Little Valley Drive is rated as "poor" or "severely degraded" due to the loss of riparian vegetation, canopy cover, pools, fish and invertebrate habitat complexity (notably in the form of wood), and the excessive deposition of fine sediments. Reaches above Little Valley Drive are generally "fair" with better riparian vegetation and slightly more complex fish habitats. In general, Fish Creek has "good" to "excellent" SVAP scores in its most upper reaches both along the main steam and the East Fork. However, as the creek encounters roadways, horse pastures, and development, the overall ecosystem scores drops substantially.

#### 6.2.2.1 Channel Stability

Channel stability is specifically addressed in Section 6.3 Geomorphic Risk. The channel stability as measured through the SVAP2 protocol was included in the ecosystem scores.

#### 6.2.2.2 Water Quantity

The water quantity and timing in Fish Creek is mostly unaltered, with the exception of some floodplain development; therefore the natural flow regime prevails in the majority of the system.

#### 6.2.2.3 Water Quality

General water quality related to the presence of manure and/or septic was visually assessed along the Fish Creek corridor. There are several locations in the upper reaches of the mainstem of and East Fork of Fish Creek where horse pasture intersect the creek allowing untreated animal waste to flow directly into the creek and into downstream reaches.

#### 6.2.2.4 Vegetation

The scores for vegetation quantity and quality and canopy cover along the Fish Creek corridor were averaged into one score as presented in Figure 2. Nearly every reach along the Fish Creek corridor has been rated as having "severely degraded" or "poor" vegetation, with the exception of the uppermost reaches of mainstem Fish Creek and East Fork Fish Creek. The degradation has been caused by either flood damage or horse pasture access.

#### 6.2.2.5 Instream Habitat

An assessment of instream habitat, including pool presence, barriers to fish movement, fish and aquatic invertebrate habitat complexity, and riffle embeddedness, for the Fish Creek corridor is presented in Table 3. The scores representing fish habitat complexity and pool presence are displayed in Figure 3 and Figure 4, respectively. Fish habitat is severely lacking in the Fish Creek system, all of the mainstem reaches are rated as "severely degraded," "poor," or "fair." The East Fork of Fish Creek has the best fish and aquatic macroinvertebrate habitats, and is the only location in the Fish Creek system where fish habitat can currently be considered "good." Similarly, the presence of pools in the mainstem of Fish Creek is considerably limited, with only three reaches receiving a "fair" rating, the remaining mainstem reaches were rated as "severely degraded" or "poor."

Riffle embeddedness is a prominent issue for mainstem Fish Creek, the channel has large unmitigated fine sediment sources and this material is working its way through the system.

Additionally, Fish Creek has several barriers to fish movement including a breached culvert and a concrete encased sewer line causing substantial drops (Reaches 3 and 5, respectively), undersized culverts (Reaches 6 and 7), a beaver dam (Reach 8), large (approximately 6-foot high) headcuts (Reaches 10 and 14), moderate (approximately 1- to 2-foot high) headcuts (Reaches 8, 11, 13), and sediment-laden culverts (Reaches 11, 13, 14).

Similarly in East Fork Fish Creek, barriers to fish movement included moderate (approximately 1- to 3-foot high) headcuts (Reaches 1, 3a, and 4b), large (approximately 4- to 6-foot high) headcuts (Reaches 3a and 5), sediment-laden culverts (Reach 3a), and man-made structures causing substantial drops (Reach 4b).

**Table 1 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, withdrawls, 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. 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. |
| 8. 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. |
| 9. 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. |
| 10. 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. |
| 11. 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 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. | 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 channels or floodplains, and must include at least one wood/riffle combination. Low Score: No habitat features available. |
| 12. Riffle Embeddedness | Embeddedness measures the degree to which gravel and cobble substrates in riffles are surrounded by fine sediments. It is a measure of the suitability of the stream for macroinvertebrates, fish spawning, and fish egg incubation as reaches with high embeddedness suffocate eggs and macroinvertebrates. | High Score: Gravel or cobble substrates are less than 10 percent embedded. Low Score: Gravel or cobble substrates are greater than 40 percent embedded. |

**Table 2a Fish Creek Reach Break Descriptors**

| Reach Number | Downstream End | Upstream End |
|---|---|---|
| 1 | Delta at Lake Estes | 500 ft downstream from Van Horn Engineering |
| 2 | 500 ft downstream from Van Horn Engineering. | Country Club Dr. |
| 3 | Country Club Dr. | A-1 Excavating |
| 4 | A-1 Excavating | 2149 Fish Creek Rd. |
| 5 | 2149 Fish Creek Rd. | Brook Ln. |
| 6 | Brook Ln. | Whispering Pines Dr. |
| 7 | Whispering Pines Dr. | Little Valley Dr. |
| 8 | Little Valley Dr. | Rockwood Cir. |
| 9 | Rockwood Cir. | Rock outcrop just upstream of Sanborn Dr. |
| 10 | Rock outcrop just upstream of Sanborn Dr. | Rockwood Ln. |
| 11 | Rockwood Ln. | Meadow (105°31'13.603"W 40°19'40.054"N) |
| 12 | Meadow (105°31'13.603"W 40°19'40.054"N) | 200ft downstream of Fish Creek Rd. |
| 13 | 200ft downstream of Fish Creek Rd. | Rockwood Creek (Cheley Camp) |
| 14 | Rockwood Creek (Cheley Camp) | Fish Creek Rd. cul-de-sac |
| 15 | Fish Creek Rd. cul-de-sac | Lily Lake |

**Table 2b East Fork Fish Creek Reach Break Descriptors**

| Reach Number | Downstream End | Upstream End |
|---|---|---|
| 1 | Confluence with Fish Creek | Little Valley Dr. |
| 2 | Little Valley Dr. | Barn (40°19'48.01"N 105°29'43.27"W) |
| 3 | Barn (40°19'48.01"N 105°29'43.27"W) | Jacob Rd. crossing (downstream) |
| 4 | Jacob Rd. crossing (downstream) | Jacob Rd. crossing (upstream) |
| 5 | Jacob Rd. crossing (upstream) | - |
| 6 | Confluence with eastern tributary | - |
| 2a | Confluence with East Fork | 40°19'44.78"N 105°29'54.77"W |
| 3a | 40°19'44.78"N 105°29'54.77"W | Confluence with of upper West Fork tributaries |
| 4a | Confluence with of upper West Fork tributaries | Upper end of western tributary |
| 4b | Confluence with of upper West Fork tributaries | Upper end of eastern tributary |

Road and Bridge Damage - Fish Creek Road and Whispering Pines

**Table 3a SVAP2 Results for Fish Creek**

| Reach | Stream Slope (%) | Channel Condition | Hydrologic Alteration | Bank Condition | Riparian Quantity | Riparian Quality | Canopy Cover | Vegetation Composite | Manure or Septic | Pools | Barriers to Movement | Fish Habitat Complexity | Aquatic Invertebrate Habitat | Embeddedness | Overall Ecosystem Score | Reach |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.14 | 1 | 9 | 1 | 1 | 1 | 0 | 0.7 | 10 | 0 | 10 | 0 | 1 | 0 | 2.8 | 1 |
| 2 | 1.69 | 1 | 9 | 1 | 0 | 0 | 0 | 0.0 | 10 | 0 | 10 | 0 | 1 | 0 | 2.7 | 2 |
| 3 | 1.75 | 1 | 9 | 1 | 0 | 0 | 0 | 0.0 | 10 | 0 | 8 | 0 | 1 | 0 | 2.5 | 3 |
| 4 | 2.11 | 3 | 9 | 3.5 | 2 | 1.5 | 1 | 1.5 | 8 | 0 | 10 | 0 | 1 | 1 | 3.3 | 4 |
| 5 | 2.48 | 3 | 9 | 3 | 0.5 | 0.5 | 1 | 0.7 | 10 | 0 | 3 | 0 | 1 | 1 | 2.7 | 5 |
| 6 | 2.60 | 2 | 9 | 1 | 2 | 1 | 1 | 1.3 | 9 | 1 | 7 | 2 | 3 | 1 | 3.3 | 6 |
| 7 | 3.45 | 4 | 9 | 5 | 4 | 4 | 4 | 4.0 | 10 | 4 | 8 | 5 | 6 | 3 | 5.5 | 7 |
| 8 | 3.96 | 4 | 9 | 5 | 6.5 | 6.5 | 4 | 5.7 | 10 | 6 | 8 | 5 | 6 | 5 | 6.3 | 8 |
| 9 | 2.71 | 4 | 9 | 4 | 5 | 4.5 | 4 | 4.5 | 10 | 2 | 10 | 4 | 5 | 2 | 5.3 | 9 |
| 10 | 4.23 | 1 | 9 | 0 | 1 | 2 | 1 | 1.3 | 10 | 2 | 1 | 2 | 3 | 3 | 2.9 | 10 |
| 11 | 4.01 | 4 | 9 | 6 | 9 | 4 | 1 | 4.7 | 10 | 5 | 1 | 5 | 6 | 5 | 5.4 | 11 |
| 12 | 4.45 | 2 | 9 | 1 | 5 | 4 | 1 | 3.3 | 10 | 6 | 10 | 3 | 4 | 6 | 5.1 | 12 |
| 13 | 5.88 | 0 | 9 | 1 | 1 | 1 | 1 | 1.0 | 0 | 2 | 8 | 1 | 2 | 1 | 2.3 | 13 |
| 14 | 8.92 | 4 | 9 | 4 | 7 | 6 | 7 | 6.7 | 8 | 2 | 1 | 6 | 7 | 4 | 5.4 | 14 |
| 15 | 13.53 | 6 | 9 | 9 | 8.5 | 9.5 | 10 | 9.3 | 10 | 1 | 10 | 5 | 6 | n/a | 7.6 | 15 |

**Table 3b SVAP2 Results for East Fork Fish Creek**

| Reach | Channel Condition | Hydrologic Alteration | Bank Condition | Riparian Quantity | Riparian Quality | Canopy Cover | Vegetation Composite | Manure or Septic | Pools | Barriers to Movement | Fish Habitat | Aquatic Invertebrate | Embeddedness | Overall Ecosystem | Reach |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 5 | 9 | 5 | 6 | 6 | 4 | 5.3 | 10 | 9 | 4 | 7 | 8 | 9 | 6.8 | 1 |
| 2 | 5 | 9 | 5 | 6 | 6 | 4 | 5.3 | 10 | 8 | 10 | 7 | 8 | 9 | 7.3 | 2 |
| 3 | 3 | 9 | 3 | 3.5 | 3.5 | 1 | 2.7 | 6 | 4 | 10 | 2 | 3 | 9 | 4.8 | 3 |
| 4 | 5 | 9 | 4 | 2 | 2 | 1 | 1.7 | 10 | 1 | 10 | 1 | 2 | 9 | 4.7 | 4 |
| 5 | 7 | 9 | 6 | 9 | 9 | 8 | 8.7 | 10 | 8 | 4 | 8 | 9 | 9 | 8.0 | 5 |
| 6 | 7 | 9 | 8 | 9 | 9 | 8 | 8.7 | 10 | 8 | 10 | 6 | 7 | 9 | 8.3 | 6 |
| 2a | 1 | 9 | 2 | 6.5 | 8 | 9 | 7.8 | 10 | 2 | 10 | 6 | 7 | 8 | 6.5 | 2a |
| 3a | 4 | 9 | 5 | 8 | 8 | 8 | 8.0 | 6 | 4 | 3 | 7 | 8 | 6 | 6.3 | 3a |
| 4a | 2 | 9 | 3 | 9 | 9 | 9 | 9.0 | 10 | 3 | 3 | 5 | 6 | 7 | 6.3 | 4a |
| 4b | 5 | 9 | 5 | 9 | 9.0 | 9 | 9.0 | 10 | 2 | 2 | 5 | 6 | 7 | 6.5 | 4b |

## 6.3 Geomorphic Risk Assessment

As part of the Fish Creek Corridor Master Planning project, the technical team completed a geomorphic assessment of the Fish Creek system, consisting of a rapid geomorphic assessment and the mapping of a planning-level channel migration zone (pCMZ). The rapid assessment and pCMZ mapping covers the Fish Creek from Lily Lake downstream to Lake Estes, including the East Fork Fish Creek. This memo is intended exclusively for planning purposes and only within the context of the Fish Creek Corridor Master Planning project. Finally a community asset inventory was used to characterize risk associated with the geomorphic hazards identified through the rapid assessment and pCMZ mapping.

The geomorphic assessment began with a remote sensing evaluation of geomorphic reaches followed by several field days of field evaluations to observe and record field data related to stream channel type, stream channel and floodplain alteration, bed material and bedform, and active channel erosion and sedimentation processes. This initial fieldwork was followed by supplemental analysis of alluvial landforms using available GIS data and aerial imagery. Final evaluation and quality checks and assurances were obtained during a follow-up field day.

There are three objectives for these data and analysis:

**1) System Understanding via Rapid Geomorphic Assessments:**

Define post-flood geomorphic conditions in the Fall River system to supplement an overall understanding of the dynamics of Fall River and assist with focusing on geomorphically appropriate flood risk reduction and restoration strategies. Rapid assessments do not include comprehensive evaluations of berms, crossing structures, floodplain fills, and other features that contribute to instability. Further analysis of these channel stressors may be warranted on a reach or watershed level.

**2) Mapping of a Planning-Level Channel Migration Zone (pCMZ):**

A channel migration zone (CMZ) refers to the area a stream has occupied in recent history and may migrate through again as it moves, stores, and reworks its sediment load on its path down the valley. Identification and management of these channel migration zones is intended to reduce flood damage to community and private infrastructure – all of which may be in jeopardy when and if the channel does re-occupy this area.

A CMZ can also be thought of as the "river corridor" where dynamic system processes, under a broad range of flow conditions, can occur providing for long-term geophysical and biological stability. The pCMZ is intended to offer local governments insight into the likely long-term behavior of their streams and to aid their efforts to reduce future flood and erosion damage and improve riparian and aquatic habitat through the management of a river corridor.

**3) Evaluation of geomorphic risk by combining the pCMZ analysis with a community asset inventory:**

An assessment of risk includes an evaluation of probability with costs. The community asset inventory is used as a tool to estimate some of the costs associated with the geomorphic instability of the river corridor. The community asset inventory assessment overlays property, structure, and utility costs with the elements of the pCMZ to get an estimate of risk. The assessment does not include many other costs and is intended as a long-term planning tool for local coalitions and governments.

### 6.3.1 Methodology

**6.3.1.1Rapid Geomorphic Assessments**

As a first step in the rapid geomorphic assessment, Walsh scientists and engineers identified geomorphic reaches, or sections of Fish Creek, with roughly homogenous physical and dynamic characteristics. For planning purposes it is important to delineate zones with similar migration potential, river planform patterns, and/or valley characteristics. Possible geomorphic reach-break criteria included:

- Changes in gradient (proportional to sediment transport capacity)
- Changes in valley width and channel confinement
- Tributary junctions (changes in the ratio of sediment transport capacity to sediment supply)
- Changes in channel pattern
- Changes in infrastructure that control lateral erosion and migration
- Changes in geology/ erodibility of adjacent valley slopes
- Changes in land use

In total, 12 geomorphic reaches were identified within the study area,

Walsh scientists and engineers conducted a rapid survey of existing geomorphic conditions by walking the river corridor to the extent practical. Qualitative assessments of the geomorphic conditions for each reach were recorded at representative locations within each reach. While it is our best professional judgment that the qualitative assessments represent general conditions in the reach, they are a generalization of the most dominant characteristics in the corridor and do not exclude the possibility that other conditions are or could be present. This study was scoped to be a rapid visual assessment and as such, no quantitative measures

Based on visual assessments, estimates of existing and reference stream channel type and form, dominant bed material,

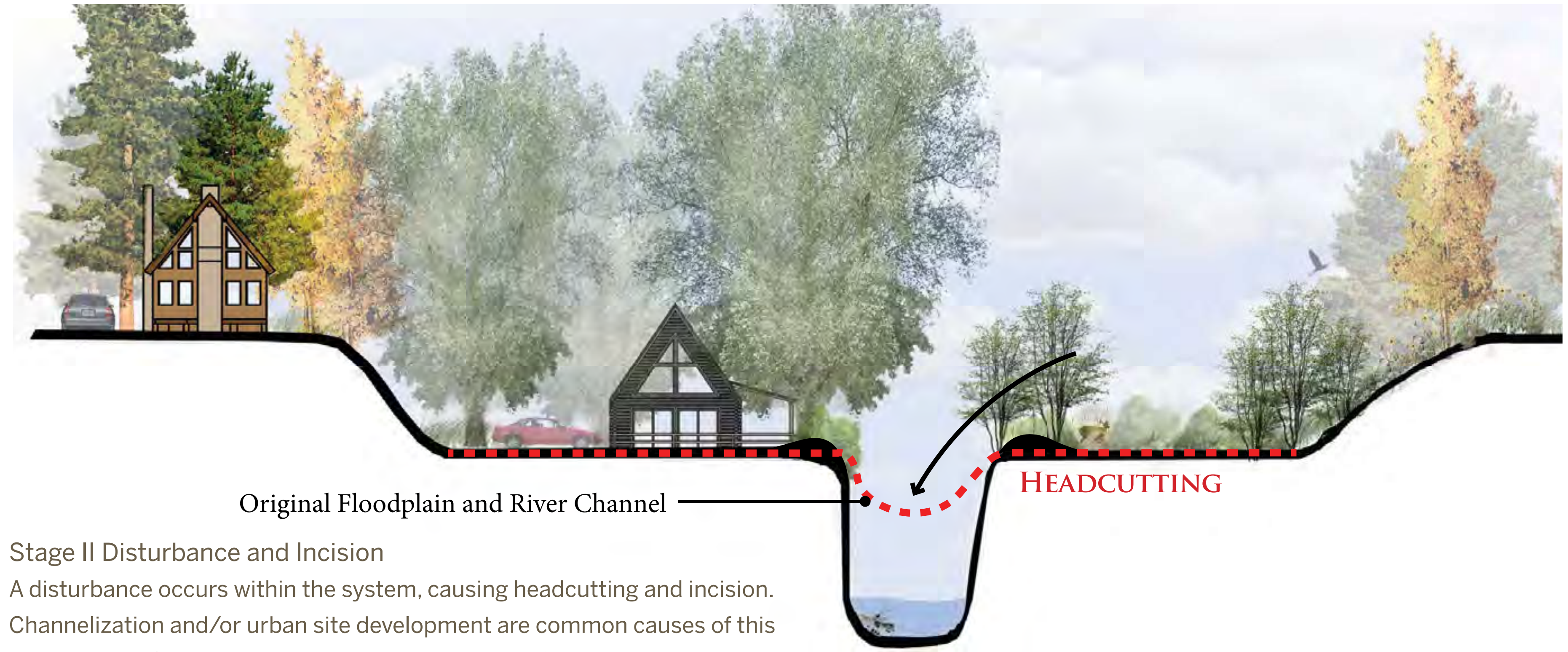

Stage I Stable
River channel is stable (at equilibrium) with considerable bank vegetation and is in frequent contact with the original floodplain.

channel evolution stage, and dominant sediment transport processes were made for each reach.

- Existing and reference stream channel type and form—Stream channel type, using Rosgen (1994) and Montgomery-Buffington (1997) stream type classifications, were assessed for existing conditions as well as reference conditions (i.e., equilibrium conditions). Rosgen classification uses numerous discrete classes represented by a suit of morphologic parameters used to categorize a stream reach (e.g., B2, C3b). Montgomery-Buffington (primarily used in mountain stream systems) uses seven categories represented by channel substrate or bed form (e.g., cascade, step pool, pool riffle, plane bed).

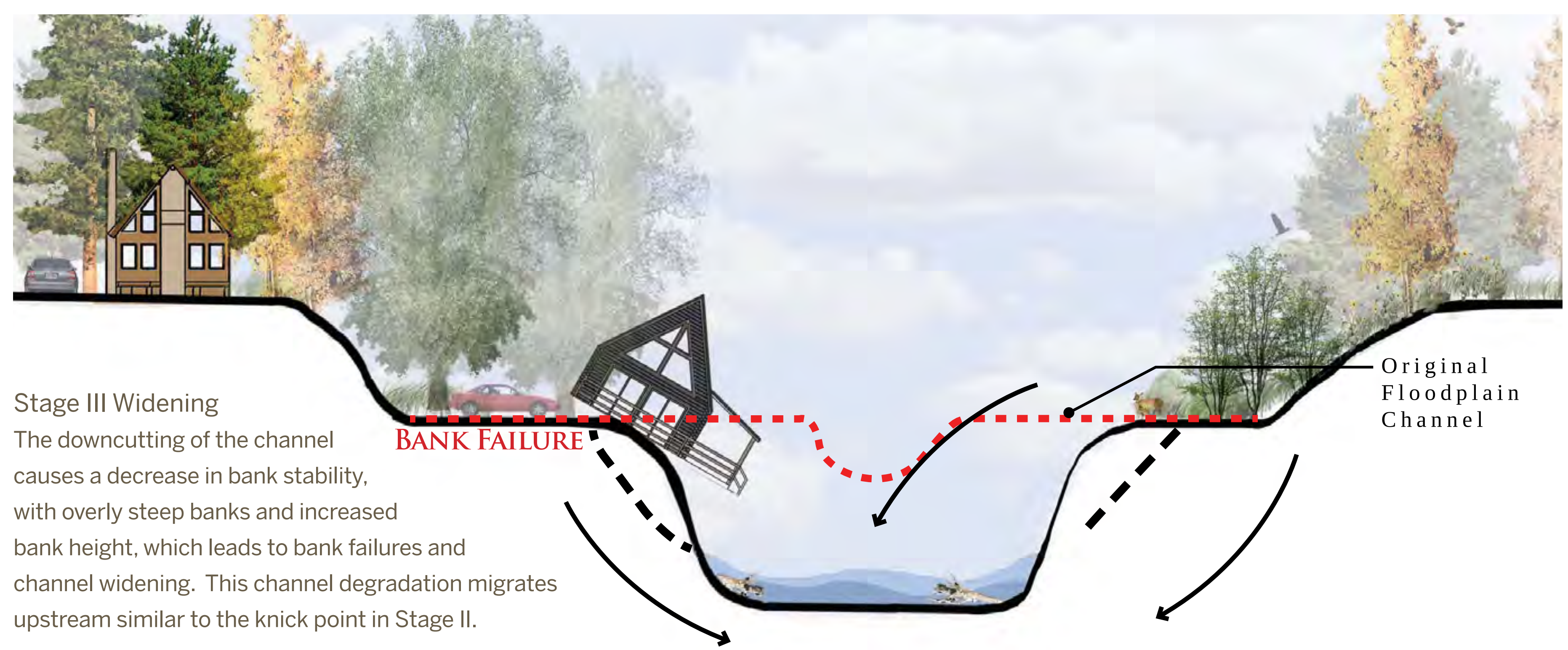
- Dominant bed material—Dominant bed material (D50) was visually and qualitatively identified for each reach as either bedrock, boulder, cobble, gravel, or sand. An assessment was also made as to whether the existing dominant material would be part of the reference conditions.

- Channel evolution stage—The channel evolution model described by Schumm, et. al. (1984) was used to assess the current channel condition and active processes in terms of streambed adjustment. As shown in Figure 2, the model includes five stages that describe the adjustment of a streambed starting with incision, the detachment from the existing floodplain, and eventually the formation of a new floodplain at a lower elevation. Based on evidence of bank stability, floodplain connectivity, and meander migration, each reach was assigned a channel evolution stage. While these stages are provided for instructional purpose and to aid in predicting future adjustments (and indeed strong on-the-ground correlations do frequently exist) it should be noted that the Schumm model does not account for aggrading channels, multi-thread channels, and non-linear processes, all of which exist in the Fish Creek system. New models are being developed to describe these conditions, such as the Stream Evolution Model (Cluer & Thorne, 2013), however, for the purposes of this rapid geomorphic assessment, the widely adopted and current industry standard Schumm model was utilized.




Stage II Disturbance and Incision

A disturbance occurs within the system, causing headcutting and incision. Channelization and/or urban site development are common causes of this disturbance. Channelization (channel straightening) creates a system with a steeper slope with more stream power. Urban development increases stormwater flows due to the increase in impervious surfaces, which also increases stream power. With the increase in stream power the stream system begins to incise in an attempt to adjust to a lower channel slope. This incision progresses as a knick point upstream. The stream and floodplain have less frequent interaction. [Diversions are another disturbance that can disrupt the equilibrium of a stream system by decreasing base flows which may cause aggradation, moving the system into Stage IV.]




Stage III Widening

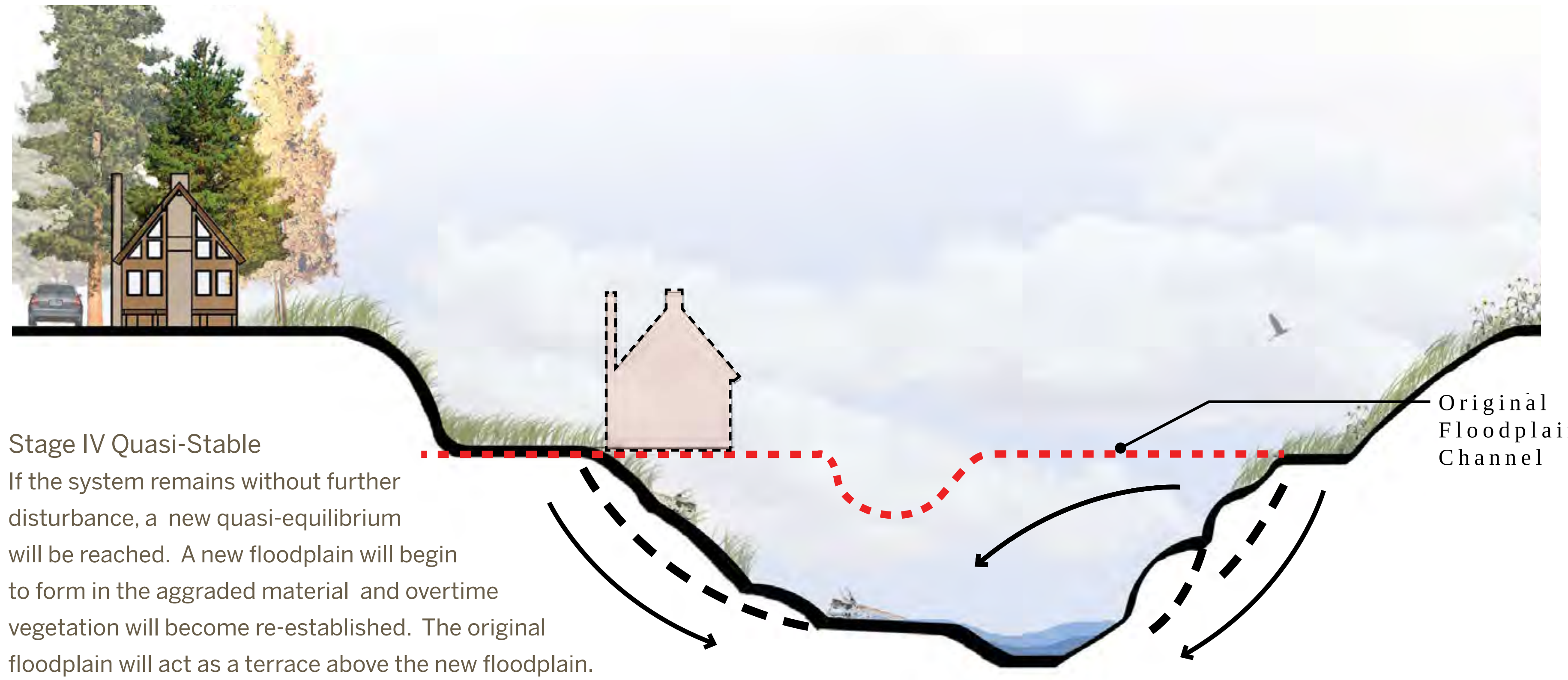
The downcutting of the channel causes a decrease in bank stability, with overly steep banks and increased bank height, which leads to bank failures and channel widening. This channel degradation migrates upstream similar to the knick point in Stage II.

- Dominant sediment regime type—Dominant sediment regimes were evaluated for each reach, using guidelines presented in Kline (2010). Sediment regime mapping attempts to characterize the source and fate of both fine and course sediment loads (i.e., wash and bed loads) which can be a useful exercise in project development and attempting to restore equilibrium conditions to a watershed. Based on existing stream type and condition, channel evolution stage, degree of incision and width, and channel alterations, each reach is categorized singularly or as a combination of a "source", "transport", or "deposition" reach.

**6.3.1.2 Planning-Level Channel Migration Zone Mapping**

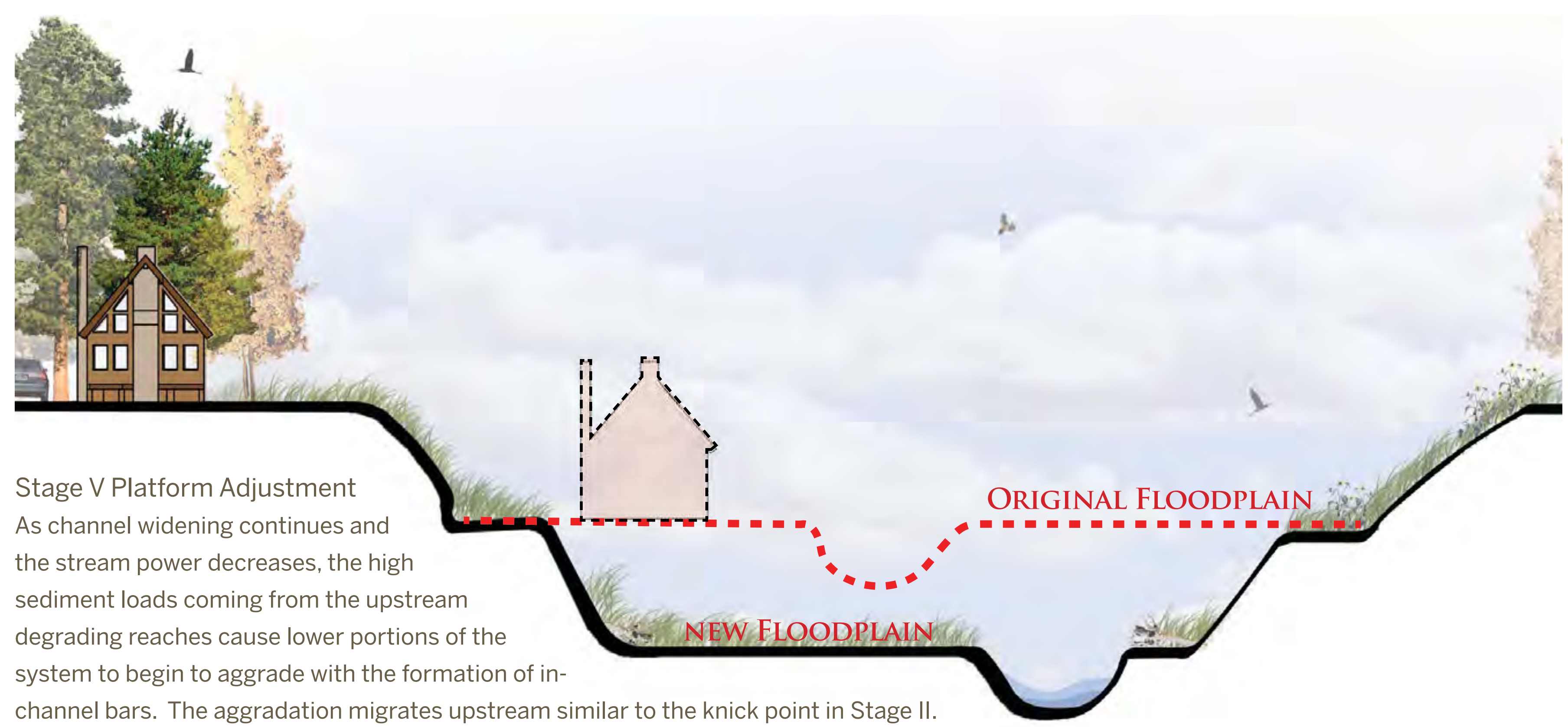
Channel migration is the lateral movement of a channel, including processes such as channel widening, bend migration, and/or abrupt channel shifts, and vertical movement of a channel through incision or aggradation. A channel migration zone (CMZ) refers to the area a stream has occupied in recent history and may migrate through again as it moves, stores, and reworks its sediment load on its path down the valley. Identification and management of these channel migration zones is intended to reduce flood damage to community and private infrastructure – all of which may be in jeopardy when and if the channel does re-occupy this area. A CMZ can also be thought of as the "river corridor" where dynamic system processes, under a broad range of flow conditions, can occur, posing a hazard to infrastructure and communities, but also providing for long-term topographic stability and biological complexity.

There are several scientifically vetted protocols in states with similar physiographic characteristics that provide guidance on the mapping of channel migration zones. For this assessment, Washington State's planning-level channel migration zone (pCMZ) method was selected, based on Washington State Department of Ecology's A Methodology for Delineating Planning-Level Channel Migration Zones (2014).




Stage IV Quasi-Stable

If the system remains without further disturbance, a new quasi-equilibrium will be reached. A new floodplain will begin to form in the aggraded material and overtime vegetation will become re-established. The original floodplain will act as a terrace above the new floodplain.




Stage V Platform Adjustment

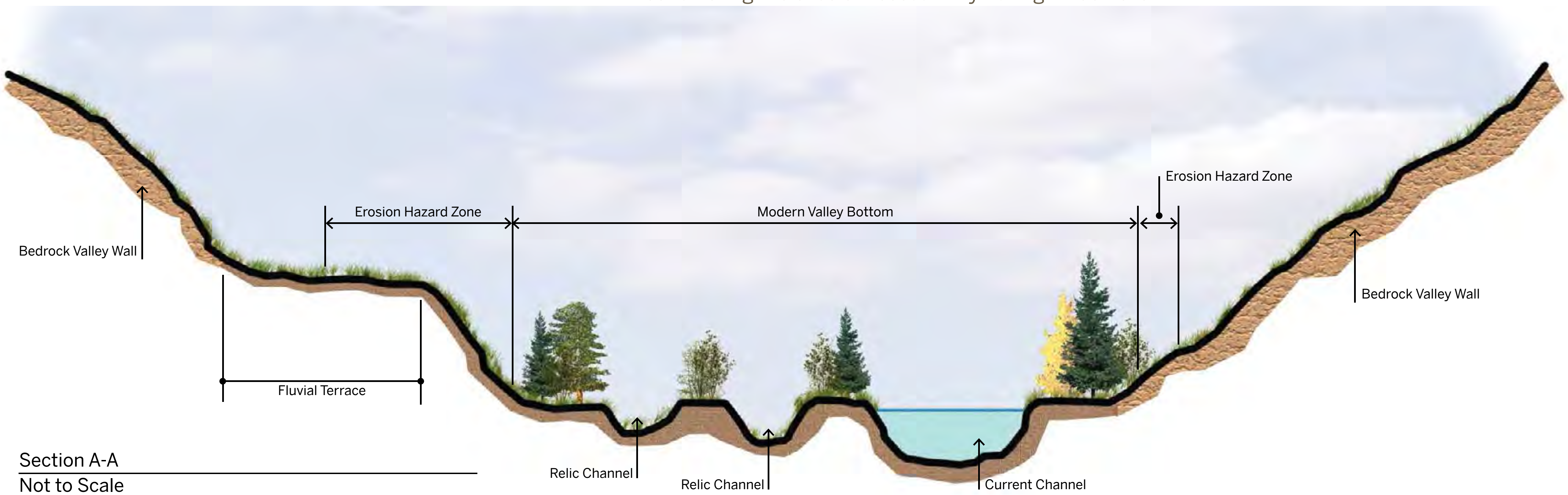
As channel widening continues and the stream power decreases, the high sediment loads coming from the upstream degrading reaches cause lower portions of the system to begin to aggrade with the formation of in-channel bars. The aggradation migrates upstream similar to the knick point in Stage II.

The pCMZ method utilizes channel migration records preserved in landforms, soils and geology to describe the spatial influence of channel migration. The pCMZ is intended to offer local governments insight into the likely long-term behavior of their streams and to aid their efforts to reduce future flood and erosion damage and improve riparian and aquatic habitat through the management of a river corridor.

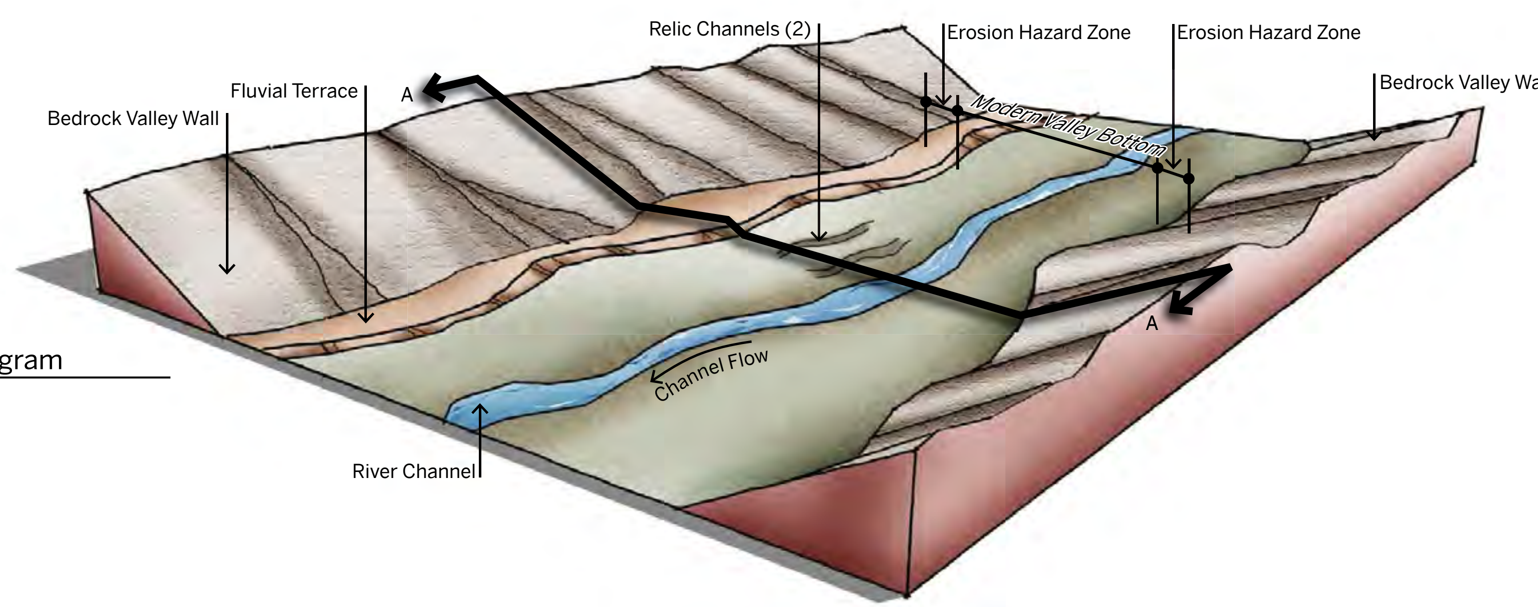
The following components were mapped for the Fish Creek system as part of defining the pCMZ, using digital elevation models (DEMs) derived from the 2013 post-flood LiDAR and 2013 post-flood aerial photography:

**1) Modern Valley Bottom (MVB):** The MVB is the fundamental component of the pCMZ, it represents the area where channel migration has occurred in the past few thousand years. Reoccupation of this area by the river during a flood event is likely, considering the ease of accessibility during a flood event and the nature of the surficial geology (alluvium), therefore the MVB is an area of very high hazard.

**2) Avulsion Hazard Zones (AVZ):** AVZs are mapped within the MVB, where there are low areas with abandoned or relict channels connecting to the main active channel, or low portions of the valley connected to the active channel with gradients steeper than the active channel gradient. AVZs are areas where abrupt shifts (avulsions) in channel location have the




Section A-A
Not to Scale

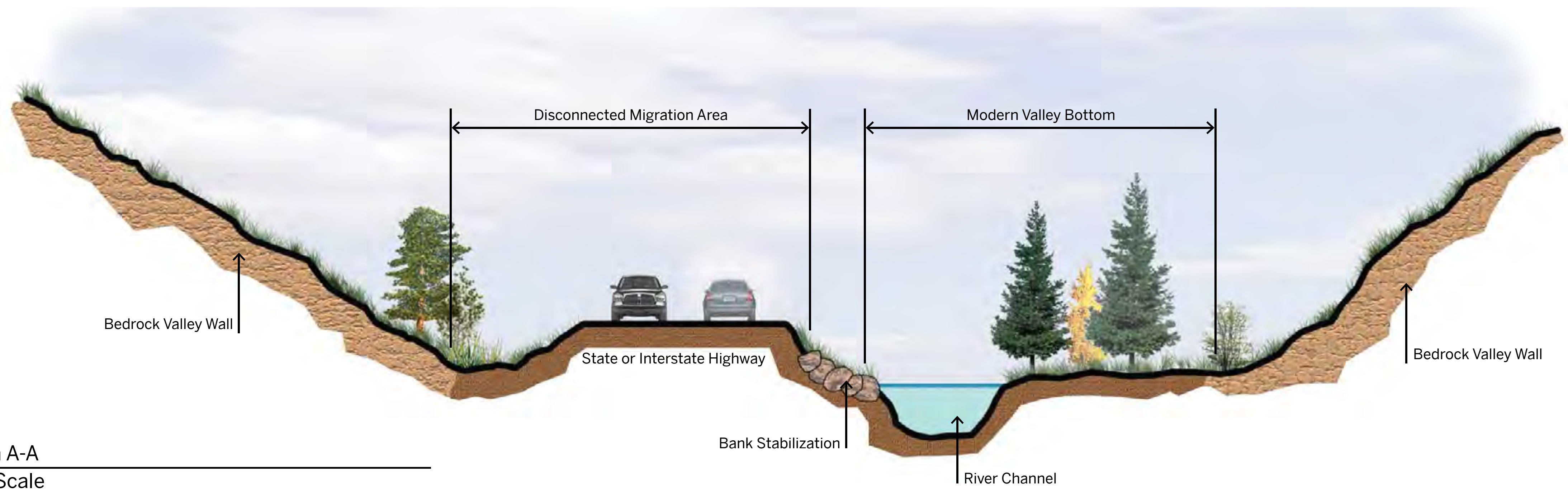



Axonometric Diagram
Not to Scale

possibility to occur at moderate to high flows and may have catastrophic consequences for adjacent property and infrastructure. These are extreme hazard areas.

**3) Erosion Hazard Area (EHA):** The EHAs are mapped outside the MVB to account for potential valley widening caused by future channel migration. The extent of the EHA is related to the erodibility of the valley walls as well as the likelihood that the stream channel will come into contact with these features. These are areas of high hazard.

**4) Alluvial fans (AF):** Alluvial fans are fan-shaped accumulations of sediment that form along the margins of valleys at the mouths of tributary channels. The natural tendency of the tributary streams to drop their sediment loads and avulse on AF surfaces makes them potentially hazardous areas for development. These are areas of very high hazard.




Section A-A
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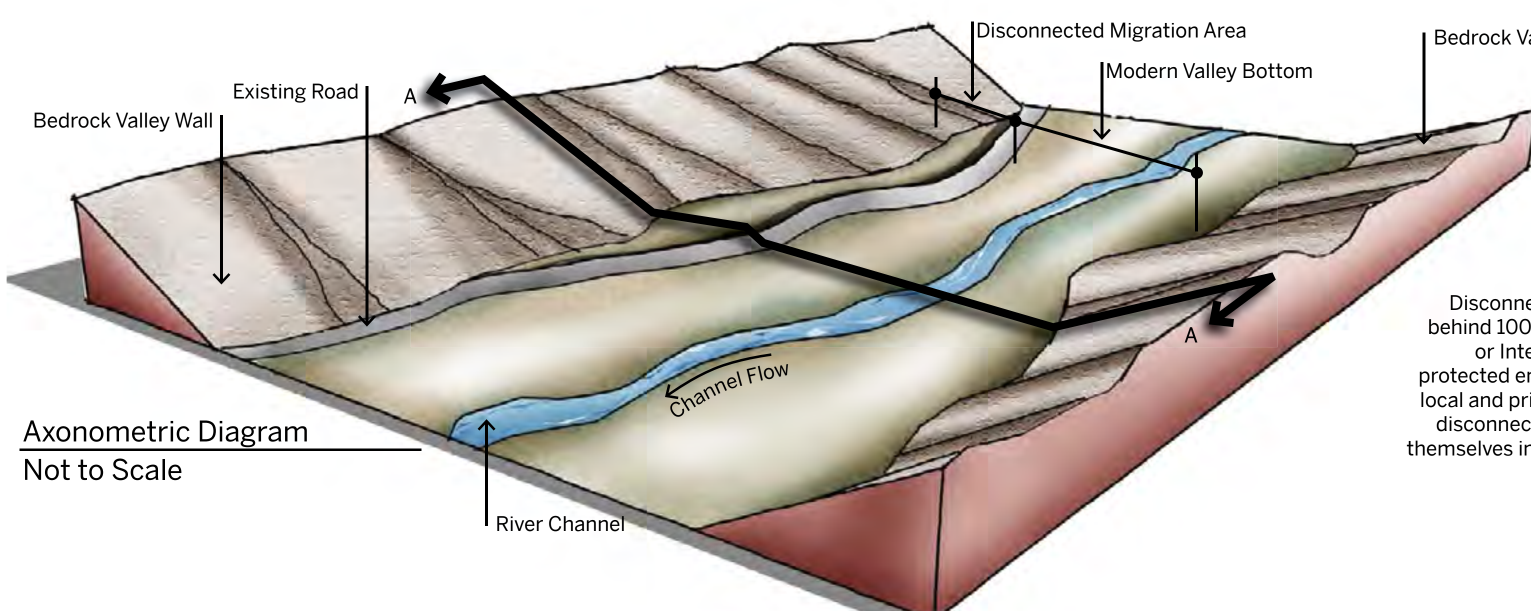
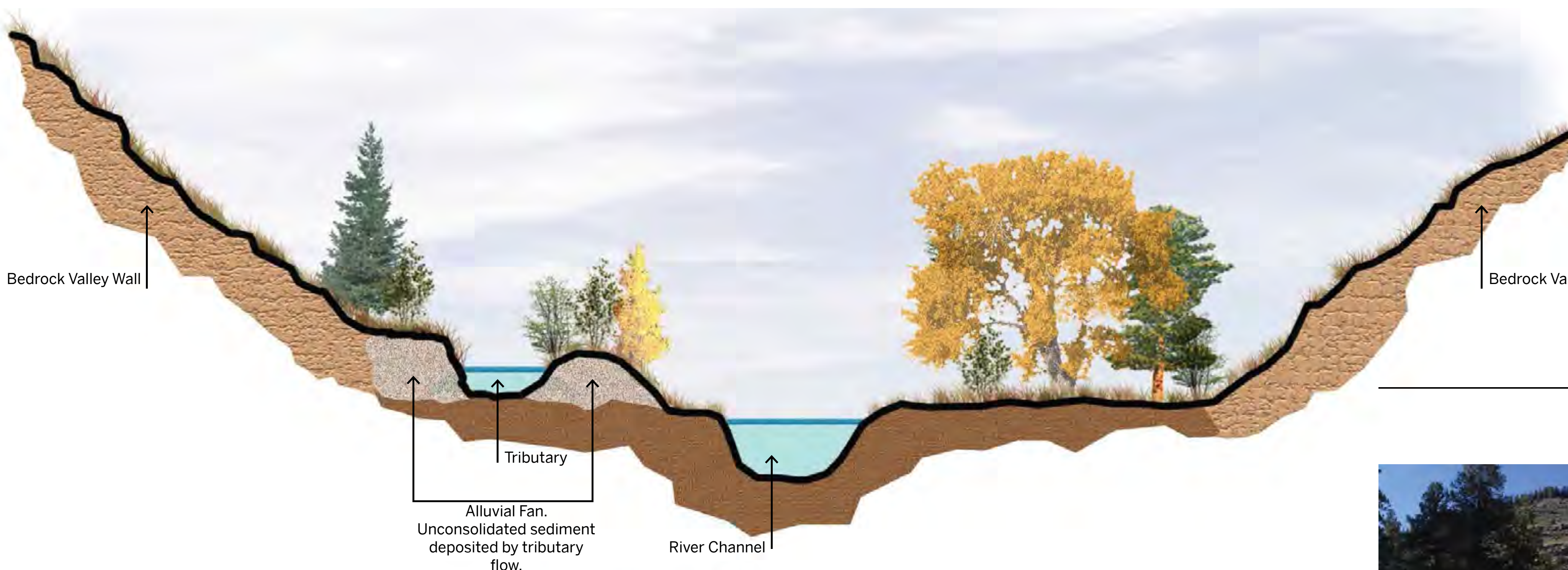



Axonometric Diagram
Not to Scale

Disconnected Migration Zones occur behind 100-year levees or behind State or Interstate Highways with highly protected embankments. County, town, local and private roads DO NOT result in disconnected migration zones and are themselves included in the modern valley bottom

**5) Disconnected Migration Area (DMA):** DMA are low-lying areas that would naturally be mapped within the MVB of a stream channel, but are disconnected from channel migration processes by man-made structures such as levees, railroads, and major roads. When observed, these areas were mapped outside of the pCMZ though still have the potential to capture flow if the infrastructure fails. Their mapping may indicate areas where future floodplain reconnection projects could occur. These are areas of high hazard.

The complete methodology for the pCMZ method can be found in Washington State's A Methodology for Delineating Planning-Level Channel Migration Zones (2014).




Section A-A
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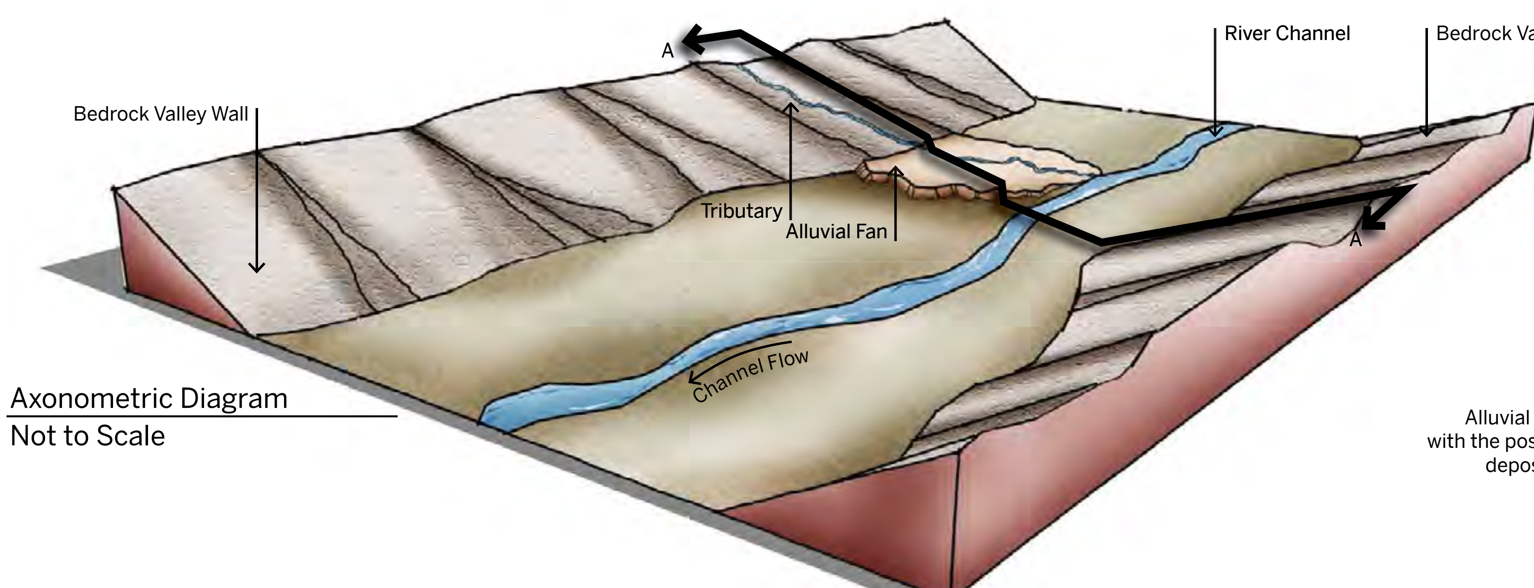



Axonometric Diagram
Not to Scale


Alluvial fans are very dynamic areas with the possibility of massive sediment deposition happening at any time

#### 6.3.1.3 Community Asset Inventory

The community asset inventory accounted for the monetary consequences of property, structures, and utilities within the pCMZ extents. The community asset inventory analysis was performed using ArcGIS (2013) software package for parcels (properties and structures), and utilities separately. Parcel location, extents, estimated property dollar value, and estimated property improvement (structure) dollar value were gathered from publically available Larimer County data (June 3, 2013).

The estimated dollar values are not assessed values for properties. Utility locations were provided by the Town of Estes Park for potable, lateral and sewer main categories. Potable utilities include water supply mains, laterals are secondary the water main, such as hydrants, bleeders, and service. Utility cost per foot were estimated from Larimer County values and are summarized in Table xx.

To calculate the geomorphic risk for parcels, total land and improvement values were multiplied by the fraction of the parcel within the extents of the pCMZ as derived from a GIS analysis of the union of delineated pCMZ areas and Larimer County parcel data.

This is not a detailed account of whether or not the structures themselves would be damaged or destroyed. For example, if 50% of the land acreage falls within the pCMZ area, a $10,000 plot with $50,000 improved structures is reported as $5,000 and $25,000 asset loss respectively regardless of whether or not structures fall within the pCMZ area. The recalibrated square footage and dollar values were then summarized by parcel category for each area/zone using excel pivot tables.

To calculate the geomorphic risk for utilities, a GIS analysis of affected utilities was derived by clipping the linear utility data provided by the City to the extent of delineated pCMZ area and summing the recalibrated footage of each utility category using excel pivot tables. The pCMZ extents were separated into four categories for analysis: avulsion hazard areas, disconnected migration areas, erosion hazard areas, and the modern valley bottom.

The community asset inventory does not account all forms of loss caused by a geomorphic risk by any means. Due to a lack of data many things such as loss of life, injury, loss of personal property inside of structures, or loss of non-structural assets on properties cannot be analyzed. However this analysis does give a starting point for understanding geomorphic risk in the river corridor.

### 6.3.2 Geomorphic Risk Assessment Results

#### 6.3.2.1 Rapid Geomorphic Assessment

Reach-scale rapid geomorphic summaries are documented in the Appendix as well as in Table 1. The following descriptions are provided as an overview, not comprehensive assessment, of the dominant forces and processes observed during a rapid geomorphic assessment.

| pCMZ Zone (Parcel type) | Number of Parcels | Number of Buildings | Value of pCMZ Property | Value of pCMZ Structures | Total Property Value | Total Structure Value |
|---|---|---|---|---|---|---|
| **Alluvial Fan** | **4** | **4** | **$54,710** | **$37,108** | **$1,520,000** | **$1,090,855** |
| Residential | 4 | 4 | $54,710 | $37,108 | $1,520,000 | $1,090,855 |
| **Avulsion Hazard** | **18** | **29** | **$856,051** | **$574,177** | **$1,771,203** | **$2,629,987** |
| Commercial | 4 | 19 | $4,491 | $91,389 | $105,523 | $1,567,369 |
| Exempt | 2 | 1 | $10,306 | $7,694 | $297,680 | $403,041 |
| Residential | 12 | 9 | $841,254 | $475,094 | $1,368,000 | $659,577 |
| (blank) | **9** | **7** | **$76,194** | **$87,141** | **$1,161,680** | **$921,902** |
| **Disconnected Migration** | 1 | 0 | $245 | $0 | $27,680 | $0 |
| Commercial | 7 | 7 | $75,949 | $87,141 | $1,134,000 | $921,902 |
| Residential | 1 | 0 | $0 | $0 | $0 | $0 |
| (blank) | **211** | **218** | **$2,434,846** | **$2,898,617** | **$29,551,692** | **$29,745,922** |
| **Erosion Hazard** | 17 | 18 | $649 | $19,771 | $87,733 | $1,645,568 |
| Commercial | 14 | 20 | $73,585 | $117,518 | $1,292,179 | $2,005,196 |
| Exempt | 8 | 13 | $54,656 | $48,088 | $1,888,180 | $1,469,739 |
| Multiple Unit | 166 | 167 | $2,305,957 | $2,713,240 | $26,283,600 | $24,625,419 |
| Residential | 6 | 0 | $0 | $0 | $0 | $0 |
| (blank) | **144** | **143** | **$5,319,062** | **$4,974,602** | **$21,376,723** | **$21,675,130** |
| **Modern Valley Bottom** | 8 | 9 | $846 | $30,350 | $43,746 | $822,784 |
| Commercial | 9 | 12 | $219,501 | $351,142 | $723,297 | $1,143,648 |
| Exempt | 7 | 7 | $94,681 | $62,395 | $1,164,180 | $936,390 |
| Multiple Unit | 115 | 115 | $5,004,033 | $4,530,715 | $19,445,500 | $18,772,308 |
| Residential | 5 | 0 | $0 | $0 | $0 | $0 |
| **Grand Total** | **386** | **401** | **$8,740,864** | **$8,571,645** | **$55,381,298** | **$56,063,796** |

**Fish Creek Mainstem Results:**

**6.3.2.1.1 Lily Lake to Cheley Camps Access Road Culvert**
From the outlet of Lily Lake the Fish Creek tumbles through a culvert under Highway 7 then down a steep semi-confined valley. Bedrock outcroppings appear on both sides of the forested valley. A driveway/road that leads to a few cabins encroaches on the left valley wall. Bank erosion through widening and micro-planform adjustments occurred throughout the reach bringing many trees down into the channel. At the downstream end of the reach, where the valley slope flattens, an undersized culvert trapped much of this sediment behind it during the September flood.

**6.3.2.1.2 Cheley Camps Access Road Culvert to Rockwood Lane**
The Fish Creek corridor enters a wide less steep valley in the vicinity of a large ranch. Within this valley the Fish Creek underwent a series cut and fill adjustments as it first cut deeply into its bed below the upstream road/culvert "sediment trap" and then filled its channel and floodplain downstream in the vicinity of the ranch. Below a grove of aspen trees the river incised heavily and then avulsed from its channel at its next deposition site several hundred feet downstream. This avulsion caused the Creek to jump west towards Fish Creek Road and cut a ~6' deep gully. Upstream of Rockwood Lane this gully erosion was deposited onto the floodplain. As the avulsion rejoined the historic channel it cut heavily into its bed and banks on its way towards a large rock outcropping south of Sandborn Road. This bedrock and the adjoining hillside naturally confine the channel and change its characteristics downstream.

**6.3.2.1.3 Rockwood Lane to East Fork Fish Creek Confluence**
From approximately Rockwood Lane to the confluence with the East Fork the Fish Creek flows through a narrow valley. Within this narrow valley Fish Creek Road was built onto the historic floodplain of the Creek confining it during high flows and limiting its ability to adjust laterally. When the Creek did attempt to adjust laterally, streambank armoring (rip-rap) was installed. During the 2013 flood the channel disrupted much of this armoring and eroded into most of its outside meanders.


Lily Lake to Cheley Camps Access Road Culvert


Cheley Camps Access Road Culvert to Rockwood Lane


Rockwood Lane to East Fork Fish Creek Confluence

**6.3.2.1.4 East Fork Fish Creek Confluence to Scott Avenue**
Below the confluence with the East Fork the condition of the Fish Creek does not change significantly. Fish Creek Road and private developments dominate the former Creek corridor and confined its ability to adjust its planform and find floodplain to access. Channel straightening and armoring, alteration of riparian vegetation, installation of frequent undersized crossings, and the reduction of beavers in the stream channel were all common within the Creek corridor. The September 2013 flood caused channel widening, planform adjustments, and the development of secondary gully-type channels where the Creek gained the opposite side of the road.

**6.3.2.1.5 Scott Avenue to Brodie Avenue**
In the vicinity of Scott Avenue the Fish Creek picks up another tributary from the west. Downstream from here the valley broadens and becomes less steep. Significant planform adjustments into erodible banks and valley walls exposed buried utilities, undermined roadways, outflanked crossings and generally wreaked havoc on the Fish Creek corridor during the September 2013 flood. Widening, aggradation, degradation, and planform adjustments all occurred at various spatial and temporal scales throughout the event.

**6.3.2.1.6 Brodie Avenue to Lake Estes**
Below Brodie Avenue the Fish Creek comes under the influence of Lake Estes. The channel turns into a broad delta of fine gravels and sand with a braided channel.

**East Fork Fish Creek Results:**

**6.3.2.1.7 Headwaters to Pond Reach**
Forested stream that had minor localized adjustments as a result of the September 2013 rain event. Our team did not investigate too far up the reach as access was slow and difficult due to the thick forest cover.

**6.3.2.1.8 Pond Reach to Downstream End of Jacob Road**
Breaching of a series of in-stream man-made ponds and plugging of an undersized culvert may have contributed to the significant channel avulsions, planform adjustments, and incision in this stretch. Massive erosion within the valley bottom occurred in this stretch.

East Fork Fish Creek Confluence to Scott Avenue

Scott Avenue to Broadie Avenue

Pond Reach to Downtown End of Jacob Road

**6.3.2.1.9 Downstream End of Jacob Road to Mainstem Confluence**

Overbank flows thorough a forested riparian floodplain resulted in storage of sediments through the floodplain. The channel for the most part held together with large wood and boulder steps providing grade control.

**6.3.2.2 Planning-Level Channel Migration Zone Mapping**

Figures x through xx display the pCMZ results and associated draft geomorphic hazard zones. These maps are provided for planning purposes and while much attention was given to accuracy, there may be locations along the boundaries that warrant additional refinement as part of future, detailed investigations.

**6.3.2.2.1 Interpreting the pCMZ maps and pCMZ Applications**

The pCMZ methodology tends to be a conservative assessment that uses LiDAR data as a basis for delineating areas of past and potential future channel migration. The planning-level method does not analyze historical channel occupation or migration rates, and therefore does not allow for assignment of a CMZ design life (effective time period), associated probabilities for migration or erosion, or migration or erosion rates.

The pCMZ boundary line is a conservative approximation of areas reasonably likely to be influenced by channel migration. While channel migration should be considered unlikely outside of the CMZ boundary, extreme events where channel migration occurs outside of CMZ boundaries are nonetheless possible. Where a perceived threat to critical infrastructure or life is present, a detailed-level assessment should be undertaken to quantify channel migration rates and processes.

The boundaries of the CMZ and FEMA floodplain generally will not coincide, and should be considered independent of one another. FEMA floodplains will commonly exceed the CMZ in channelized streams such as downtown Estes Park. Conversely, CMZs may exceed the FEMA floodplain in actively migrating streams and depositional areas.

While we present the pCMZ as a valuable planning tool with hopes of minimizing future flood damage, it is certainly not all-

Downstream End of Jacob Road to Mainstem Confluence inclusive and should be utilized with other tools such as FEMA-derived inundation maps.

In addition, the pCMZ does not capture extreme landscape disturbances such as dam failures, debris flows, landslides, earthquakes, etc., and this pCMZ analysis did not examine the potential for geotechnical slope failures. In addition to endangering life and property within these landscape disturbance areas, resulting debris, sediment, or fractures may alter the course of the Fall River into areas not identified in the pCMZ. Likewise, the possibility of diversion ditches capturing the main stem of the river is not considered in the pCMZ mapping.

The pCMZ maps are presented to support coalition efforts to work with local governments and state agencies to develop programs and codes that limit investment and asset development within the mapped pCMZ hazard areas. Erosion hazards and channel avulsions present extreme risks during high flow events in all watersheds along the Front Range and having a robust data set that assesses multiple hazards is critical to long term planning and community resilience. Avulsion hazard areas and mapped alluvial fans are priority locations for buy-outs, especially, though not limited to, where they overlap with mapped FEMA floodplains.

The modern valley bottom, erosion hazard area, and disconnected migration zones should similarly be examined for opportunities to remove critical infrastructure and homes in favor of greenways or open space corridors, or at the very least, provide education for those citizens, businesses, and government agencies that invest in high risk areas. Additionally, in some locations, mapped disconnected migration zones can be used to identify locations for floodplain reconnection projects.

**Fish Creek Mainstem Results:**

**6.3.2.2.2 Lily Lake to Cheley Camps Access Road Culvert**

The MVB below Lily Lake is a narrow corridor that represents the channel bottom and small floodplain features tucked up against the base of the steeper valley walls. It averages from ~50' to 125' wide near the downstream end. Channel migration is limited due to the mass of the adjacent steep valley hill slopes. An EHA zone of 20' was delineated on each side of the MVB in order to account for potential erosion resulting from the channel cutting near the bottom of these valley walls.

**6.3.2.2.3 Cheley Camps Access Road Culvert to Rockwood Lane**

At the mouth of the canyon, below the access road culvert, Fish Creek fans out into a naturally broad floodplain. Historically this area would likely have been occupied by dense willow and alder thickets and beaver ponds and dams. Fine sediments deposited across the floodplain hundreds and thousands of years prior may be susceptible to erosion and incision as was observed during the September 2013 flooding. Because of the broad nature of the valley bottom and susceptibility to avulsion and braiding the MVB extends to about 450' here and was designated as an Avulsion Hazard Area. With so much lateral room to meander before coming into contact with the outside valley wall the EHA was delineated as only 1 channel width wide to account for those more rare instances when the channel might try to erode at its outside extent.

**6.3.2.2.4 Rockwood Lane to East Fork Fish Creek Confluence**

The MVB naturally narrows and steepens below Rockwood Lane. Fish Creek Road encroaches onto the north side of the corridor confining the channel. Through these reaches the MVB averages about 125' in width. The EHA was delineated at 1 channel width due to the presence of bedrock and less erodible materials in the valley walls.

**6.3.2.2.5 East Fork Fish Creek Confluence to Scott Avenue**

Below the East Fish Creek confluence the valley opens up slightly and reduces in slope. Here the MVB broadens to approximately 150' wide. The Fish Creek Road embankment typically marks the MVB boundary even though flood waters in September caused severe erosion to the road surface (this was frequently a result of water getting up onto the road as opposed to water eroding it from its embankment). A wide EHA (delineated as half of a meander belt width or 40') is indicative of the likelihood that the stream will run into the erodible valley margin.

**6.3.2.2.6 Scott Avenue to Brodie Avenue**

This long section of narrow valley and meandering gravel/sand bed stream exhibited severe erosion during the September event. Frequent contact with highly erodible valley margins pushed new meander scars deep into the floodplain. Although highly susceptible to lateral migration only one reach was identified as an AHA due to a perched channel relative to the surrounding floodplain. The EHA through this section remained at half of a meander belt width while the MVB extended to an average of about 200'. Where Fish Creek Road cut off old meander bends DMA's were delineated to indicate loss of floodplain connectivity.

**6.3.2.2.7 Brodie Avenue to Lake Estes**

The lowest reach of the Fish Creek included in this study, this section, subject to extreme braiding, is characterized by a broad AHA of approximately 350' wide. To the east side of Fish Creek Road opposite the High School some relic floodplain (DMA) was identified.

**East Fork Fish Creek Results:**

**6.3.2.2.8 Headwaters to Little Valley Road Ponds**

Lack of LIDAR availability precluded this upper reach from having a pCMZ delineation. EHA would likely be delineated at 1 channel width on either side of the MVB.

**6.3.2.2.9 Little Valley Road Ponds to Downstream End of Jacob Road**

September flooding exposed a broad MVB (averaging ~125' wide) in this small stream channel. Due to the excessive widening that recently took place the EHA was designated as only 1 channel width (20') for this section.

**6.3.2.2.10 Downstream End of Jacob Road to Mainstem Confluence**

The MVB through this lower section menders with the stream course and valley walls and ranges from 40'-200' wide. The EHA is designated at one channel width on either side of the MVB.

## 6.4 Flood Risk Assessment

A flood risk analysis was employed to update the current understanding of potential flood impacts on Fish Creek. This analysis is a preliminary post-flood assessment and cannot replace FEMA flood mapping. A detailed local hydraulic assessment will be required for design at any site. FEMA inundation maps provide an estimate of 100 year inundation extents; however they do not provide an understanding of the uncertainty in this assessment. The inundation maps also fail to extrapolate the location of inundation to an understanding of risk to assets in the river corridor. By definition, risk is the product of probability and consequence.

Infrastructure Damage

This assessment accounts for both components of risk by performing a hydraulic analysis to update flood inundation extents, and coupling this with a community asset analysis.

The hydraulic analysis was performed to account to changes in topography caused by the 2013 flooding, and updates to the estimated flood discharge values. This analysis produced updated inundation extents for the 2-, 10-, 50-, and 100-year events. The limitations of this modeling are described in detail in the results section. This information was overlaid with known property, structure, and utility values to get an estimate of risk due to flooding.

### 6.4.1 Methodology

**6.4.1.1Hydraulic Modeling**

Hydraulic modeling was conducted using the U.S. Army Corps of Engineers' River Analysis System (HEC-RAS), Version 4.1.0. Models were originally developed by the Colorado Water Conservation (CWCB) as part of the 2013 flood response, recovery, and post-flood mitigation efforts. The CWCB HEC-RAS model was slightly modified by the technical team for master planning activities.

**6.4.1.1.1 CWCB 2013 Post-Flood Hydraulic Modeling**

Hydraulic models were developed by CWCB along river reaches affected by the September 2013 flood. Models were generated using HEC-GeoRAS, an automated program that utilizes GIS, and 2013 post-flood LiDAR data. The 2013 post-flood LiDAR data references the horizontal datum of NAD 83 and the NAVD 1988 vertical datum. It should be noted that the 2013 post-flood LiDAR was raw or unprocessed along most river reaches at the time of model development. The Fish Creek CWCB model was obtained directly from CWCB.

The Fish Creek hydraulic model developed by CWCB included two separate models which include a total of 6.7 miles of river. The first model includes the lower 18,000 feet (3.4 miles) of Fish Creek above the Estes Park Lake Dam. The second Fish Creek model includes an upper reach extending from station 18,000 up to 35,300 feet, with a reach length of 17,300 feet (3.3 miles). Cross sections were cut every 200 feet along the lower reach and every 50 feet through the upper reach. Bank stations were not established.

A manning's n value of 0.04 was applied to all cross sections uniformly. There are approximately 19 road bridges/culvert crossings located on Fish Creek within the 6.7 mile model reach. The lower reach model includes geometry for 3 culvert and 1 bridge crossing (Brook Drive, Country Club Drive, Private Rd at Station 7850, and Brodie Ave). The source of the bridge/culvert geometry in the lower model is unknown.

The upper model does not include any bridge or culvert crossings. Critical depth was applied as the downstream boundary condition. The FEMA effective 100-year discharges ranging from approximately 200 cfs up to 400 cfs were included in the model. FEMA effective discharge values from the Larimer County FIS are provided in Appendix.

| pCMZ Zone (Utility type) | Length of impacted utilities (ft) |
|---|---|
| **Alluvial Fan** | **166** |
| ACT | 26 |
| Collector | 140 |
| **Avulsion Hazard** | **1,680** |
| ACT | 429 |
| Collector | 647 |
| Interceptor | 604 |
| **Disconnected Migration** | **458** |
| Collector | 17 |
| Interceptor | 356 |
| Service | 85 |
| **Erosion Hazard** | **13,074** |
| ABN | 52 |
| ACT | 2,979 |
| Collector | 1,557 |
| Hydrant | 50 |
| Interceptor | 6,884 |
| Service | 1,552 |
| **Modern Valley Bottom** | **14,702** |
| ABN | 276 |
| ACT | 3,112 |
| Collector | 1,273 |
| Hydrant | 57 |
| Interceptor | 8,610 |
| Service | 1,374 |
| **Grand Total** | **30,080** |

#### 6.4.1.1.2 Modified CWCB 2013 Post-Flood Hydraulic Modeling

The Fish Creek CWCB 2013 post-flood hydraulic model was slightly modified by the technical team for use in the Master Planning process.

Modifications made to the Fish Creek model include the following:

- Downstream Boundary Conditions – The downstream boundary conditions were modified from critical depth to a known water surface elevation representing high water in Lake Estes. A known water surface elevation at Lake Estes of 7479.1 ft NAVD 88 was obtained from the effective FEMA FIS for Larimer County (dated May 2, 2012). This water surface elevation was used as the downstream boundary condition for all flood events evaluated.

- Discharge Profiles – Flood discharge values for Fish Creek were obtained from a detailed hydrologic study conducted by Matrix Design Group and documented in a report entitled "Road, Trail, and Utilities Repair/Reconstruction, Fish Creek, Hydrology Report" and dated August of 2014, see Attachment C. Data pertaining to the 2-, 10-, 50-, and 100-year discharge values from the August 2014 study were input into the hydraulic model. A 25-year discharge was estimated using regression analyses. Flood discharge values varied by location along Fish Creek and provided in the August Hydrology report are summarized in Table 2.

**Table 2 Fish Creek Flood Discharge (cfs)**

**(Fish Creek Hydrology, Matrix Design Group, August 2014)**

| Location | 2-Year | 10-Year | 25-Year* | 50-Year | 100-Year |
|---|---|---|---|---|---|
| Lake Estes | 23 | 181 | 371 | 651 | 990 |
| Powelly Lane | 22 | 177 | 363 | 637 | 970 |
| Johnsen Lane | 20 | 154 | 322 | 568 | 870 |
| Scott Avenue | 18 | 141 | 292 | 515 | 786 |
| Conf w/ East Fork Upstream of Little Valley Rd | 14 | 58 | 145 | 266 | 426 |
| Upstream of Rockwood Lane | 10 | 23 | 61 | 111 | 178 |

*Estimated using regression.

#### 6.4.1.2 Community Asset Inventory

The community asset inventory accounted for the monetary consequences of property, structures, and utilities within the predicted inundation extents. The community asset inventory analysis was performed using ArcGIS (2013) software package for parcels (properties and structures), and utilities separately. Parcel location, extents, estimated property dollar value, and estimated property improvement (structure) dollar value were gathered from publically available Larimer County data (June 3, 2013). The estimated dollar values are not assessed values for properties. Utility locations were provided by the Town of Estes Park for potable, lateral and sewer main categories. Potable utilities include water supply mains, laterals are secondary the water main, such as hydrants, bleeders, and service. Utility cost per foot were estimated from Larimer County values and are summarized in Table xx.

To calculate the flood consequences for parcels, total land and improvement values were multiplied by the fraction of the parcel inundated as derived from a GIS analysis of the union of delineated inundation areas/CMZ zones and Larimer County parcel data. This is not a detailed account of whether or not the structures themselves were inundated. For example, if 50% of the land acreage falls within the inundation area, a $10,000 plot with $50,000 improved structures is reported as $5,000 and $25,000 asset loss respectively regardless of whether or not structures fall within the inundation area. The recalibrated square footage and dollar values were then summarized by parcel category for each area/zone using excel pivot tables.

To calculate the flood consequences for utilities, a GIS analysis of affected utilities was derived by clipping the linear utility data provided by the City to the extent of delineated inundation areas/CMZ zones and summing the recalibrated footage of each utility category using excel pivot tables.
The community asset inventory does not account all forms of loss caused by a flood by any means. Due to a lack of data many things such as loss of life, injury, loss of personal property inside of structures, or loss of non-structural assets on properties cannot be analyzed. However this analysis does give a starting point for understanding flood risk in the river corridor.

Little Valley Road and Infrastructure Damage

### 6.4.2.1 Hydraulic Modeling

Results of the Fish Creek hydraulic modeling were used to determine estimated 2-, 10-, 25-, 50-, and 100-year water surface elevations. Mapping of 2-, 10-, 50-, and 100-year inundation was conducted using HEC-RAS model results and the 2013 post-flood LiDAR data. The results are presented in a map book in the Appendix that shows the extents of the modeled inundation.

#### 6.4.2.1.1 Hydraulic modeling limitations and assumptions

The hydraulic model and inundation mapping developed for Fish Creek are considered to be approximate and do not meet standards of a detailed analysis. Model results and inundation mapping should be used with the following caveats/limitations in mind:

- The Fish Creek hydraulic model geometry and inundation mapping was developed using un-processed LiDAR data.
- The Fish Creek hydraulic model geometry does not include in-channel bathymetric survey data. (Note that LiDAR data does not include data below water.)
- The origin of bridge/culvert model geometry from CWCB is unknown.
- Bridge/culvert model geometry added to CWCB models was estimated and is not based upon field survey data.
- A majority of bridges/culverts are not represented in the modeling. The absence of crossing structures in the model will result in underestimation of water surface elevations in the vicinity of bridges or culverts.

The level of detail provided in the Fish Creek hydraulic modeling was considered sufficient for the purposes of conceptual level activities associated with Master Planning efforts. However, more detailed hydrologic and hydraulic studies will need to be completed subsequent to Master Planning efforts.

### 6.4.2.2 Community Asset Inventory

The results of the community asset inventory for flood hazards are summarized in Tables x through x for parcels in the Fall River corridor for 2-, 10-, 25-, 50-, and 100-year inundation levels. The results of the asset inventory for utilities is presented in Tables x through x for 2-, 10-, 25-, 50-, and 100-year inundation levels respectively.

**Fish 2-Year Floodplain Utilities**

| Utility Type | Length of Impacted Utility (ft) |
|---|---|
| Lateral | 104 |
| Potable | 447 |
| SewerMain_UTSD | 1190 |
| Grand Total | 1741 |

**Fish 10-Year Floodplain Utilities**

| Utility Type | Length of Impacted Utility (ft) |
|---|---|
| Lateral | 152 |
| Potable | 761 |
| SewerMain_UTSD | 2157 |
| Grand Total | 3070 |

**Fish 25-Year Floodplain Utilities**

| Utility Type | Length of Impacted Utility (ft) |
|---|---|
| Lateral | 286 |
| Potable | 973 |
| SewerMain_UTSD | 3108 |
| Grand Total | 4367 |

**Fish 50-Year Floodplain Utilities**

| Utility Type | Length of Impacted Utility (ft) |
|---|---|
| Lateral | 361 |
| Potable | 1124 |
| SewerMain_UTSD | 3837 |
| Grand Total | 5322 |

Road and Infrastructure Damage

**Fish 100-Year Floodplain Utilities**

| Utility Type | Length of Impacted Utility (ft) |
|---|---|
| Lateral | 417 |
| Potable | 1317 |
| SewerMain_UTSD | 4346 |
| Grand Total | 6080 |

| Fish Creek 2-Year Floodplain Parcel Assets | | | | | | |
|---|---|---|---|---|---|---|
| **Parcel Type** | **Number of Parcels** | **Number of Structures** | **Inundated Property Value** | **Inundated Structure Value** | **Total Property Value** | **Total Structure Value** |
| Agricultural | 7 | 9 | $768 | $14,725 | $41,149 | $822,784 |
| Commercial | 9 | 14 | $36,179 | $53,525 | $922,163 | $1,394,948 |
| Exempt | 20 | 8 | $427,597 | $8,481 | $2,153,580 | $1,540,374 |
| Residential | 82 | 78 | $750,063 | $536,650 | $12,975,000 | $11,234,781 |
| (blank) | 3 | 0 | $0 | $0 | $0 | $0 |
| **Grand Total** | **121** | **109** | **$1,214,607** | **$613,381** | **$16,091,892** | **$14,992,887** |

| Fish Creek 10-Year Floodplain Parcel Assets | | | | | | |
|---|---|---|---|---|---|---|
| **Row Labels** | **Count of PARCELNUM** | **Sum of BLDGS** | **Sum of frac_VALLAND** | **Sum of frac_VALIMP** | **Sum of VALLAND** | **Sum of VALIMPALL** |
| Agricultural | 7 | 9 | $909 | $17,555 | $41,149 | $822,784 |
| Commercial | 9 | 14 | $67,358 | $92,558 | $922,163 | $1,394,948 |
| Exempt | 20 | 8 | $442,928 | $17,176 | $2,153,580 | $1,540,374 |
| Residential | 85 | 81 | $1,169,336 | $802,632 | $13,399,500 | $11,565,258 |
| (blank) | 3 | 0 | $0 | $0 | $0 | $0 |
| **Grand Total** | **124** | **112** | **$1,680,531** | **$929,922** | **$16,516,392** | **$15,323,364** |

| Fish Creek 25-Year Floodplain Parcel Assets | | | | | | |
|---|---|---|---|---|---|---|
| **Row Labels** | **Count of PARCELNUM** | **Sum of BLDGS** | **Sum of frac_VALLAND** | **Sum of frac_VALIMP** | **Sum of VALLAND** | **Sum of VALIMPALL** |
| Agricultural | 7 | 9 | $1,153 | $22,701 | $41,149 | $822,784 |
| Commercial | 9 | 14 | $79,913 | $112,015 | $922,163 | $1,394,948 |
| Exempt | 21 | 8 | $453,524 | $24,922 | $2,188,720 | $1,540,374 |
| Residential | 87 | 82 | $1,493,830 | $1,022,349 | $13,618,500 | $11,659,745 |
| (blank) | 3 | 0 | $0 | $0 | $0 | $0 |
| **Grand Total** | **127** | **113** | **$2,028,420** | **$1,181,987** | **$16,770,532** | **$15,417,851** |

| Fish Creek 50-Year Floodplain Parcel Assets | | | | | | |
|---|---|---|---|---|---|---|
| **Row Labels** | **Count of PARCELNUM** | **Sum of BLDGS** | **Sum of frac_VALLAND** | **Sum of frac_VALIMP** | **Sum of VALLAND** | **Sum of VALIMPALL** |
| Agricultural | 7 | 9 | $1,372 | $27,420 | $41,149 | $822,784 |
| Commercial | 9 | 14 | $90,061 | $131,918 | $922,163 | $1,394,948 |
| Exempt | 20 | 8 | $461,000 | $29,625 | $2,153,580 | $1,540,374 |
| Residential | 90 | 84 | $1,908,598 | $1,267,317 | $13,909,500 | $11,993,598 |
| (blank) | 3 | 0 | $0 | $0 | $0 | $0 |
| **Grand Total** | **129** | **115** | **$2,461,030** | **$1,456,280** | **$17,026,392** | **$15,751,704** |

| Fish Creek 100-Year Floodplain Parcel Assets | | | | | | |
|---|---|---|---|---|---|---|
| **Row Labels** | **Count of PARCELNUM** | **Sum of BLDGS** | **Sum of frac_VALLAND** | **Sum of frac_VALIMP** | **Sum of VALLAND** | **Sum of VALIMPALL** |
| Agricultural | 7 | 9 | $1,589 | $32,481 | $41,149 | $822,784 |
| Commercial | 9 | 14 | $101,306 | $154,902 | $922,163 | $1,394,948 |
| Exempt | 21 | 8 | $466,774 | $33,216 | $2,158,580 | $1,540,374 |
| Residential | 95 | 89 | $2,218,486 | $1,512,214 | $14,610,500 | $12,793,811 |
| (blank) | 3 | 0 | $0 | $0 | $0 | $0 |
| **Grand Total** | **135** | **120** | **$2,788,155** | **$1,732,813** | **$17,732,392** | **$16,551,917** |

Utility and Road Damage- Fish Creek Road

# 7 Recovery and Restoration Project Recommendations

## 7.1 Overview

Fish Creek Flood Damage

Recommended projects were generated by the technical team, with the help of the River Advisory Committee, and public feedback. The recommended projects represent the best alternatives to reduce flood and geomorphic risk for homeowners, business owners, and the public as well and increase the ecological quality of Fish Creek. The projects were summarized in a matrix and evaluated for their ability to reduce risk and meet community values, and evaluation criteria relative to all the other potential projects. After going through a public review and editing process, the top five projects were chosen based on their matrix rankings. The purpose of the prioritization is to direct community organizers to projects that best meet the goals of reduced flood and geomorphic risk, and increased ecological function, as well as meeting the community values and criteria. The prioritized projects also take into account their relative cost and funding potential. The prioritization of the five projects does not guarantee that they will be constructed or even funded. The prioritized projects are described in greater detail in individual cut sheets.

### 7.1.1 How to use this Document

The information in the recommended project section of the master plan is meant to be used as a planning tool for the community and the future leadership of the river coalition. The results of the project recommendation process resulted in:

- The Concept Drawings showing specific project recommendations
- The Project Matrix which compares all of the recommended projects
- The Top 5 Prioritized Projects with cut-sheets show these projects in more detail

Each recommended project is a reach on Fish Creek where specific project elements are laid out to best reduce flood and geomorphic risk, increase ecological function, and meet the community values. The specific recommendations are shown on the Plans for Resiliency in this section. The recommended projects are summarized and evaluated in the project matrix, which can be used for comparison of benefits between projects.

The recommended project matrix should be used as a comparison tool and guide for the pursuit of funding for different projects. It is not the final decision about what projects to pursue for implementation. For example, several projects address the specific needs of local structures to reduce high geomorphic or flood risk, but due to the highly developed and confined nature of the reach, the project provides little other benefit outside of risk reduction. These projects do not compare as favorably to projects that provide multiple benefits, but they are still necessary to the safety of the local residents and public.

While the technical team recommends completing all of the projects to reduce risk and improve stream function, five projects were prioritized because of large multiple benefits to Fish Creek. The prioritized project cut sheets describe in greater detail the project objectives and strategy. They provide information on potential funding sources, implementation guides, construction considerations, and projects costs which can be used to help pursue funding, and guide the design and implementation.
The projects recommended by the technical team represent the best alternatives for reducing risk in the Fish Creek Corridor. They provide a long-term vision for the river that groups can use to guide future projects and development. As projects are funded and moved into design and implementation phases there is room for further change and refinement to meet the needs of residents and specific site limitations.

## 7.2 System-wide Recommendations

### 7.2.1 River Restoration Strategies

**7.2.1.1 Channel Design and Rehabilitation Strategies**

In-channel restoration projects typically result in lots of public attention and stakeholder involvement. They are the 'sexy' aspect of watershed restoration – big machines working in the river to recreate a natural looking channel, bank, and floodplain with promises that trout and other wildlife will call it home. While undeniably in-channel work has resulted in some excellent results it also has a mixed track record and the cost-benefit has not always added up. In order to increase the likelihood of successful channel restoration two themes surface. First is the theme of watershed management. Stream systems, because they receive from the surrounding landscape, are an indicator of the condition of the land that drain into them. Treating an in-channel symptom without concern/attention to the health of the surrounding land may result in a failed project. It makes sense then that an in-channel restoration goal may start with (or at least be done in conjunction with) an out of channel restoration project (e.g. manage overgrazing of elk in order to establish riparian vegetation that then supports beaver recolonization in order to reconnect floodplains).

Second is the concept of process-based restoration. Rivers, given enough time, space, and water moving through them (in the right quantities and timing - including seasonal flooding) are inherently self-healing. Flood altered streams find their equilibrium and reestablish habitat features and floodplains given enough time. Time, however, for a river, can be much longer than a community is willing to wait – especially in Colorado's mountains where natural systems are brittle and recovery can be very slow. Projects that allow for and even encourage natural channel forming processes to take place can help to speed up a streams rehabilitation. These processes include the ability to meander; generate, transport, and store sediments and organic debris; and dissipate energy onto floodplains.

Specifically with this second concept of process based restoration in mind the following channel design strategies are recommended for the Fall River.

**7.2.1.1.1 Create compound channels (Figure 1)**

The quest of engineers and hydrologist's to seek knowledge of river systems may have inadvertently led to the proliferation of trapezoidal channel design being considered a "stable" river and optimum for flood control. For ease of graphic description and mathematical calculation a trapezoid is a straightforward way to think of river channel's shape. It has also is the preferred shape to move water quickly and efficiently at flood stage. The wide-bottomed, steep banked shape, however, promotes shallow low water flows and high powered flood flows. Natural stream channels and their floodplains are much more complex. This complexity (and the resulting products including ecological diversity, biogeochemical processing, and ultimately resilience) is both created and derived from rivers occupying different areas of the channel and floodplain at different stages. Unlike a trapezoid channel's wide flat bottom which increases water temperature and promotes algae growth, a low-flow channel, provides refuge and shade for aquatic biota. Bank and floodplain benches below, at, and above the top of bank provide stepped relief for the stream channel maintaining sediment conveyance at crucial times while also providing refuge for fish and niches for plant diversity.

While multi-staged channels may be constructed they are also built naturally. Overflow channels and flood chutes carved though floodplains during the 2013 flood provide opportunities for floodplain access at varying flows (sometimes a low floodplain bench is not directly adjacent to the main channel but rather exists as a flood-chute separated from the main channel). Too frequently following the September 2013 flood these areas have been filled back in and the stream channel bulldozed back into a "bad trapezoid". It is recommended that the Fall River Coalition prioritize protecting and restoring secondary channel 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 multi-stage compound channels.

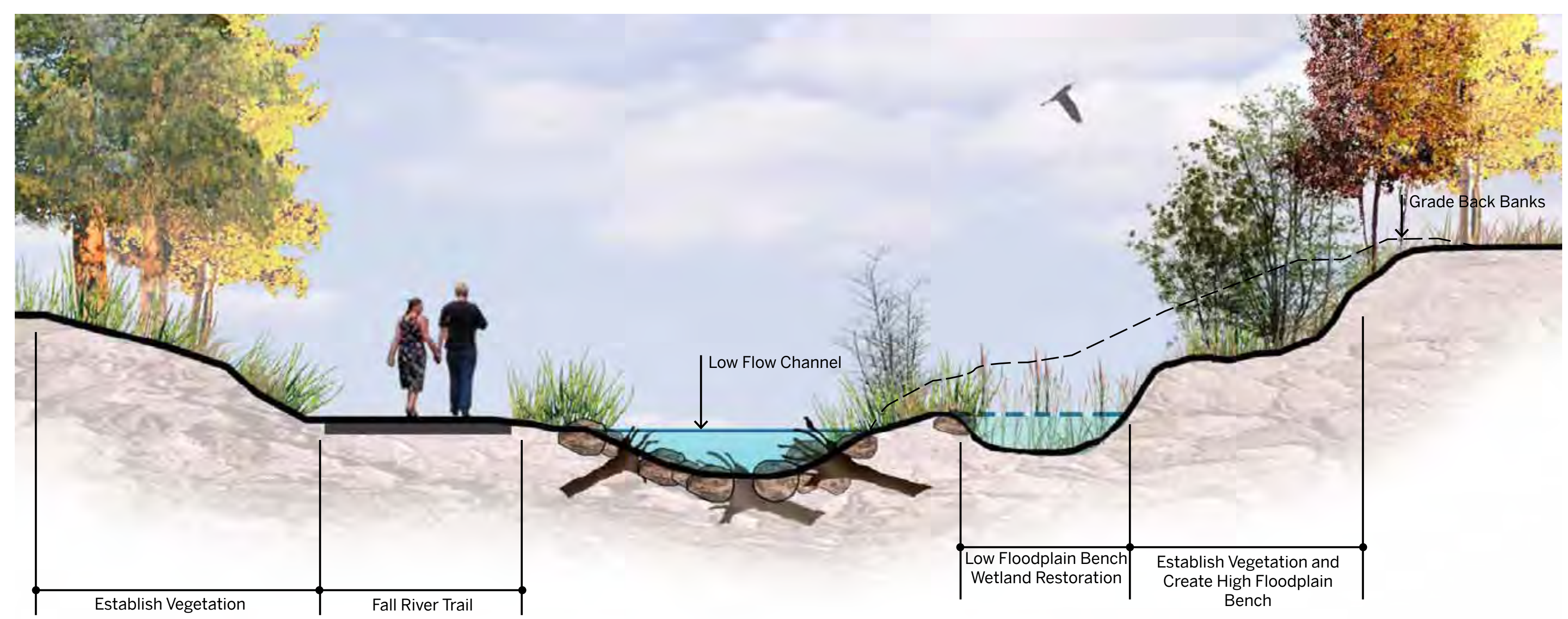



*Figure 1. Compound channel for connected and variable floodplains. Compound or nested channels with floodplain benches below, at, and above the top of bank reduce flood surface elevations, maintain sediment transport while also providing refuge for fish and niches for diverse riparian plant communities.*

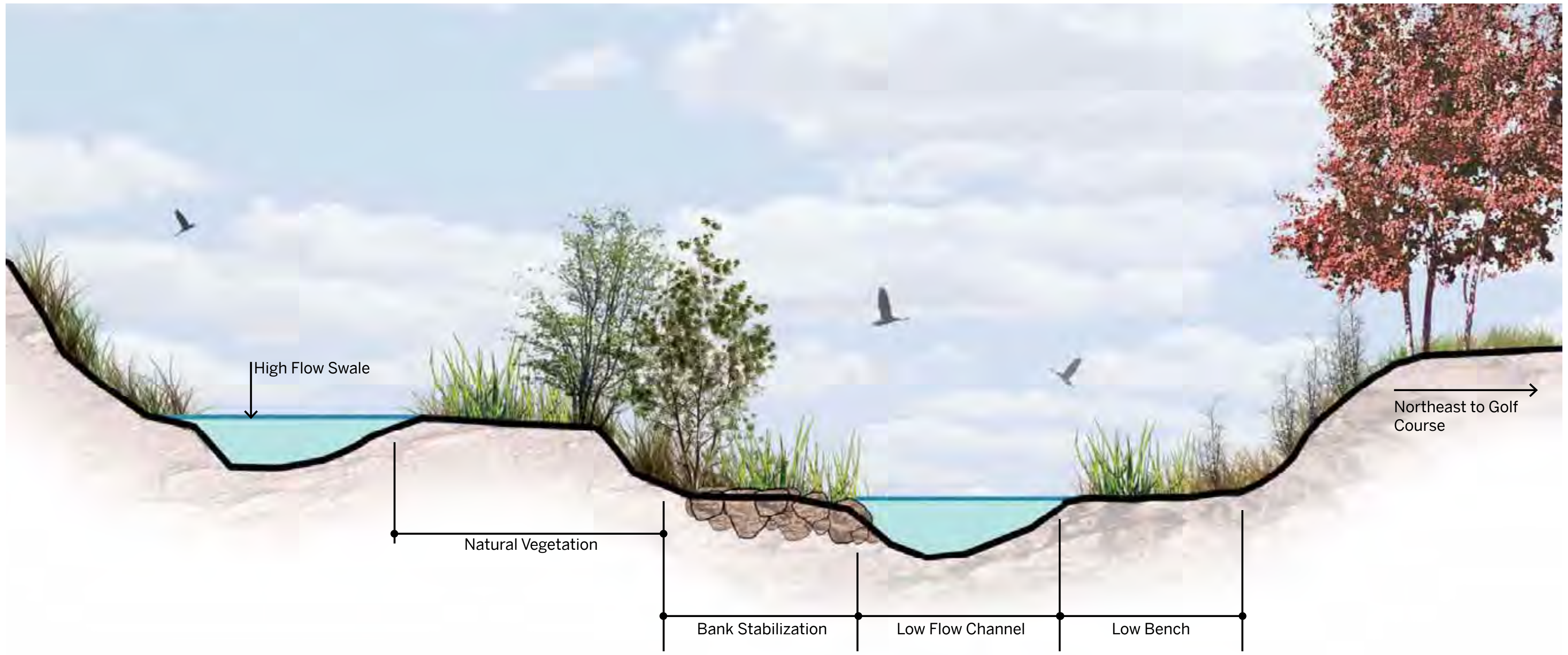


*Figure 2. Overflow channels. Where corridor width allows, establishing designated high flow paths to relieve the flow in the main channel provide the safest and most reliable means of dealing with overbank flow and potential damaging floodwaters.*

**7.2.1.1.2 Create complex "messy" channels (Figure 2)**

Prevailing public perception of "natural" river channels has led to some unfortunate pervasive problems in Colorado mountain streams. Where once beaver dams and log jams choked stream channels forcing water into numerous side channels and complex bedforms (tight curves, splits, pools, etc.), today's Fall River is largely a "clean" single-thread channel running from it's headwaters to it's confluence. This metamorphis from an anabranched channel with excellent and frequent floodplain connection to a simplified channel has limited the retention of organic matter (carbon), nutrients, and flood waters and reduced the ecological diversity it once held. Although relatively stable due to its large substrates the existing channel has limited potential to deal with excessive alterations to chemical and sediment inputs and provides limited fish and riparian habitats. The concept of "clean" has also been applied to streambanks where lawns and machine placed rock have replaced natural vegetation along much of the Fall River. While it may provide an easier place to backcast a trout fly, lawns and rip-rap offer little to the stream ecosystem. They also provide a false sense of stability and flood protection. To the extent possible efforts to reintroduce complexity into the channel and its floodplain should be embraced and efforts to treat the river as a manicured landscape should be resisted.

**7.2.1.1.3 Create a "River Corridor" (Figures 4 and 5)**

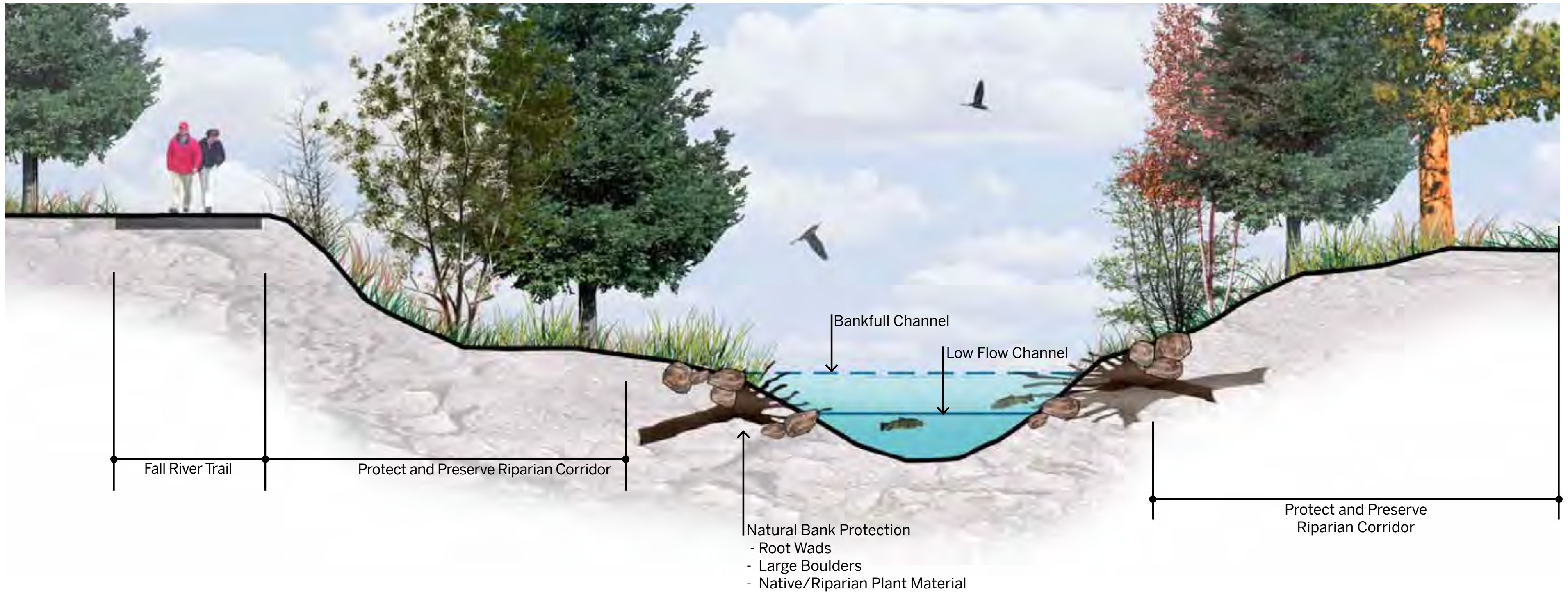
There is an amnesia regarding rivers that pervades many minds. Because their change is often slow and because we have been largely successful at removing and taming those things that make them wild and unruly (beavers and fallen trees particularly) we tend to think of rivers as being locked into one location. This thinking along with the common reaction to flooding - straightening, dredging, armoring, and berming – has aided a false sense of security allowing development to encroach further into river corridors. As recent events in September of 2013 demonstrated, however, our current methods of relying solely on flood elevation maps to reduce flood risk offers limited protection as even properties located far away or high above creeks were affected. As a matter of physics, streams can become highly energetic during a flood event. As a general rule materials that were laid down by a river are subject to removal by the river at some future event (i.e., what the river builds the river may take away). Sudden changes to a river's course are an inevitability. Geomorphologists read these changes in the landscape by looking at old scars left behind by the moving channel. Sometimes these meander scars become hidden when development fills and levels sites within the historic river bed.

Long term resilience therefore looks at a river as not only the place where we see it today but also as the place where we may see it tomorrow. It recognizes that the water in the channel is bounded by water under the banks and floodplain. It recognizes that there are physical and ecological processes occurring on the land around the river that are integral to the health of the river itself (and vice a versa). These notions are summarized in the term "river corridor" which accounts for the area of land adjacent to and including river that is required to accommodate the dimensions, slope, planform, floodplain and riparian habitat of the naturally stable channel, and necessary to maintain or restore stable conditions and minimize erosion hazards. For more information on river corridors visit: http://cwcb.state.co.us/environment/watershed-protection-restoration/documents/co_rivercorridorprotectionfs.pdf and http://www.floods.org/PDF/ASFPM_TNC_Active_River_%20Area.pdf

### 7.2.2 Road Infrastructure , Stream Crossings, and Diversions Strategies

At the watershed scale road networks can have significant impacts to the hydrologic regime and floodplains of the Fall River. Excessive road networks may decrease water storage capacity of the landscape as water is quickly and effectively transferred into conveyance ditches. These land use changes decrease the time it takes water to enter the channel and may increase the peak volume of water. Changes in runoff volume and timing can disrupt the water/sediment balance in creek systems. Erosion, incision, and channel widening are often associated with increased stormwater resulting from development.

In addition, where roads border the river, vegetation tends to be disturbed and not as robust as if the stream were meeting an unaltered floodplain forest. Berming, straightening




*New Figure 5. Establish and preserve a river corridor. Any new development within the river corridor will increase risk and future damage. Where the floodplain and riparian corridor is undeveloped, preservation of this space should be the top priority. Where there is encroachment, slow and systematic restoration of the land and removal of assets will have the largest effect on reducing the community's risk. development in recommended preservation areas will increase risk to assets.* Where floodplain is intact, preserve this natural buffer to best protect assets. Enhance floodplain connectivity and presence of woody materials

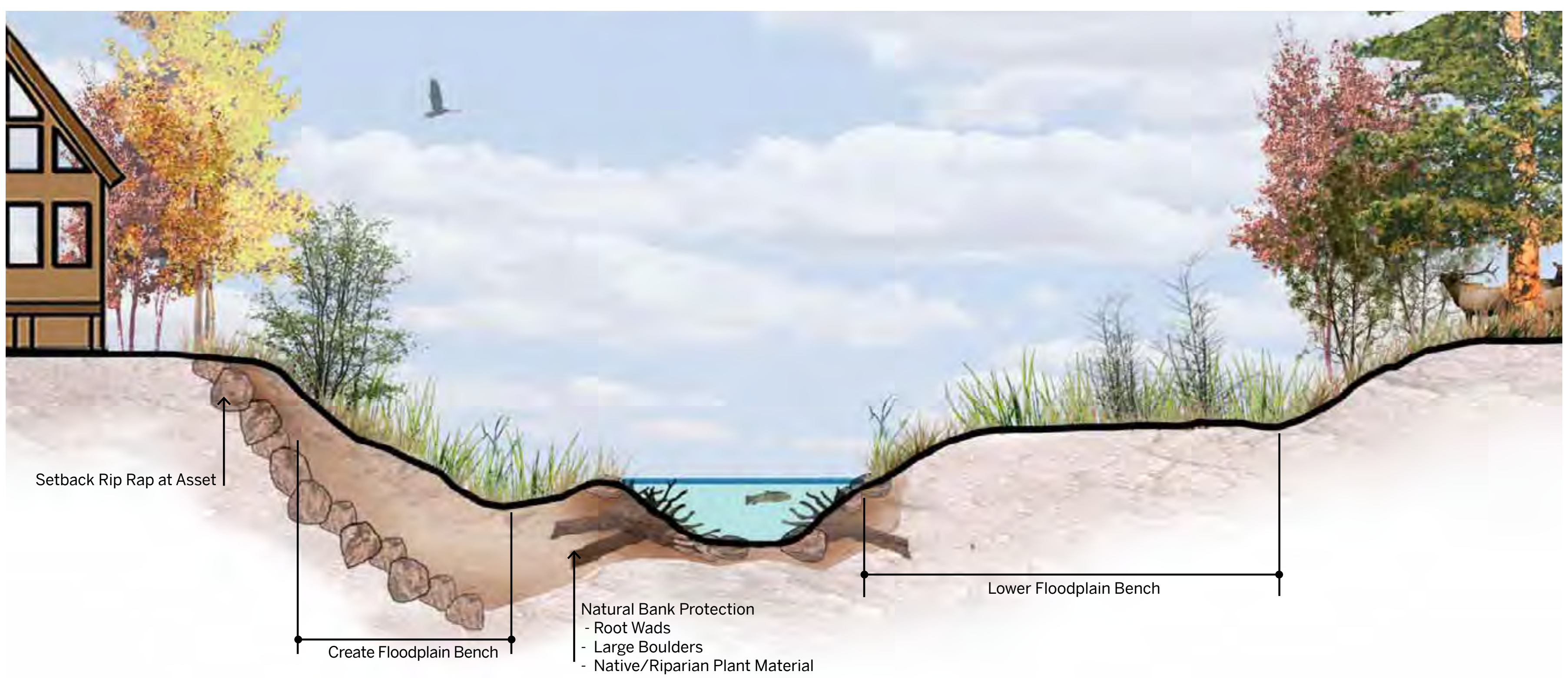



*Figure 4. Multiple lines of defense. Streams are dynamic and need flexibility to respond to a range of flows. Hard protection in the form of rip rap or retaining walls should occur at the outer most boundaries of the river corridor and directly adjacent to the asset at risk and should be the last line of defense, not the first. Closer to the active stream channel natural bank protection (large wood, boulders, and woody vegetation) should be used to stabilize banks and dissipate stream energy.*

and armoring associated with the building of the road along a stream corridor effectively raises the bank height, increasing channel erosive energy and disconnects the river from its floodplain. These efforts have proven to be temporary fixes at best, and in some cases have led to disastrous property losses and natural resource degradation. Elkhorn Avenue, Fall River Road, Fish Hatchery Road are all examples of roads that have encroached on the stream corridor. These corridor alterations have likely transformed some adjacent reaches from sediment storage areas to sediment transport reaches, which potentially impacts downstream reaches where the excess sediment then deposits. When these roads are repaired, coordination with qualified fluvial geomorphologist(s) and/or river engineer(s) is highly recommended to limit constrictions, maintain sediment transport, reduce sheer stress against the road embankments, and maintain floodplain and in-channel habitat.

A comprehensive road maintenance manual should be developed for the Town of Estes Park to include recommendations on post-disaster emergency road rebuilding, building roads and crossings that are compatible with the river, identification of reroute and realignment options as opportunities become available.

The need to span the Fall River via bridge is imperative for the human community that inhabits its corridor. Historically the process of placing a bridge over the river involved constructing stone or timber abutments onto which rested timbers and later iron and steel. In order to minimize the timber span length these abutments were often built narrower than the natural channel bankfull width unintentionally creating instability upstream and down. Mid and late 20th century updates frequently kept these narrow abutment locations in the name of short term savings on materials as well as simplified designs allowed by a narrow crossing. Modern crossings designed by hydraulic engineers to pass a certain volume of water and resist a certain amount of scour during a flood event have typically neglected to account for the contextual surroundings of the bridge (i.e. the bridge may stay in place but the stream bed and banks around it may erode severely). Additionally most of these "modern" structures have neglected to account for sediment and debris transport and subsequently become drivers of instability during a flood event.

Fish Creek Little Valley Road Damage

The narrowing of the river from bridge abutments becomes problematic when, during high flows, floodwaters back up due to the constriction thus causing flooding upstream and sometimes outflanking of the bridge. This is worsened by debris and sediment that can accumulate at a constriction which typically further exacerbate upstream instability. It is important to understand that this is most often a structure problem not a sediment/ debris problem and as such, it can often be ameliorated through improved design and/or structure retrofit.

During flood conditions, stream power is increased on the downstream side of the constriction (like putting your thumb on the end of a garden hose). The extra energy causes erosion and typically leaves a wide scoured area downstream of an undersized bridge. In additional, physical changes to the river channel such as straightening/dredging and armoring of the banks in order to protect narrow bridge abutments may further keep a river from achieving functional stability.

Long-term crossing resilience relies heavily on a number of factors including: bridge width and height, flood conveyance planning, reach location (in relation to channel geomorphology), aquatic organism passage and intelligent planning for additional features.

Removing channel constrictions by significantly expanding the width and height of stream crossings will allow the Fall River to transport water, sediment, and debris in equilibrium. When and where design and surrounding land use allow, retrofitting existing structures with high flow culverts to aid passing water under a road may be an option. A different but similar strategy would be to design roadway approaches so that water can pass over them thus providing a low flow option – the channel may cut into these areas but would leave the bridge, its abutments, and decking in place for easier repair. Breakaway designs where the decking swings on a hinge downstream (so as to prevent a washout from becoming flood debris) should also be explored.

Similarly, it is recommended that the Fall River Coalition consider reconstructing low-head diversion dams to transport sediments and not re-direct flow into weak embankments.

These types of low-head structures have the additional benefits of allowing for fish and aquatic organism passage, while reducing the sediment load into ditches. Numerous examples now exist in Colorado where boulder-weir structures replace concrete dams and provide ditch water for irrigators and water supply .

Bridge planning for floods resilience should also include a comprehensive analysis of the location of a bridge in relation to the stream channel and its propensity for lateral adjustment, streambank erosion, and/or aggradation (this goes hand in hand with road layout and design). Critical structures should avoid being situated at the mouths of canyons, on alluvial fans, and or in avulsion hazard zones for instance. Because each bridge crossing should be a thoughtful endeavor with relation to the stream channel, less is often more – opportunities to reduce the number of crossings by sharing major road arteries over a flood proof bridge may not be as convenient but may have numerous benefits. Further improving this bridge design, retrofit, and planning would call for utilities, pedestrian bridges, and other associated infrastructure to be located on the downstream side so as to reduce the likelihood

Stone Bridge Structure Foundation Damage of their damage by passing debris.

Ecological impacts from bridge and culvert crossings are most severe when artificial bottoms, high velocities, or otherwise impassable barriers are created due to the dimension, slope, and material of a bridge or culvert. Design for aquatic organism passage frequently entails natural channel bottoms, velocity dissipation, and/or grade control structures in the vicinity of the structure.

Temporary crossings, while a necessary post-flood endeavor, are subject to become permanent as interest, funding and oversight wane. Because of the persistent and acute problems bad bridge design inflicts on stream corridors these temporary crossings need to be replaced with long-term resilient designs – complete removal being one of those options.

### 7.2.3 Development Strategies

Often many reach level problems are best addressed through watershed-level, community initiated strategies that seek to address the 'source' of a problem. These large-scale watershed efforts may be initiated through the Town of Estes Park, County, or the local watershed coalition. They may also be embraced and driven by local residents that are inspired through demonstration projects (i.e. low-impact development site) or other outreach and education efforts (workshops, etc.).

Development strategies that would benefit the Fall River include:

- The establishment and maintenance of riparian forests along the entire river corridor.
- On-site stormwater management retrofitting for all existing residential and commercial building sites and implementation of low-impact design (LID) techniques for all future development.
- Replacing and/or retrofitting undersized bridges and culverts and ensuring all new structures are sized for geomorphic

  stability as well as habitat connectivity along the river corridor.
- Practicing soil conservation and erosion control practices (AMP's and BMP's) on all construction and other sites where soil is disturbed.
- Floodplain and river corridor planning and protection (such as adoption of Fluvial Erosion Hazard zones, stream setbacks, wetland regulations, etc.) to eliminate future floodplain encroachment.
- Individual flood risk recognition and acquisition programs to remove/relocate existing structures from the river corridor
- Reconsider the location of community emergency response infrastructure and relocate as necessary

#### 7.2.3.1 Road Infrastructure and the Fish Creek System

Man-made structures such as bridges and diversion dams may exacerbate channel migration or lateral erosion if the infrastructure directs flow directly into a bank or embankment or more typically the structure fails to pass sediment and debris being transported by the water. There are many examples of undersized crossings that racked debris of all types and caused the creek to back up and eventually flank the bridge or culvert. It is important to understand that this is most often a structure problem not a sediment/ debris problem and as such, it can often be ameliorated through improved design and/or structure retrofit.

The pCMZ mapping included in this report does not attempt to predict debris jams at man-made structures or the most likely location of new channels should infrastructure jam or fail. It is recommended that the Fall River Coalition consider road crossing designs that allow for appropriate sediment transport at low, medium, and high flows (including the overflow areas), as well as the capability to pass debris and/or design crossings that break away if debris racks and upstream pressure becomes too great. Similarly, it is recommended that the Fall River Coalition consider reconstructing low-head diversion dams to transport sediments and not re-direct flow into weak embankments. These types of low-head structures have the additional benefits of allowing for fish and aquatic organism passage, while reducing the sediment load into ditches.

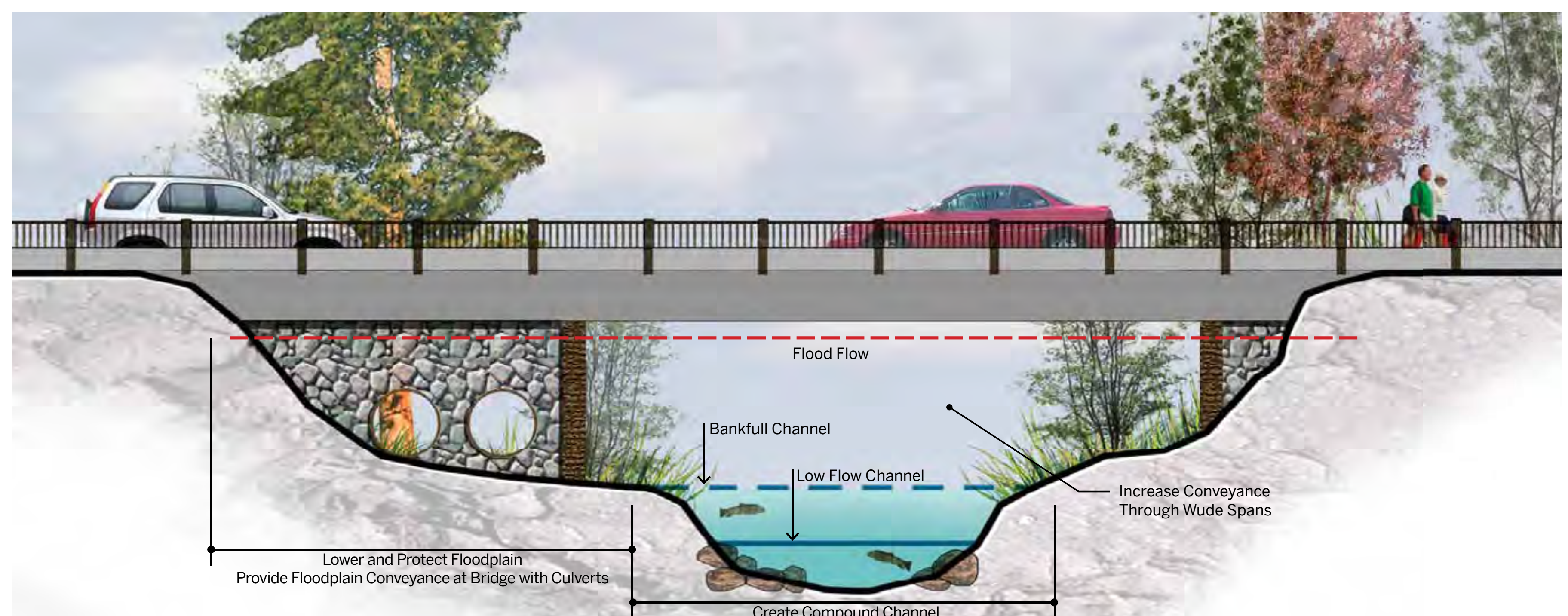



*Figure 3. Improvements and retrofits to bridges. Bridge and culverts embankments block floodplain flow and increase the risk of debris jams and flanking. Bridge removal, replacements, and retrofits can help to convey flood flows and sediment reducing risk to adjacent properties and the infrastructure itself.*

Elkhorn Avenue, Fall River Road, Fish Hatchery Road and a number of other local roads have encroached on the stream corridor. In turn flow depths, shear stresses, and sediment transport capacities may become higher than they would be in a more natural condition. This corridor alteration has likely transformed some reaches from sediment storage areas to sediment transport reaches, which potentially impacts downstream reaches where the excess sediment then deposits. When these roads are repaired, coordination with qualified fluvial geomorphologist(s) and/or river engineer(s) is highly recommended to limit constrictions, maintain sediment transport, reduce sheer stress against the road embankments, and maintain floodplain and in-channel habitat.

#### 7.2.3.2 Channelization, Armoring, and Floodplain Disconnections (Figure 3)

Channelization (straightening) and streambank armoring occurs throughout the Fall River system. The response of the stream system to these modifications typically occurs within and beyond the modified reach and frequently begins with a bed incision process. As channels incise or berms are constructed, channels are disconnected from their floodplains, and in turn, the excess energy in the system causes an increase in erosion laterally and/or vertically. The increased erosion leads to an increase in sediment load transferred downstream of the channelized reach, where the channel may not have the capacity to continue to move the sediment through, ultimately leading to bed aggradation.

Furthermore, this increased scour directed at the channel bed reduces bed form features and typically leaves a homogenous plane bed channel morphology. Channelization and armoring not only disrupt the water sediment balance in the stream system, but the modifications also disrupt the ecological character of the stream and riparian corridor. When possible the Fall River Coalition should seek to maintain a naturally meandering stream with frequent opportunities for floodplain access.

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 Fall River Coalition 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.

#### 7.2.3.3 Acquisitions

Three tiers of acquisitions were recommended for the resiliency plan. The different tiers reflect the range of hazards and risks in the Fall River corridor. The following are descriptions of the three types of acquisitions:

**1st Tier**: acquisition and removal of an asset (e.g., home, business, or other infrastructure, such as road or bridge) from a high hazard area should be considered first for maximum risk reduction.

**2nd Tier**: when acquisition is not an option, the owner in the high hazard area makes an informed decision to stay despite the risks. Similarly, when relating a road or removing a bridge from a high hazard area is not an option, agencies and affected landowners make an informed decision on how to proceed. Then, to best protect assets, the community and to improve stream health, multiple project partners can collaborate on larger project(s) with system-wide engineering solutions that move towards resiliency.

**3rd Tier**: when a larger project is not feasible, affected parties can consider localized solutions to protect the asset, including flood-proofing structures, specialized foundations, revetments, retrofits, etc..

### 7.2.4 Regulatory Frameworks and Funding Strategies

The invisible structures that support many watershed efforts are those of regulatory and funding nature. From the Federal Clean Water Act of 1972 to recent legislative appropriations to continue the Colorado floodplain map modernization program, old frameworks are being enhanced and new regulations are being put in place to promote long term river resiliency.

Where existing frameworks exist to support flood recovery and resiliency some minor tweaks could promote better long term solutions. One such idea is the restructuring of how disaster recovery funding is allocated. Currently much federal funding post-disaster goes directly towards band-aid fixes (e.g., NRCS exigent sites that receive "temporary" rip-rap) particularly at assets identified in high hazard zones (A1, A2, B1, B2 lists). Alternatively these funds could have been provided to buyout critical (prioritized and willing) sellers that instead received these emergency funds and are now more inclined to feel safe and stay.

Another framework that could be used to assist the Fall River community is the National Flood Insurance Program's (NFIP) Community Rating System (CRS ). CRS is a voluntary incentive program that recognizes and encourages community floodplain management activities that exceed the minimum NFIP requirements. As a result, flood insurance premium rates are discounted to reflect the reduced flood risk resulting from the community actions meeting the goals of reducing flood damage to insurable property; strengthening and supporting the insurance aspects of the NFIP, and encouraging a comprehensive approach to floodplain management. Additional rate discounts may be obtained by projects that aim to reduce flood losses, promote flood risk awareness and flood insurance, and protect natural floodplain functions. Rate discounts may also become available for communities that adopt a channel migration zone or erosion hazard zone map as part of their planning efforts.

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#### 7.2.4.1 Altered Hydrologic Regime

Changes in hydrologic regimes disrupt the water/sediment balance in creek systems. Stormwater runoff from development within the river corridor may have some minor effects on the Fall River hydrograph by increasing the volume of runoff and accelerating its delivery into the channel. Erosion, incision, and channel widening are often associated with increased stormwater resulting from development.

## 7.3 Recommended Projects

Each recommended project represents a reach of the creek where recommendations were made to best reduce flood and geomorphic risk, increase ecological function, and meet the community values. A project can include multiple elements such as bridge improvements, floodplain reconnection, or grade control that addresses the specific needs identified in that reach by the technical team with the input of the public. The project reach extents do not always match the reach extents used for evaluating risk.

The recommended projects are summarized in the Concept Drawings in the following sections. The project matrix evaluates the recommended projects and allows for comparison between the other projects on Fish Creek.

### 7.3.1 Recommended Project Development

The recommended projects were developed by the technical team as a direct result of the flood, geomorphic, and ecological assessments. The technical team brainstormed potential projects, and recommended those that best reduce risk and meet the overall values of the community. The draft recommended projects were brought to the River Advisory Committee to be vetted. The RAC provided feedback for honing and improving the recommended projects. The draft recommended projects were then updated and presented for public review. The feedback received during this process was used to further refine the recommended projects, and the final versions are presented in the following pages.

East Fork - Fish Creek


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NOTES APPLICABLE TO ALL MAP SHEETS:
1) PROPERTY BOUNDARIES SHOWN HEREON ARE ESTIMATED AND SHALL BE USED FOR INFORMATIONAL PURPOSES ONLY.
2) PRELIMINARY POST-FLOOD GEOMORPHIC ND FLOOD HAZARD BOUNDARIES AND POST-SEPTEMBER 2013 (CURRENT) ALIGNMENTS ARE BASED ON LIDAR DATA PROVIDED BY FEMA AND COLLECTED IN OCTOBER 2013.
3) HIGH RESOLUTION BACKGROUND IMAGERY (WHERE AVAILABLE) IS POST-FLOOD AND PROVIDED BY LARIMER EMERGENCY TELEPHONE AUTHORITY (FALL 2013).
4) LOW RESOLUTION BACKGROUND IMAGERY FROM NAIP (OCTOBER 2013).

Fish Creek Corridor
"Path to Resiliency"
Resiliency Ideas
Index Map

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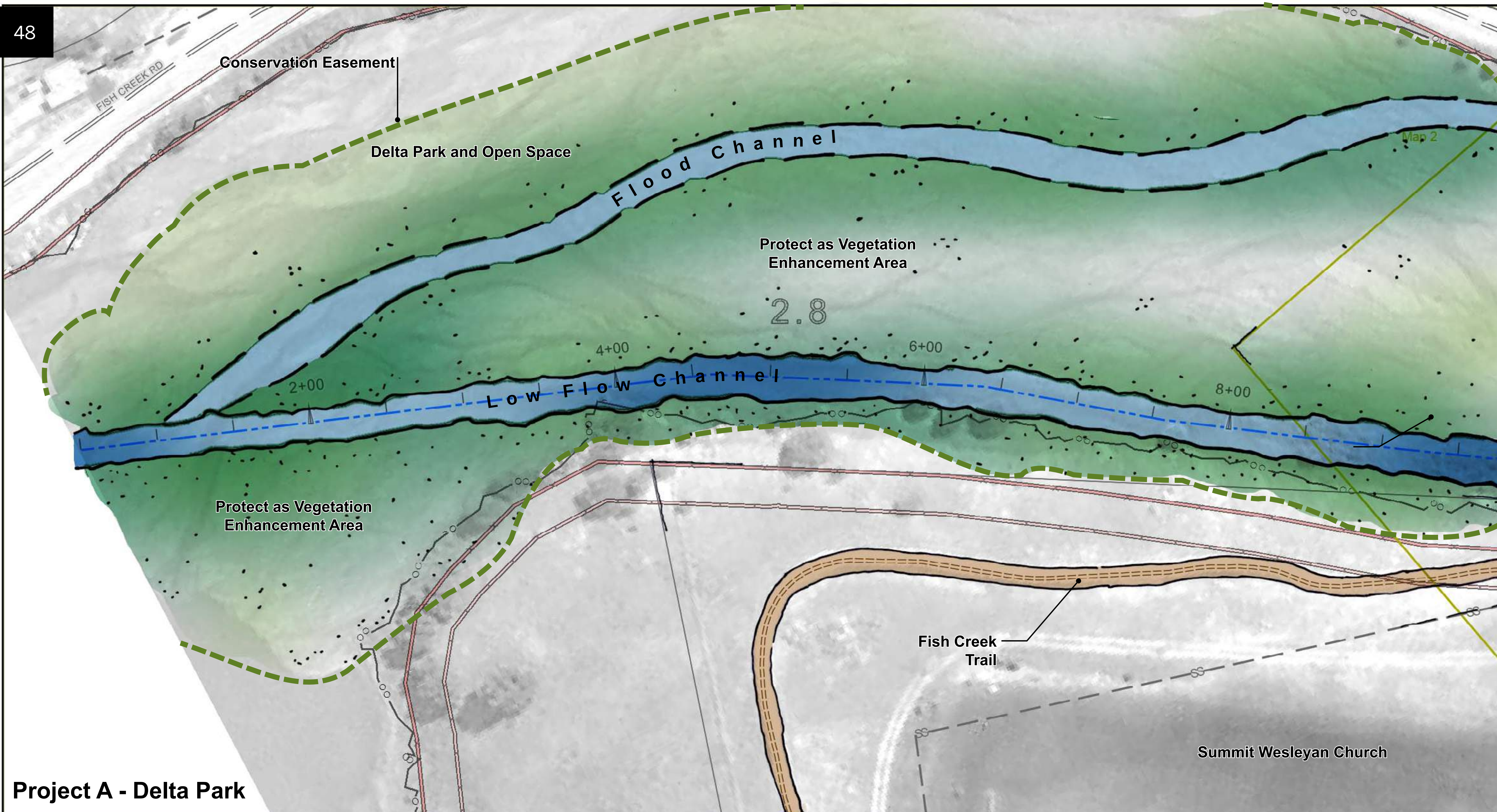


Robert Peccia & Associates
Walsh
an ecology and environment company
Great Outdoors Consultants
Round River Design
FlyWater
Anderson Consulting Engineers
Crane Associates

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1 inch = 60 feet
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Feet

Pre-Sep 2013 Trail Alignment
Pre-Sep 2013 Road Alignment
Pre-Sep 2013 Sanitary Sewer Alignment
Estimated Parcel Boundary (See Notes)
Adjacent Map
Post-Sep 2013 (ca. Nov. 2013) Creek Alignment
Pre-Sep 2013 Creek Alignment

4.5 Ecosystem Score

**A1** = Highest Risk/1st Tier Project:
Resiliency options include acquisitions/relocation of habitable structure outside of highest hazard area.

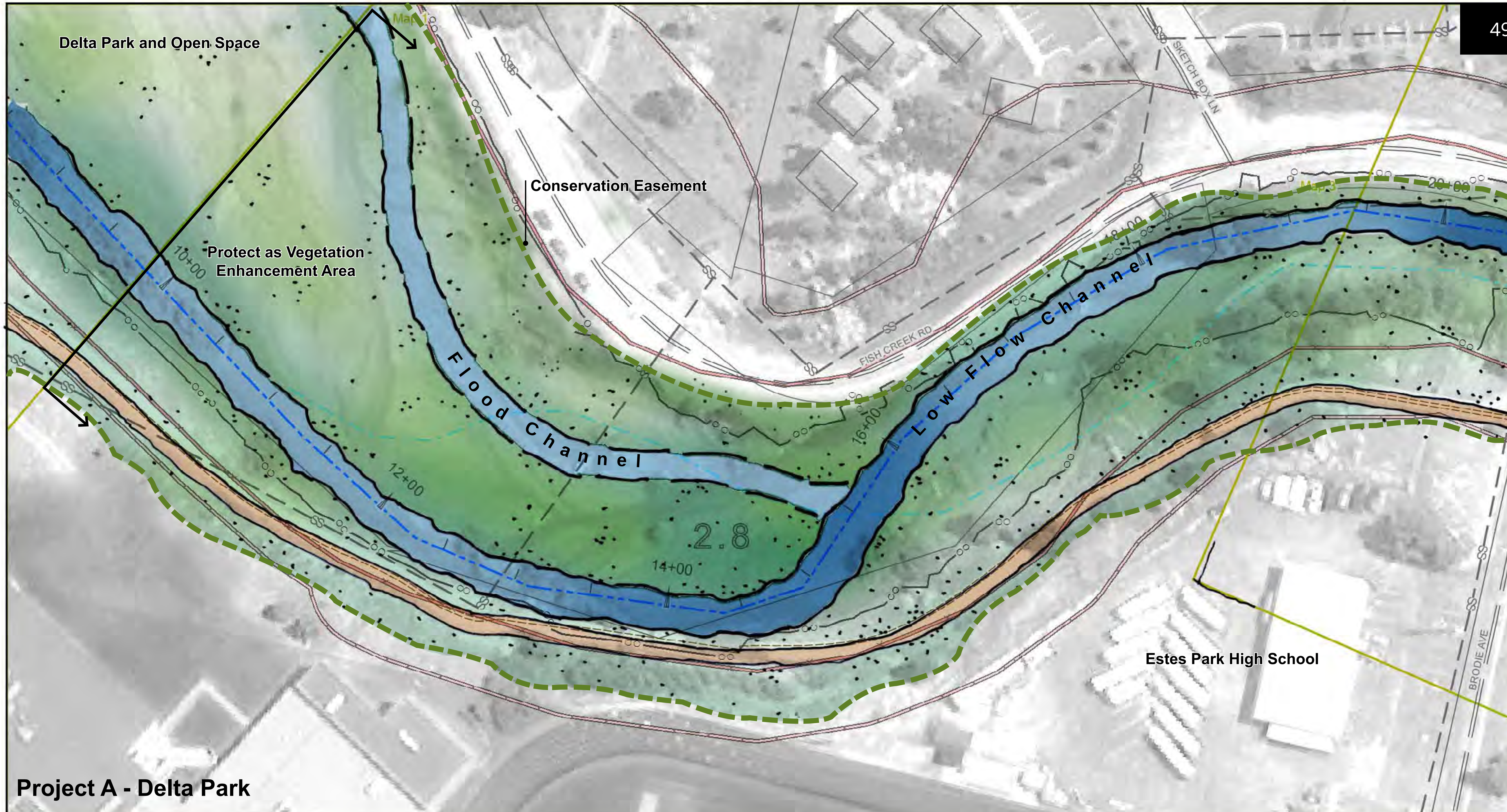
**A2** = High Risk/1st, 2nd & 3rd Tier Options:
Resiliency options include acquisition and relocation (1st Tier), large projects with system-wide benefits (2nd Tier), or localized solutions (3rd Tier).

*Preliminary 100-Year Floodplain
*Planning-Level Channel Migration Zone (pCMZ)
High Hazard Areas
Additional Hazard Areas

*** See IMPORTANT details on Floodplain or Geomorphic Hazard Mapbooks.**

EP Fish Creek Coalition

**Fish Creek Corridor**
**"Path to Resiliency"**
**Resiliency Ideas**
**Map 1 of 27**

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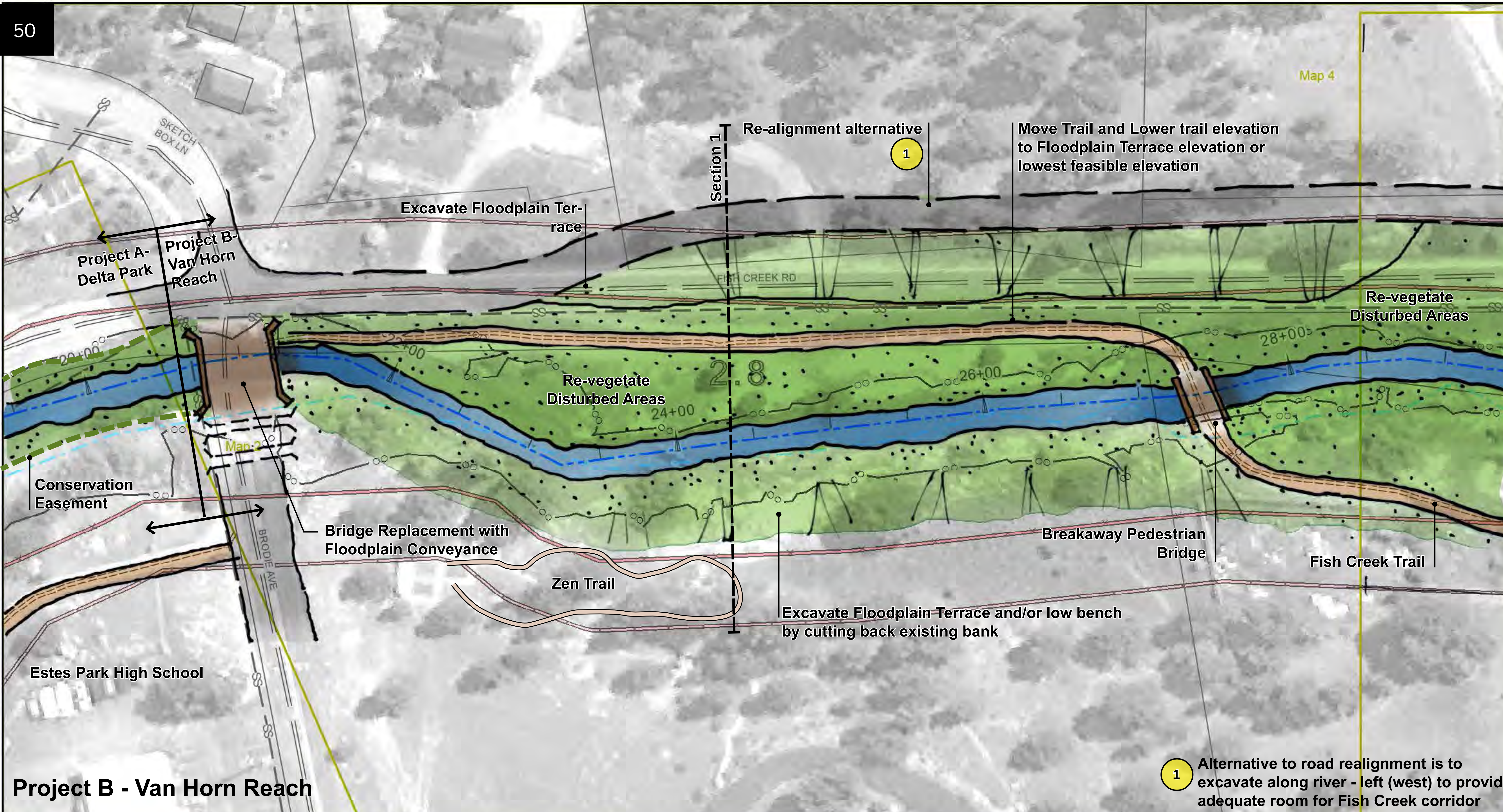
**Fish Creek Corridor**
**"Path to Resiliency"**
**Resiliency Ideas**
**Map 2 of 27**

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- Additional Hazard Areas

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**Fish Creek Corridor**
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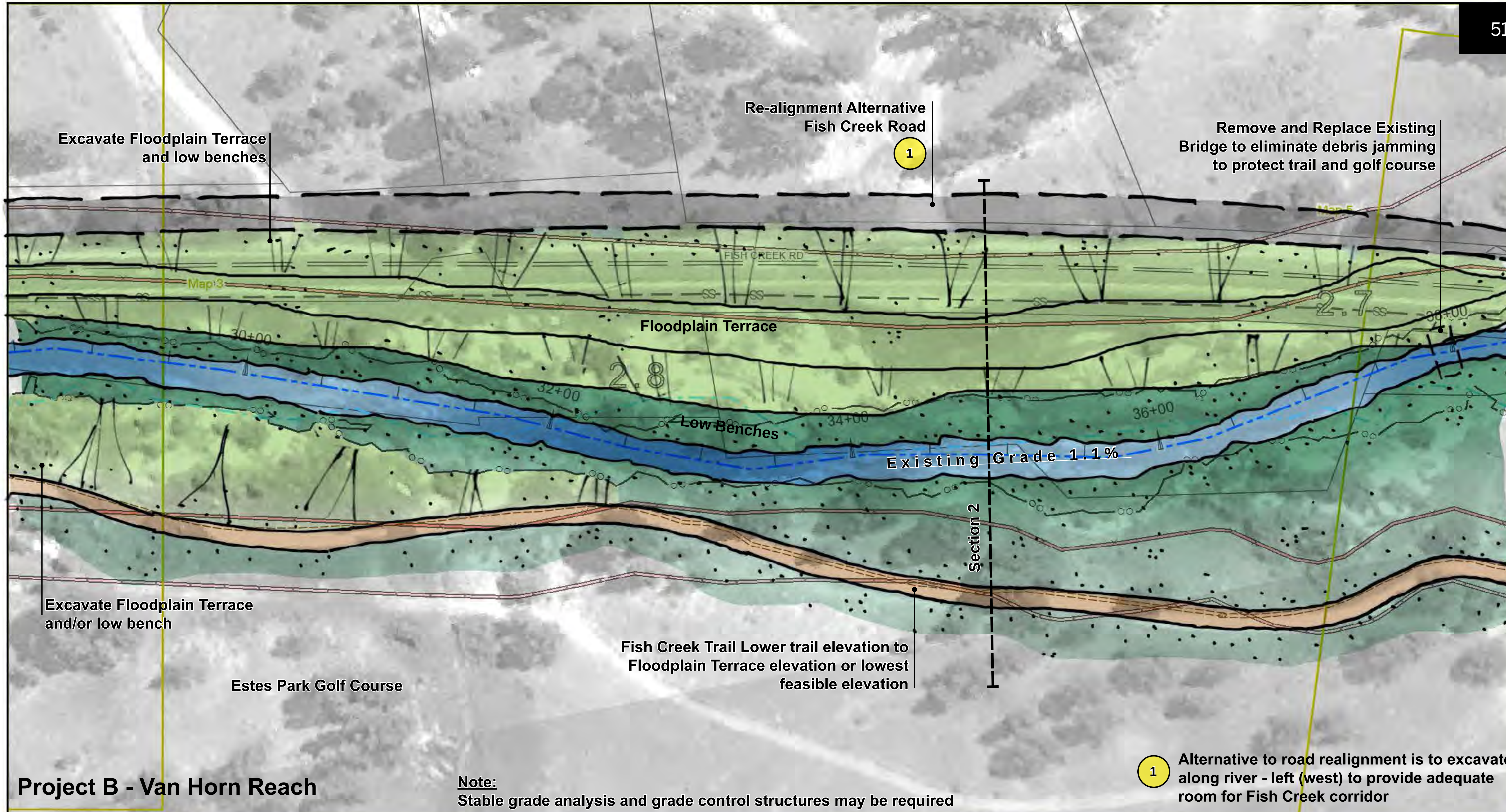
**Map 3 of 27**




Robert Peccia & Associates — Walsh — Great Outdoors Consultants — Round River Design — FlyWater — Anderson Consulting Engineers — Crane Associates

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Additional Hazard Areas

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Fish Creek Coalition

**Fish Creek Corridor**
**"Path to Resiliency"**
**Resiliency Ideas**
**Map 4 of 27**

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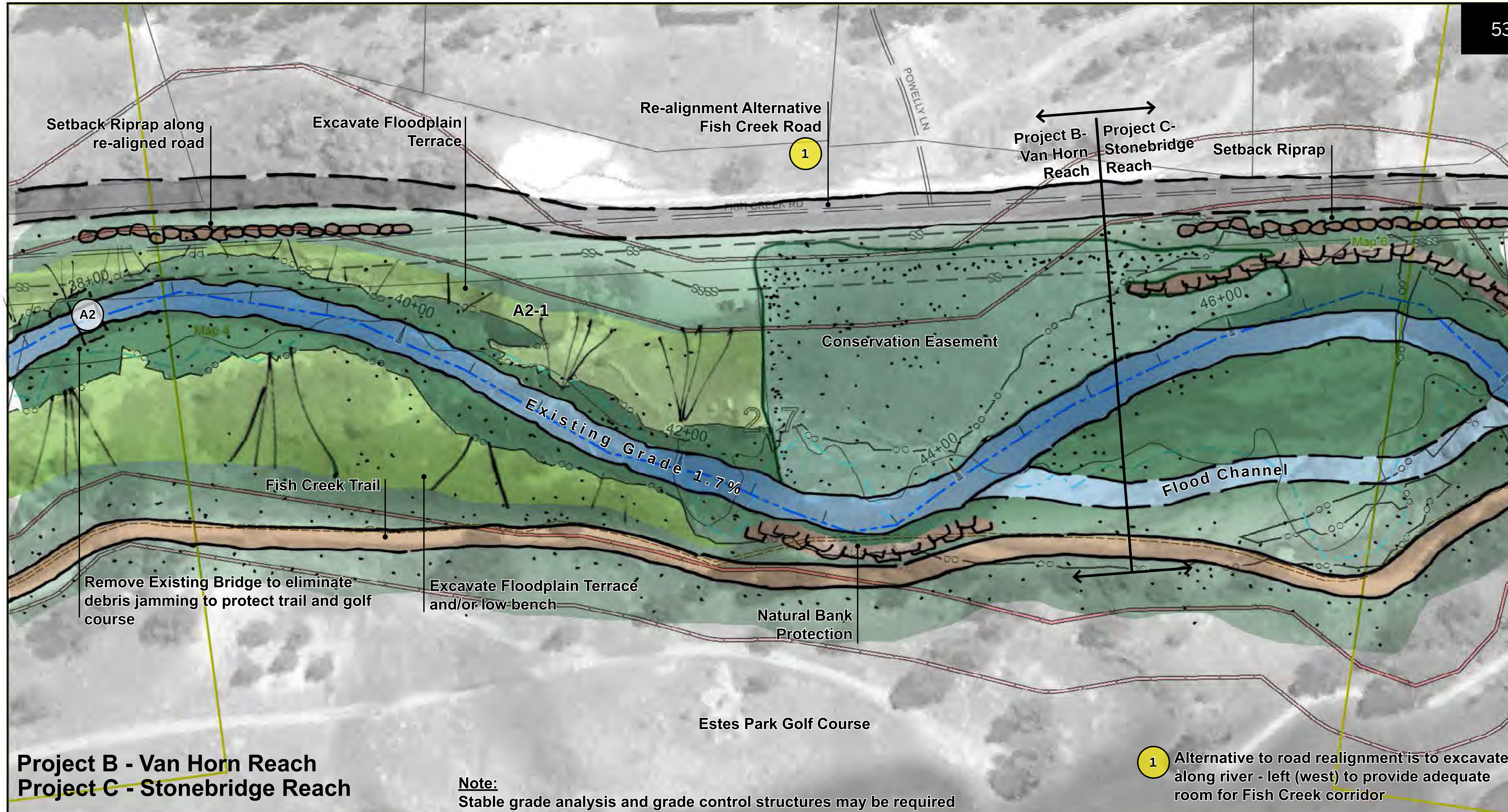


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Additional Hazard Areas

*** See IMPORTANT details on Floodplain or Geomorphic Hazard Mapbooks.**

EP Fish Creek Coalition

**Fish Creek Corridor**
**"Path to Resiliency"**
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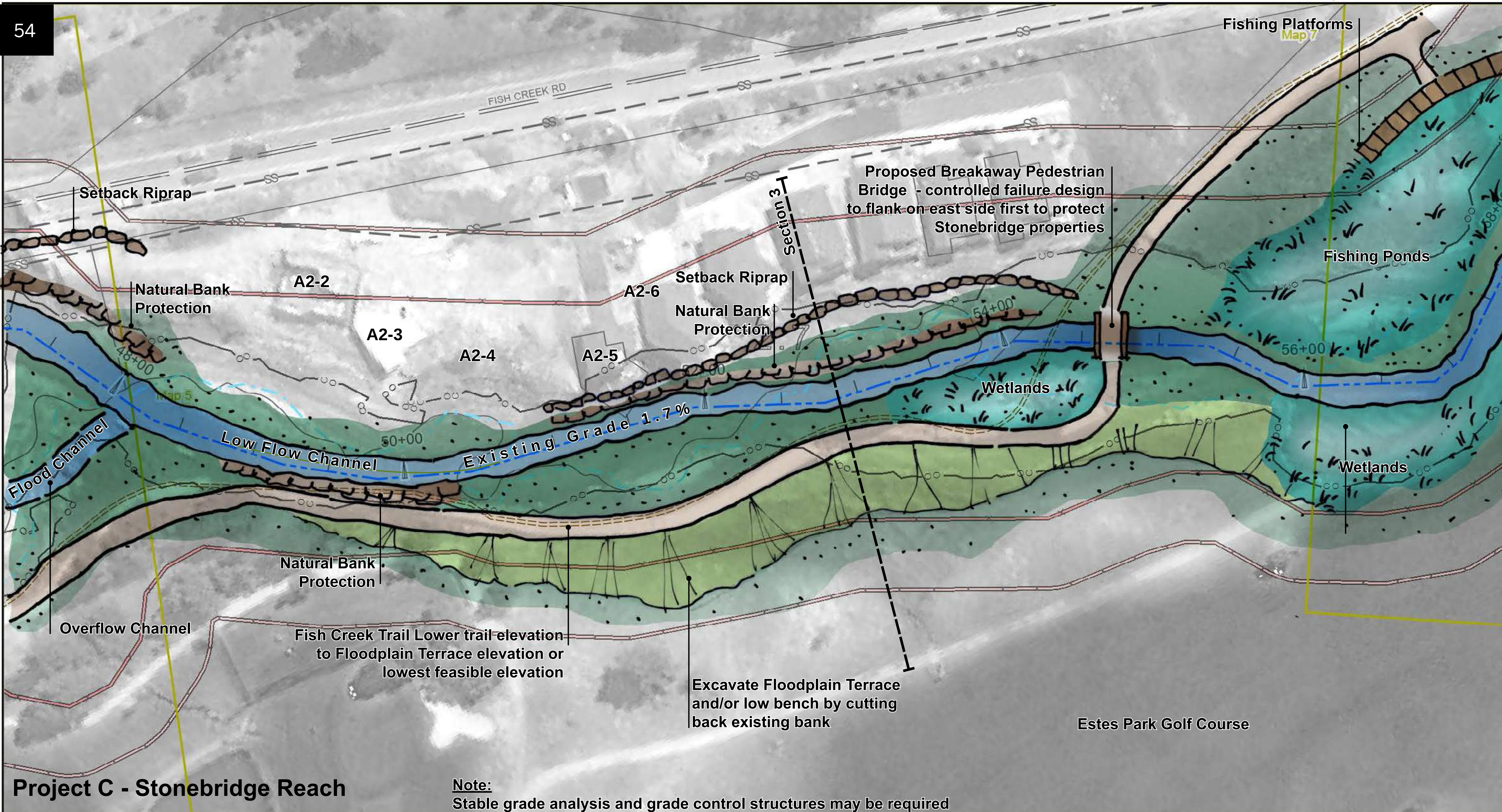
**Map 5 of 27**




## Project C - Stonebridge Reach

**Note:**
Stable grade analysis and grade control structures may be required

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1 inch = 60 feet
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- Pre-Sep 2013 Trail Alignment
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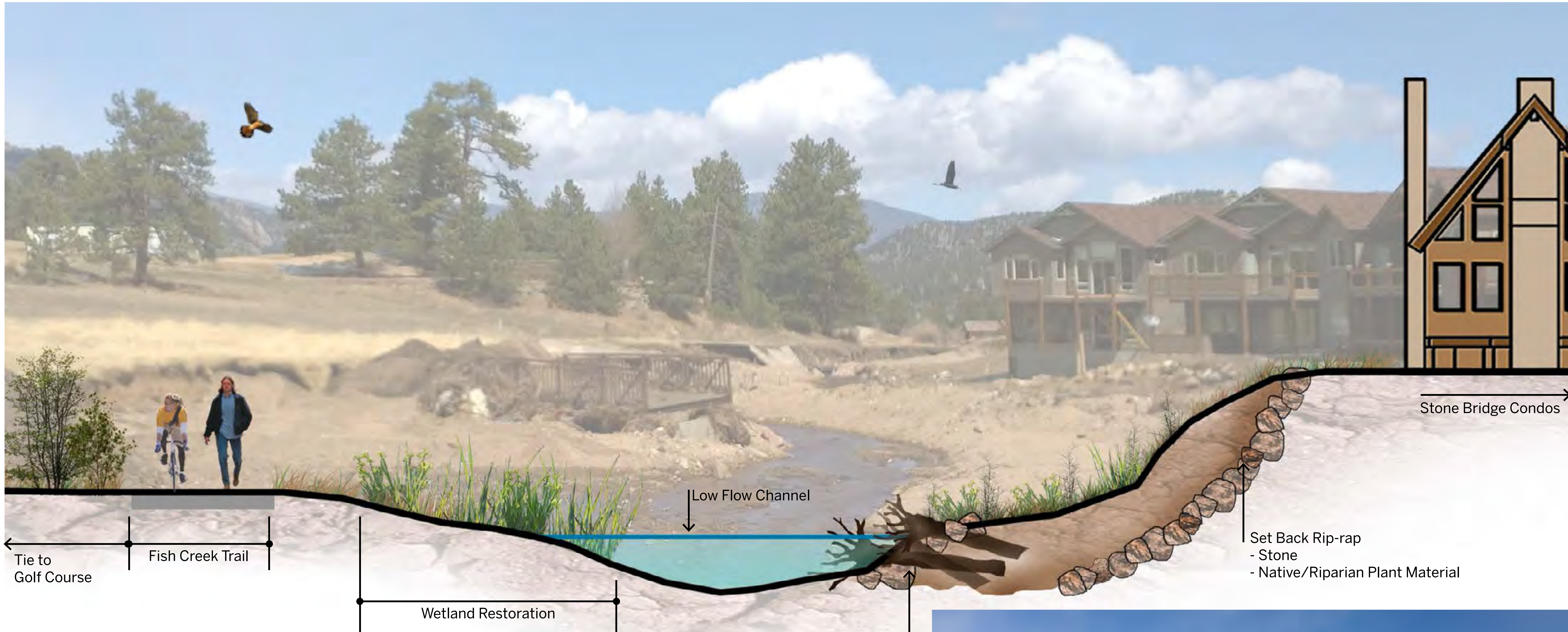
*** See IMPORTANT details on Floodplain or Geomorphic Hazard Mapbooks.**

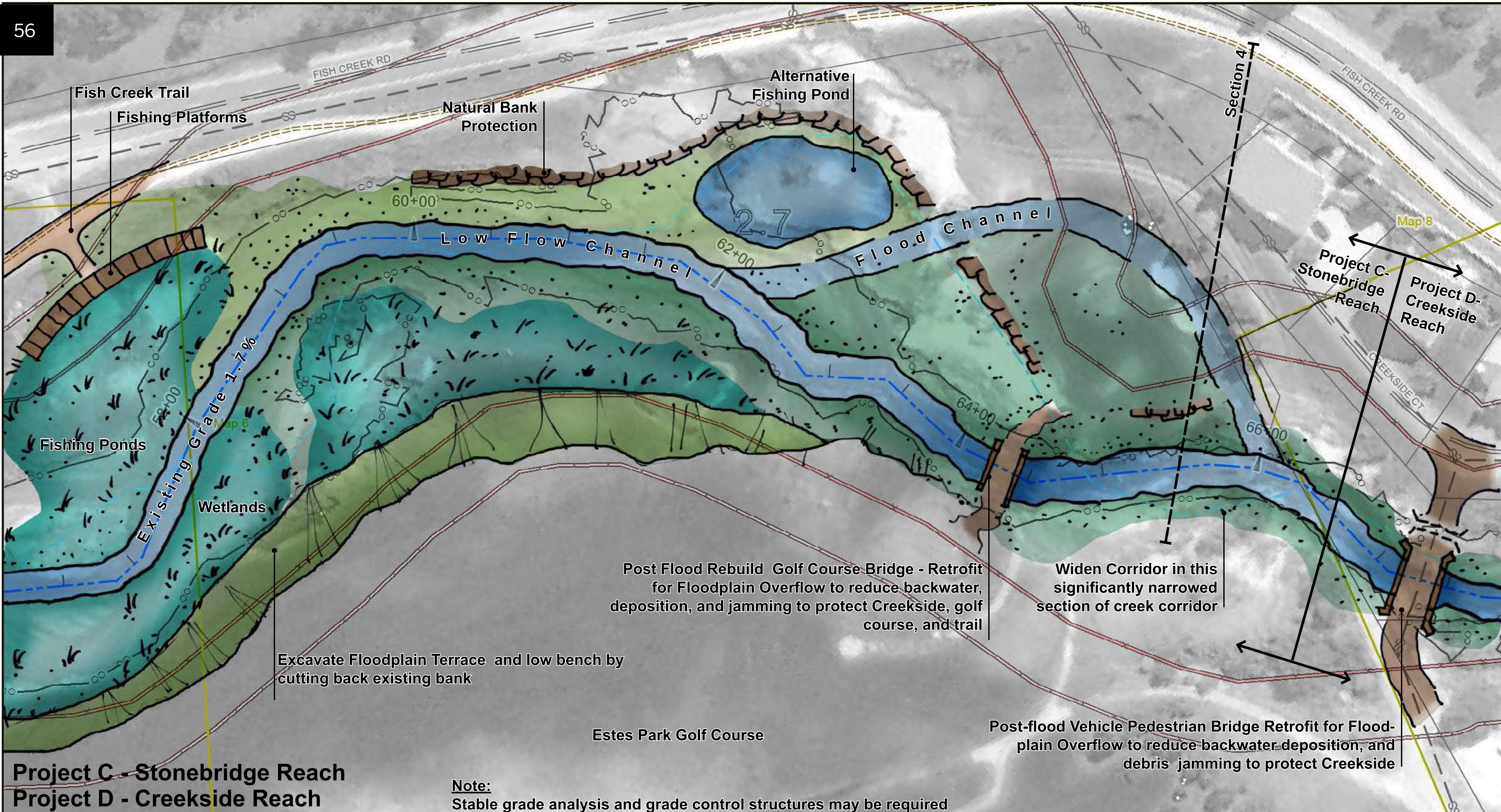
Fish Creek Coalition

**Fish Creek Corridor "Path to Resiliency" Resiliency Ideas**
**Map 6 of 27**




<u>Fish Creek Cross Section 3</u>
Looking Downstream
Not to Scale

Post Flood Image
Looking Downstream

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1:720
1 inch = 60 feet
0 60
Feet

- Pre-Sep 2013 Trail Alignment
- Pre-Sep 2013 Road Alignment
- SS Pre-Sep 2013 Sanitary Sewer Alignment
- Estimated Parcel Boundary (See Notes)
- Adjacent Map
- Post-Sep 2013 (ca. Nov. 2013) Creek Alignment
- Pre-Sep 2013 Creek Alignment

4.5 Ecosystem Score

**A1** = Highest Risk/1st Tier Project: Resiliency options include acquisitions/relocation of habitable structure outside of highest hazard area.

**A2** = High Risk/1st, 2nd & 3rd Tier Options: Resiliency options include acquisition and relocation (1st Tier), large projects with system-wide benefits (2nd Tier), or localized solutions (3rd Tier).

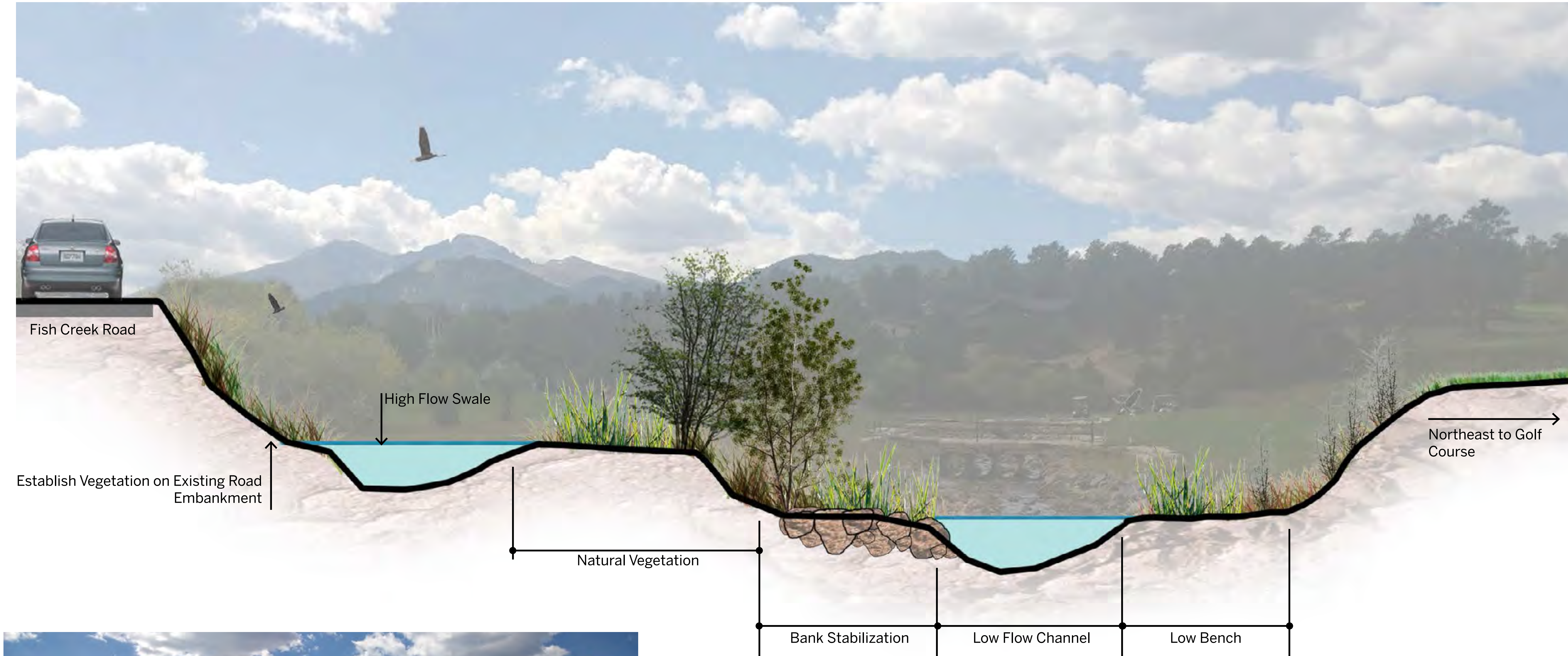
*Preliminary 100-Year Floodplain

*Planning-Level Channel Migration Zone (pCMZ)
- High Hazard Areas
- Additional Hazard Areas

*** See IMPORTANT details on Floodplain or Geomorphic Hazard Mapbooks.**

EP Fish Creek Coalition

**Fish Creek Corridor "Path to Resiliency" Resiliency Ideas**
**Map 7 of 27**




Fish Creek Cross Section 4
Looking Upstream
Not to Scale

Post Flood Image
Looking Upstream

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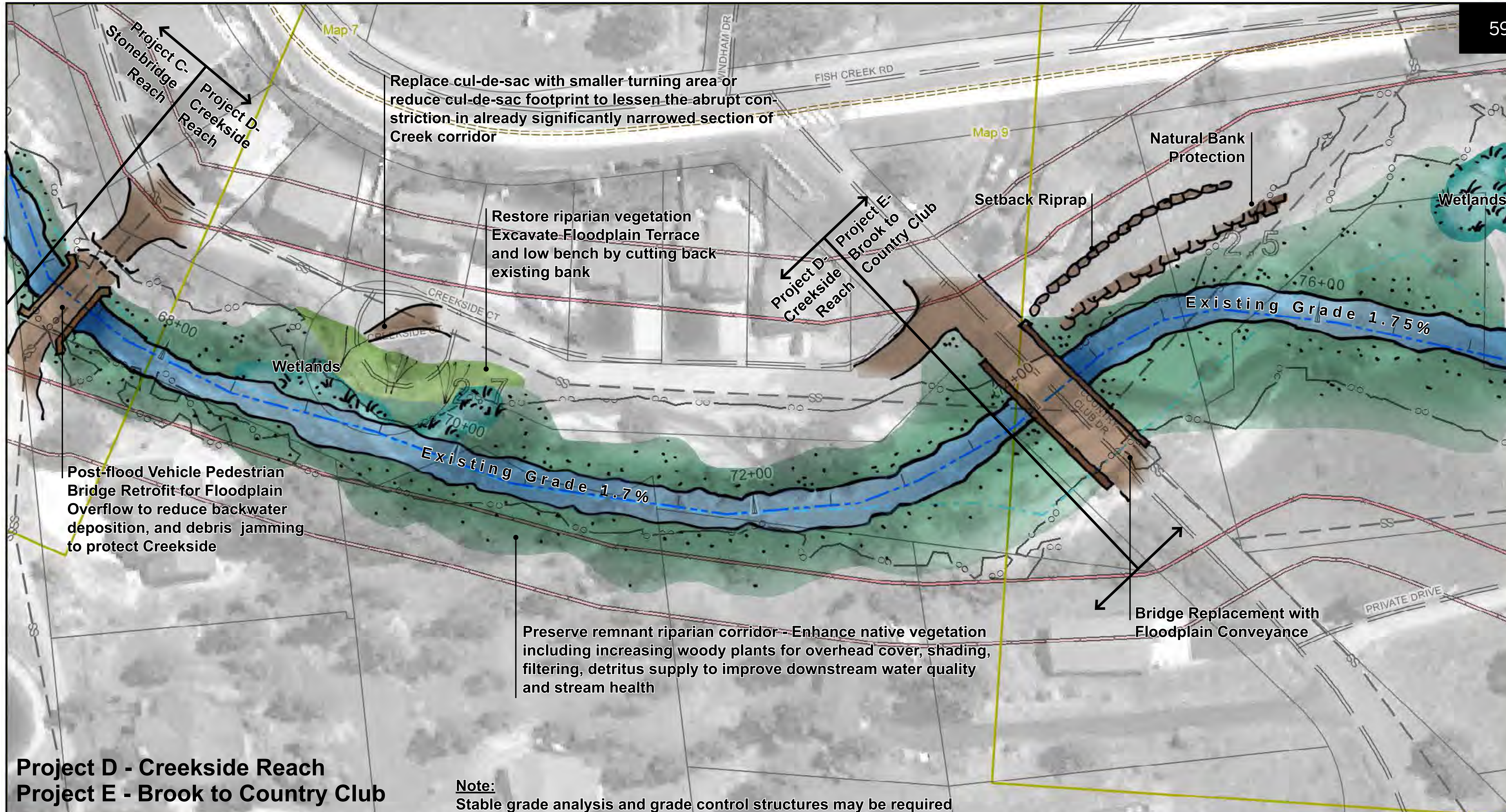


Robert Peccia & Associates

Walsh

Great Outdoors Consultants

Round River Design

FlyWater

Anderson Consulting Engineers

Crane Associates

1:720
1 inch = 60 feet
0 60
Feet

Pre-Sep 2013 Trail Alignment
Pre-Sep 2013 Road Alignment
Pre-Sep 2013 Sanitary Sewer Alignment
Estimated Parcel Boundary (See Notes)
Adjacent Map
Post-Sep 2013 (ca. Nov. 2013) Creek Alignment
Pre-Sep 2013 Creek Alignment

4.5 Ecosystem Score

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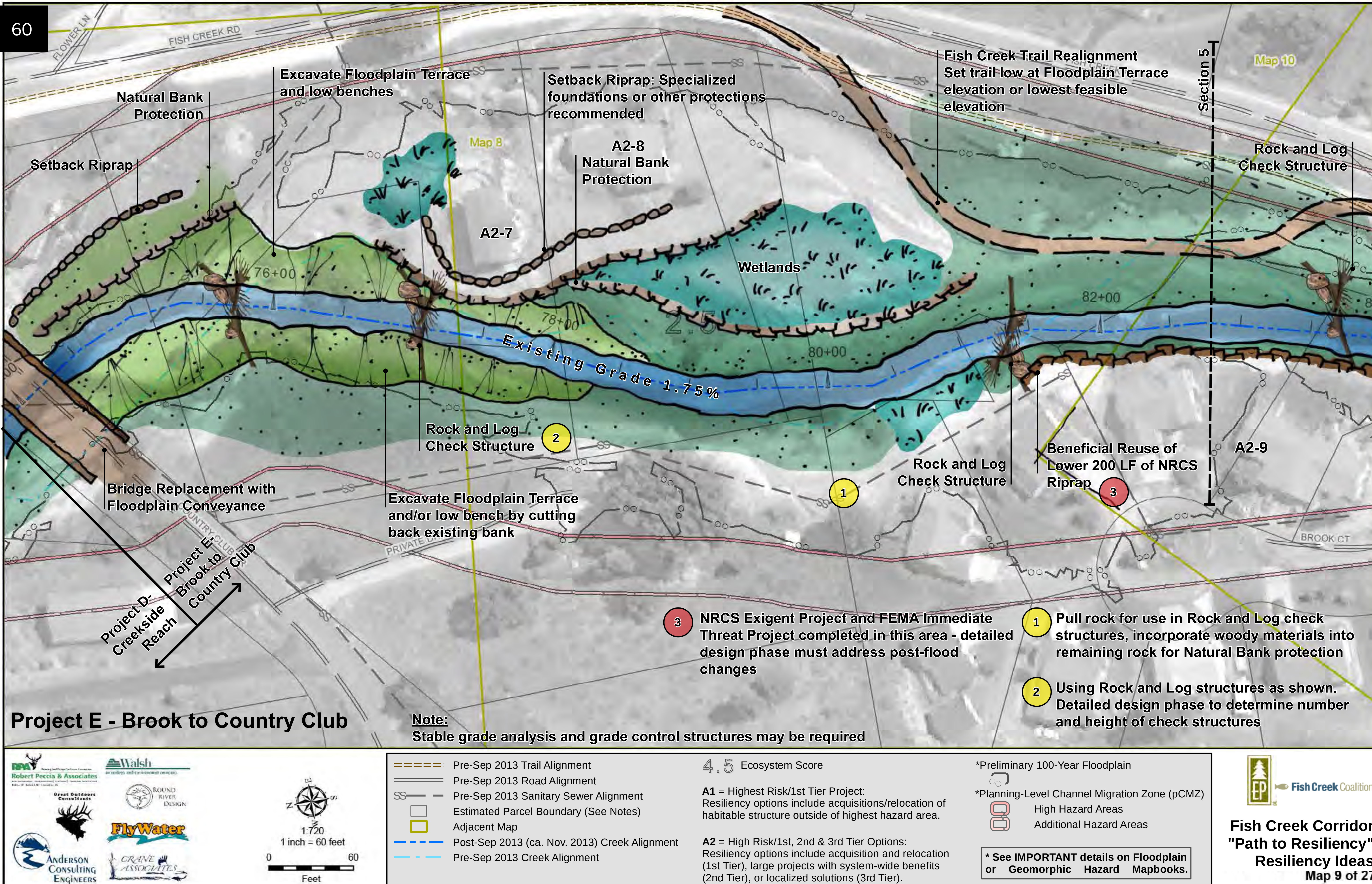
*Preliminary 100-Year Floodplain
*Planning-Level Channel Migration Zone (pCMZ)
High Hazard Areas
Additional Hazard Areas

*** See IMPORTANT details on Floodplain or Geomorphic Hazard Mapbooks.**

EP Fish Creek Coalition

**Fish Creek Corridor**
**"Path to Resiliency"**
**Resiliency Ideas**
**Map 8 of 27**


FISH CREEK RD
FLOWER LN
Excavate Floodplain Terrace and low benches
Natural Bank Protection
Setback Riprap
Setback Riprap: Specialized foundations or other protections recommended
A2-8
Natural Bank Protection
A2-7
Map 8
Fish Creek Trail Realignment
Set trail low at Floodplain Terrace elevation or lowest feasible elevation
Section 5
Map 10
Rock and Log Check Structure
Wetlands
76+00
78+00
80+00
82+00
Existing Grade 1.75%
Rock and Log Check Structure
2
Excavate Floodplain Terrace and/or low bench by cutting back existing bank
Bridge Replacement with Floodplain Conveyance
Rock and Log Check Structure
1
Beneficial Reuse of Lower 200 LF of NRCS Riprap
3
A2-9
BROOK CT
COUNTRY CLUB
PRIVATE DR
Project E-Brook to Country Club
Project D-Creekside Reach
3 NRCS Exigent Project and FEMA Immediate Threat Project completed in this area - detailed design phase must address post-flood changes
1 Pull rock for use in Rock and Log check structures, incorporate woody materials into remaining rock for Natural Bank protection
2 Using Rock and Log structures as shown. Detailed design phase to determine number and height of check structures
Project E - Brook to Country Club
Note:
Stable grade analysis and grade control structures may be required
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Walsh
Great Outdoors Consultants
Round River Design
FlyWater
Anderson Consulting Engineers
Crane Associates
1:720
1 inch = 60 feet
0
60
Feet
Pre-Sep 2013 Trail Alignment
Pre-Sep 2013 Road Alignment
Pre-Sep 2013 Sanitary Sewer Alignment
Estimated Parcel Boundary (See Notes)
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Post-Sep 2013 (ca. Nov. 2013) Creek Alignment
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4.5 Ecosystem Score
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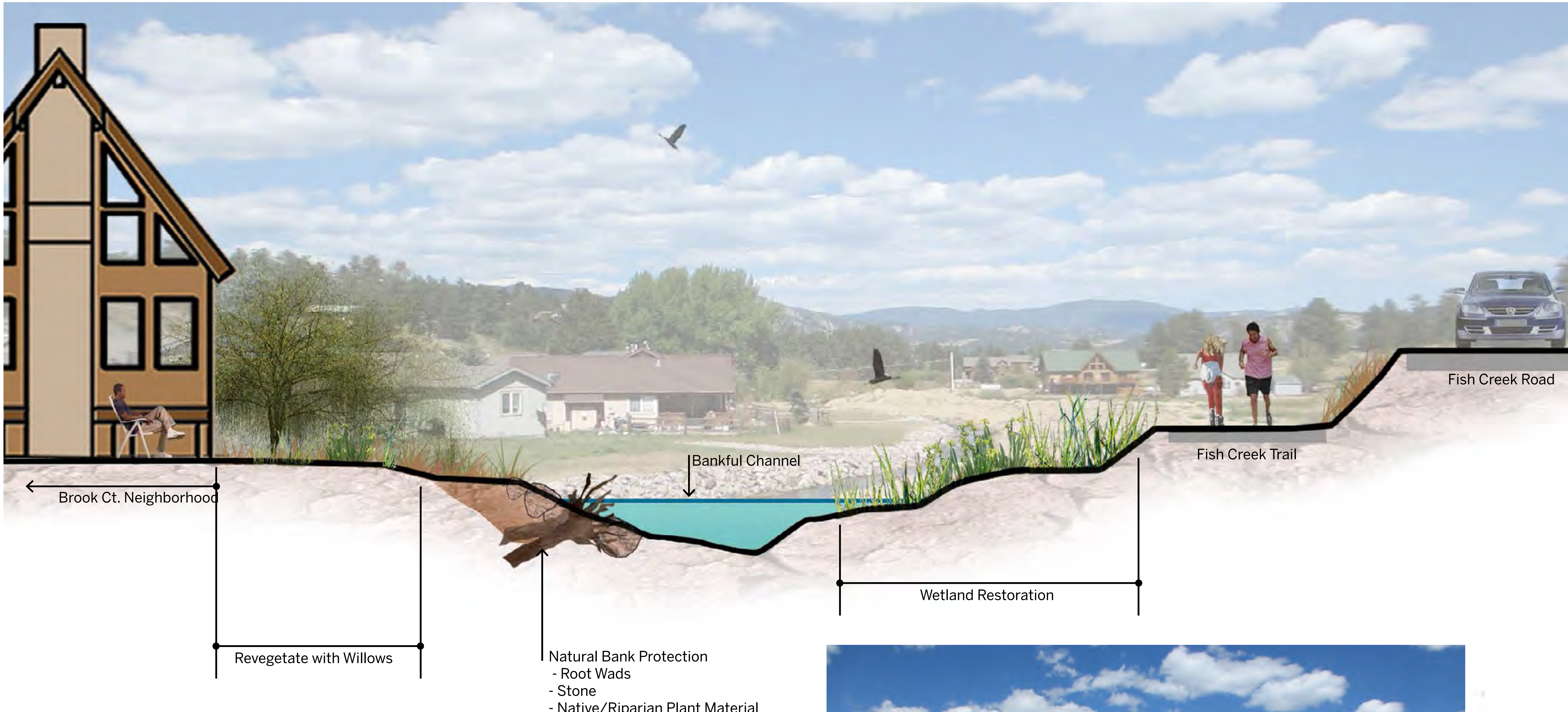
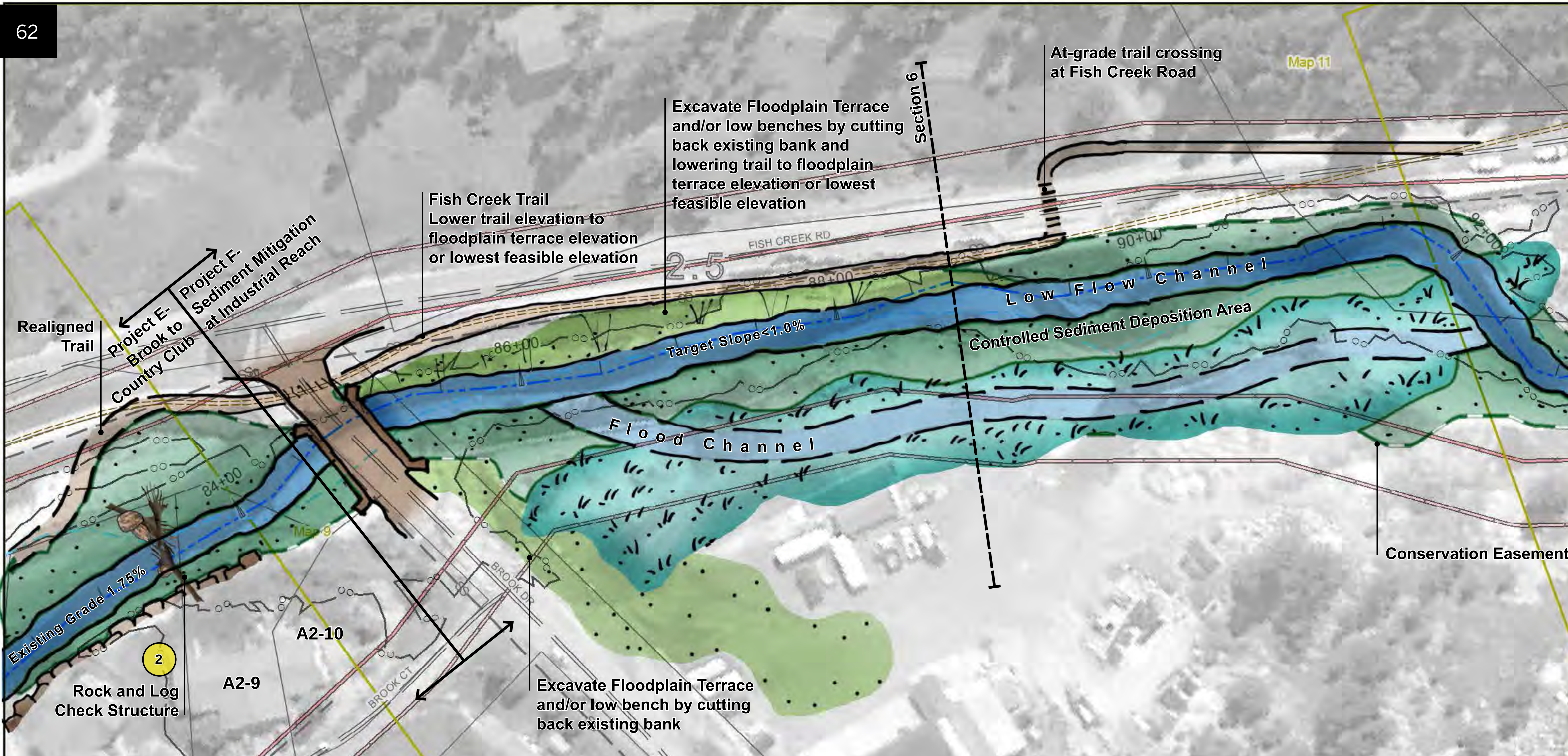
*Preliminary 100-Year Floodplain
*Planning-Level Channel Migration Zone (pCMZ)
High Hazard Areas
Additional Hazard Areas
* See IMPORTANT details on Floodplain or Geomorphic Hazard Mapbooks.
Fish Creek Coalition
Fish Creek Corridor "Path to Resiliency" Resiliency Ideas
Map 9 of 27




Fish Creek Cross Section 5
Looking Downstream
Not to Scale

Post Flood Image
Looking Downstream

Fish Creek Coalition




## Project E - Brook to Country Club
## Project F - Sediment Mitigation at Kitchen Property

**Note:**
Detailed design phase must address potential that Project E enhanced deposition zone could cause an erosion hazard in downstream reaches without proper controls. Stable grade analysis and grade control structures may be required

(2) Using Rock and Log structures as shown. Detailed design phase to determine number and height of check structures

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1:720
1 inch = 60 feet
0 — 60
Feet

| | |
|---|---|
| ===== | Pre-Sep 2013 Trail Alignment |
| ══ | Pre-Sep 2013 Road Alignment |
| SS— — | Pre-Sep 2013 Sanitary Sewer Alignment |
| □ | Estimated Parcel Boundary (See Notes) |
| □ | Adjacent Map |
| - · - | Post-Sep 2013 (ca. Nov. 2013) Creek Alignment |
| - · - | Pre-Sep 2013 Creek Alignment |

4.5 Ecosystem Score

**A1** = Highest Risk/1st Tier Project:
Resiliency options include acquisitions/relocation of habitable structure outside of highest hazard area.

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Resiliency options include acquisition and relocation (1st Tier), large projects with system-wide benefits (2nd Tier), or localized solutions (3rd Tier).

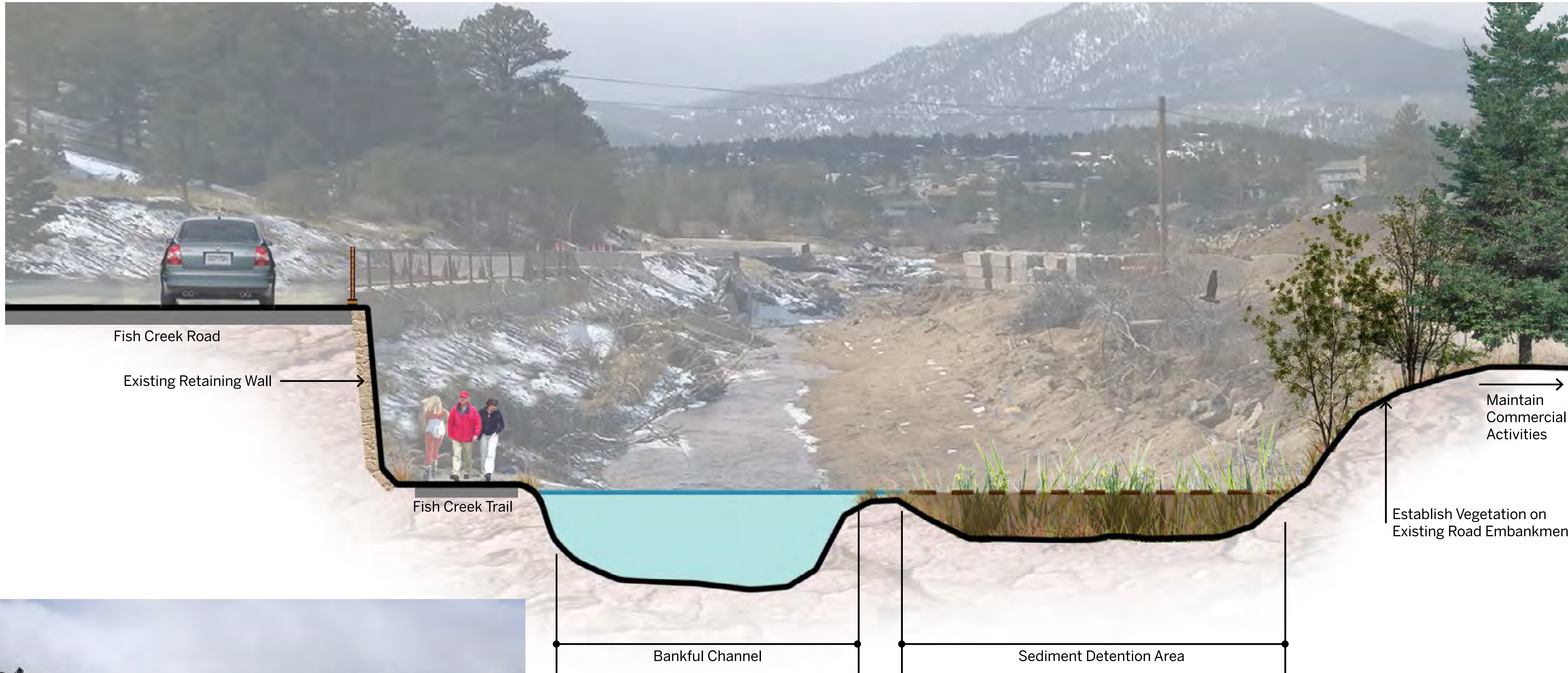
*Preliminary 100-Year Floodplain

*Planning-Level Channel Migration Zone (pCMZ)
High Hazard Areas
Additional Hazard Areas

*** See IMPORTANT details on Floodplain or Geomorphic Hazard Mapbooks.**

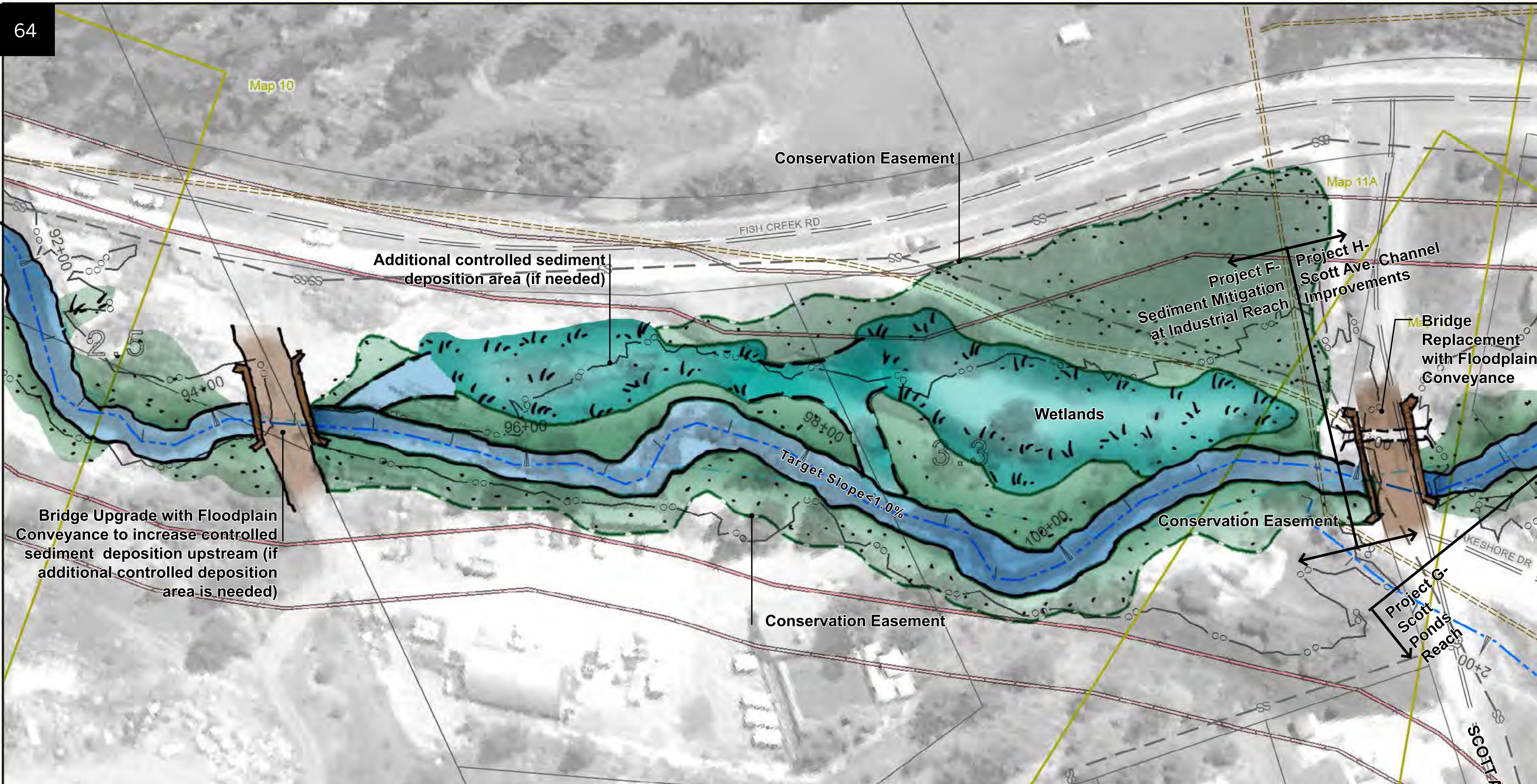
EP Fish Creek Coalition

**Fish Creek Corridor**
**"Path to Resiliency"**
**Resiliency Ideas**
**Map 10 of 27**




Fish Creek Cross Section 6
Looking Upstream
Not to Scale

Post Flood Image
Looking Upstream




## Project F - Sediment Mitigation at Kitchen Property

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Crane Associates

1:720
1 inch = 60 feet
0 60
Feet

Pre-Sep 2013 Trail Alignment
Pre-Sep 2013 Road Alignment
Pre-Sep 2013 Sanitary Sewer Alignment
Estimated Parcel Boundary (See Notes)
Adjacent Map
Post-Sep 2013 (ca. Nov. 2013) Creek Alignment
Pre-Sep 2013 Creek Alignment

4.5 Ecosystem Score

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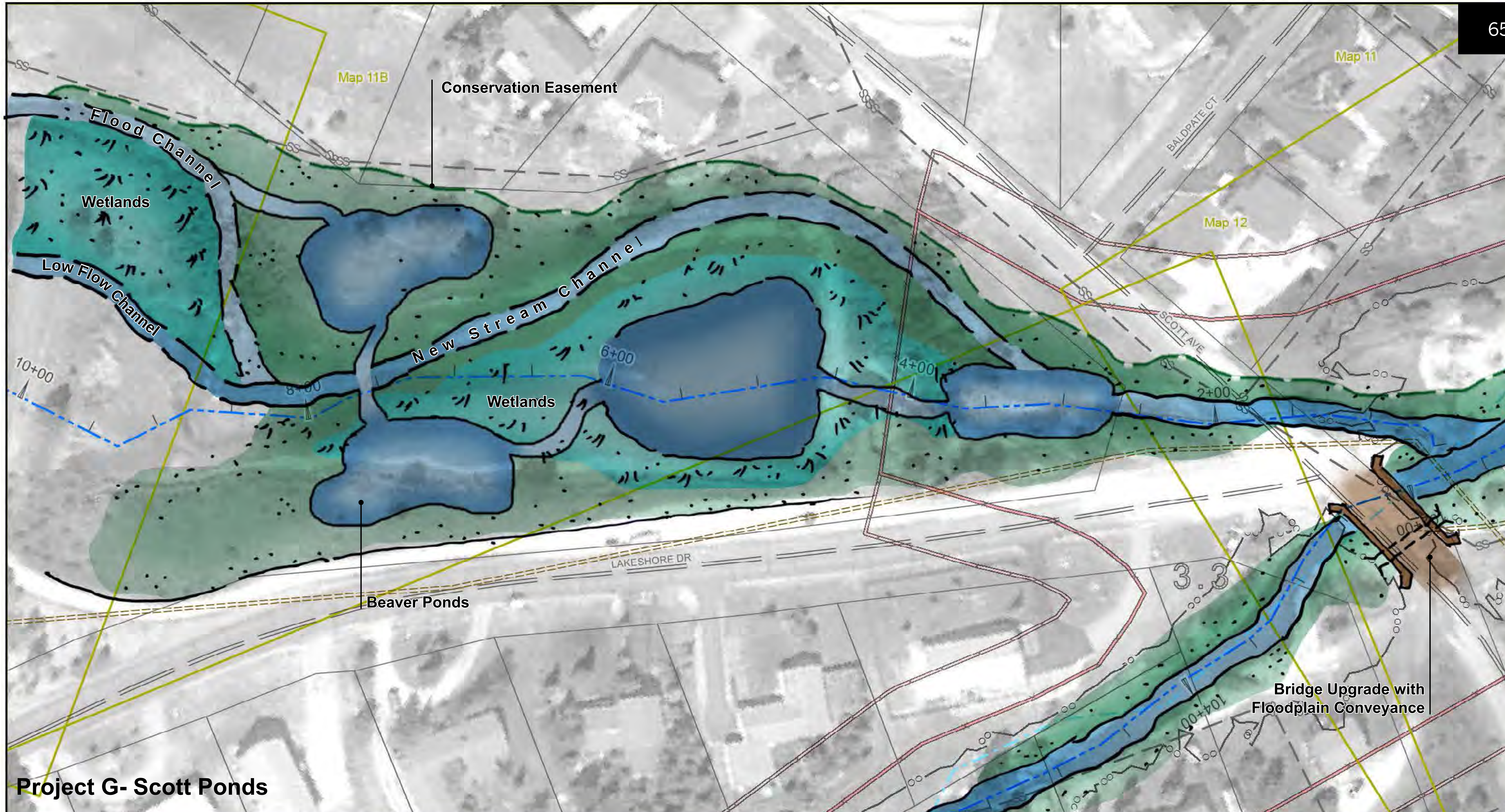
*Preliminary 100-Year Floodplain
*Planning-Level Channel Migration Zone (pCMZ)
High Hazard Areas
Additional Hazard Areas

*** See IMPORTANT details on Floodplain or Geomorphic Hazard Mapbooks.**

EP Fish Creek Coalition

**Fish Creek Corridor "Path to Resiliency" Resiliency Ideas**
**Map 11 of 27**




Pre-Sep 2013 Trail Alignment
Pre-Sep 2013 Road Alignment
Pre-Sep 2013 Sanitary Sewer Alignment
Estimated Parcel Boundary (See Notes)
Adjacent Map
Post-Sep 2013 (ca. Nov. 2013) Creek Alignment
Pre-Sep 2013 Creek Alignment

4.5 Ecosystem Score

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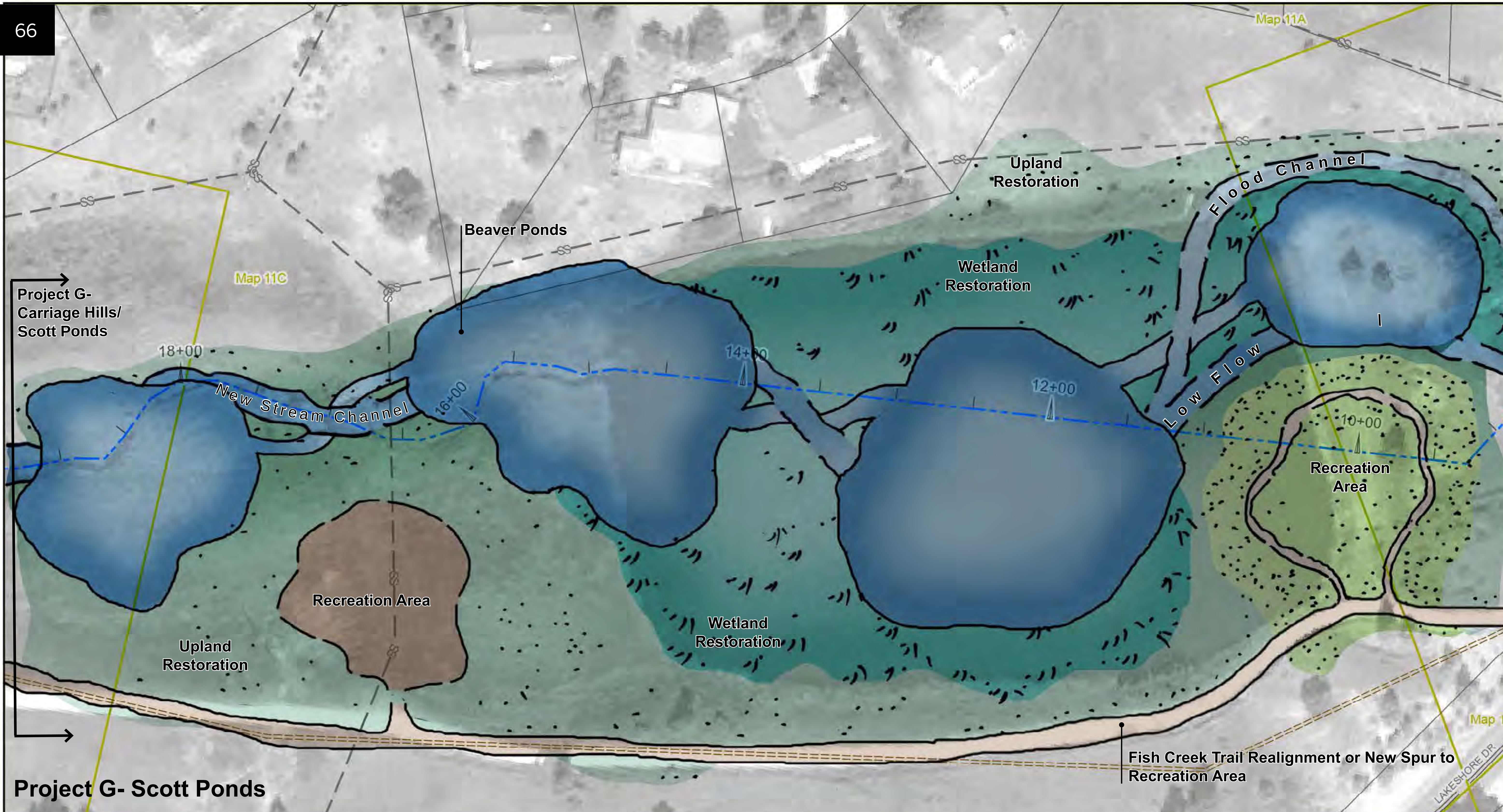
*Preliminary 100-Year Floodplain

*Planning-Level Channel Migration Zone (pCMZ)
High Hazard Areas
Additional Hazard Areas

*** See IMPORTANT details on Floodplain or Geomorphic Hazard Mapbooks.**

1:720
1 inch = 60 feet
0 60
Feet

**Fish Creek Corridor "Path to Resiliency" Resiliency Ideas**
**Map 11A of 27**

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Great Outdoors Consultants
Round River Design
FlyWater
Anderson Consulting Engineers
Crane Associates

N W E S
1:720
1 inch = 60 feet
0 60
Feet

- Pre-Sep 2013 Trail Alignment
- Pre-Sep 2013 Road Alignment
- Pre-Sep 2013 Sanitary Sewer Alignment
- Estimated Parcel Boundary (See Notes)
- Adjacent Map
- Post-Sep 2013 (ca. Nov. 2013) Creek Alignment
- Pre-Sep 2013 Creek Alignment

4.5 Ecosystem Score

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*Preliminary 100-Year Floodplain

*Planning-Level Channel Migration Zone (pCMZ)
- High Hazard Areas
- Additional Hazard Areas

*** See IMPORTANT details on Floodplain or Geomorphic Hazard Mapbooks.**

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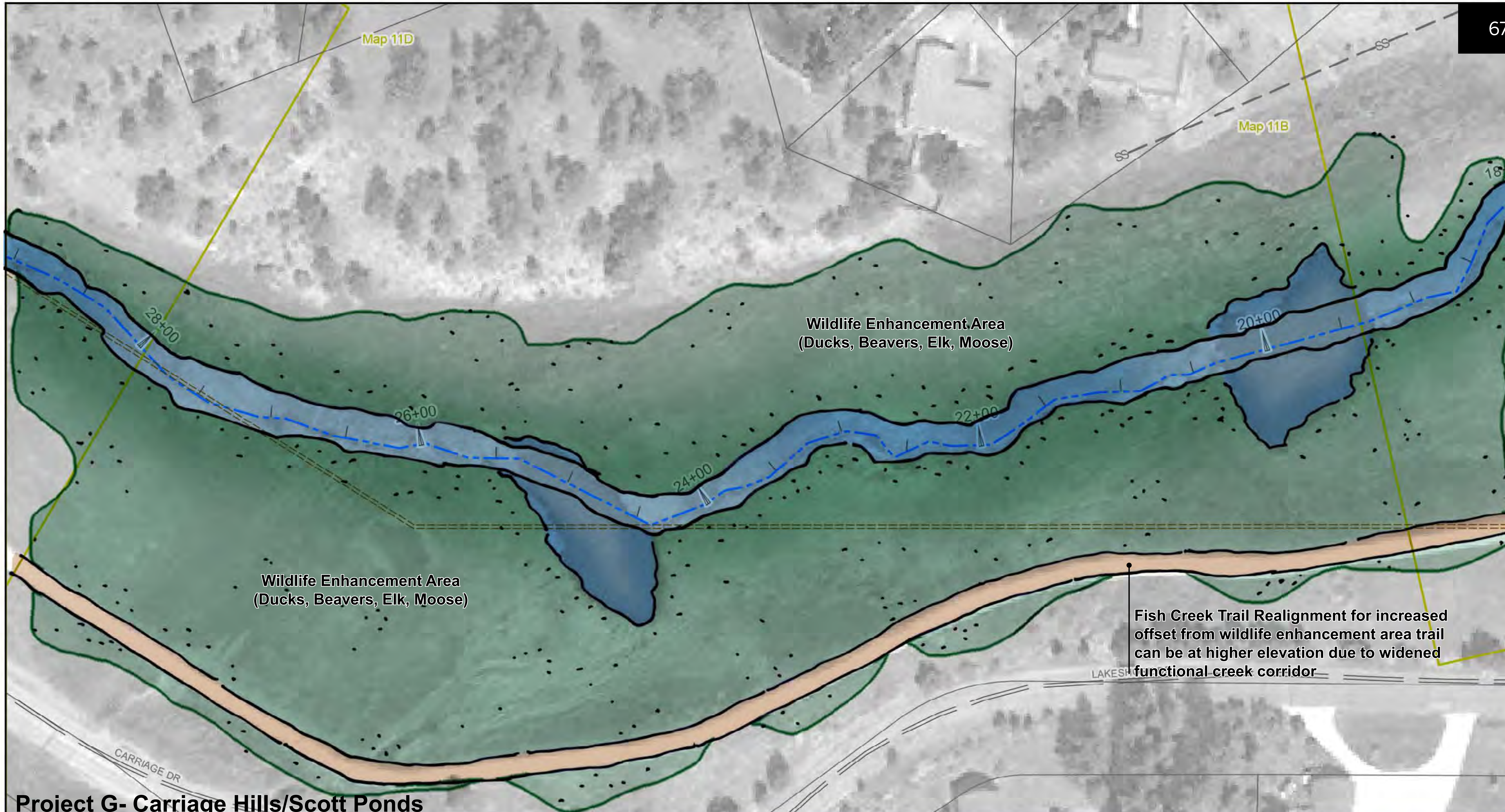
**Fish Creek Corridor "Path to Resiliency" Resiliency Ideas Map 11B of 27**

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Great Outdoors Consultants
Round River Design
FlyWater
Anderson Consulting Engineers
Crane Associates

N W E
1:720
1 inch = 60 feet
0 60
Feet

- Pre-Sep 2013 Trail Alignment
- Pre-Sep 2013 Road Alignment
- SS Pre-Sep 2013 Sanitary Sewer Alignment
- Estimated Parcel Boundary (See Notes)
- Adjacent Map
- Post-Sep 2013 (ca. Nov. 2013) Creek Alignment
- Pre-Sep 2013 Creek Alignment

4.5 Ecosystem Score

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*Preliminary 100-Year Floodplain

*Planning-Level Channel Migration Zone (pCMZ)
- High Hazard Areas
- Additional Hazard Areas

*** See IMPORTANT details on Floodplain or Geomorphic Hazard Mapbooks.**

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**Fish Creek Corridor**
**"Path to Resiliency"**
**Resiliency Ideas**
**Map 11C of 27**

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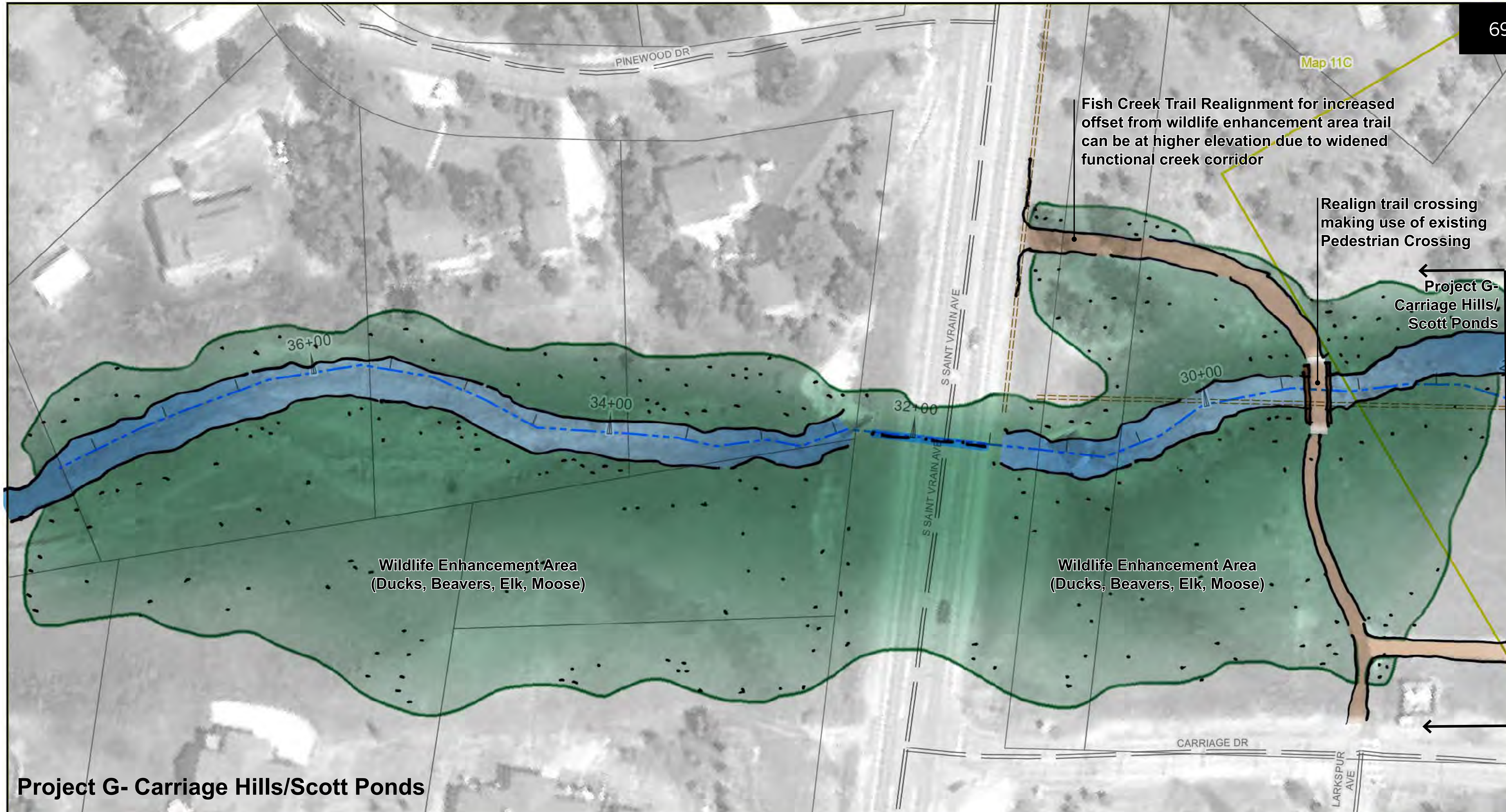


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Great Outdoors Consultants
Round River Design
FlyWater
Anderson Consulting Engineers
Crane Associates

1:720
1 inch = 60 feet
0 60
Feet

Pre-Sep 2013 Trail Alignment
Pre-Sep 2013 Road Alignment
SS Pre-Sep 2013 Sanitary Sewer Alignment
Estimated Parcel Boundary (See Notes)
Adjacent Map
Post-Sep 2013 (ca. Nov. 2013) Creek Alignment
Pre-Sep 2013 Creek Alignment

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*Preliminary 100-Year Floodplain

*Planning-Level Channel Migration Zone (pCMZ)
High Hazard Areas
Additional Hazard Areas

*** See IMPORTANT details on Floodplain or Geomorphic Hazard Mapbooks.**

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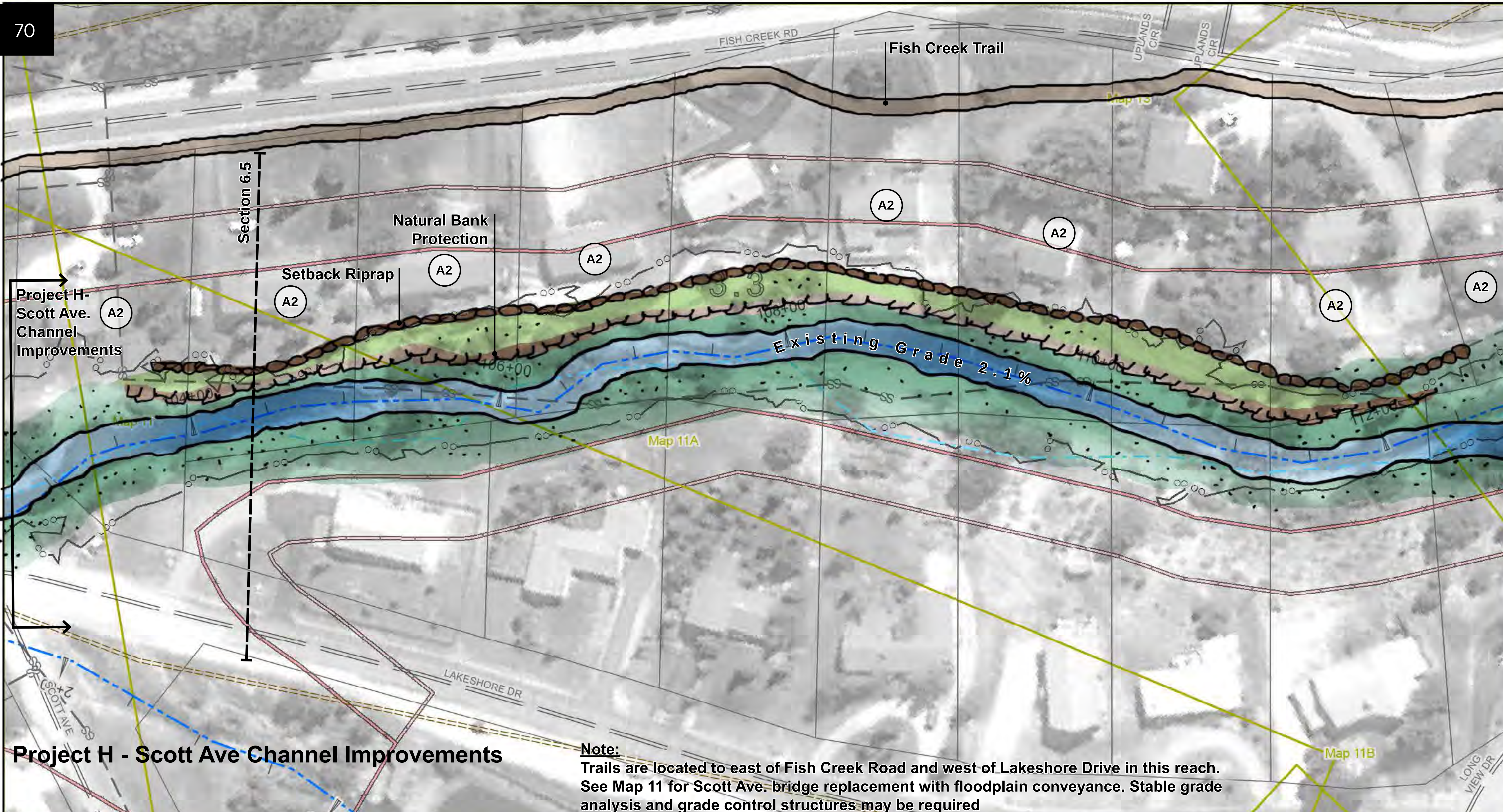
**Fish Creek Corridor**
**"Path to Resiliency"**
**Resiliency Ideas**
**Map 11D of 27**




# Project H - Scott Ave Channel Improvements

**Note:**
**Trails are located to east of Fish Creek Road and west of Lakeshore Drive in this reach. See Map 11 for Scott Ave. bridge replacement with floodplain conveyance. Stable grade analysis and grade control structures may be required**

1:720
1 inch = 60 feet
0 60
Feet

- Pre-Sep 2013 Trail Alignment
- Pre-Sep 2013 Road Alignment
- Pre-Sep 2013 Sanitary Sewer Alignment
- Estimated Parcel Boundary (See Notes)
- Adjacent Map
- Post-Sep 2013 (ca. Nov. 2013) Creek Alignment
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4.5 Ecosystem Score

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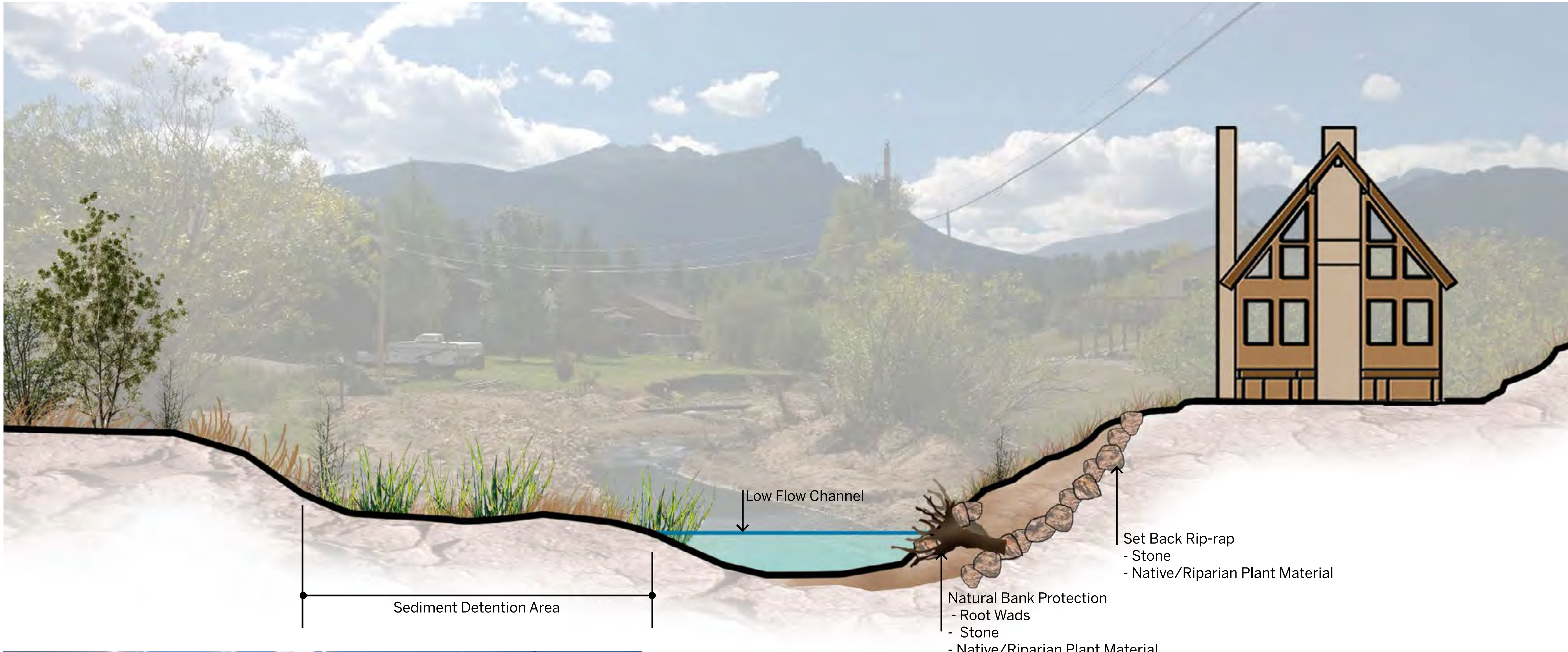
*Preliminary 100-Year Floodplain

*Planning-Level Channel Migration Zone (pCMZ)
- High Hazard Areas
- Additional Hazard Areas

*** See IMPORTANT details on Floodplain or Geomorphic Hazard Mapbooks.**

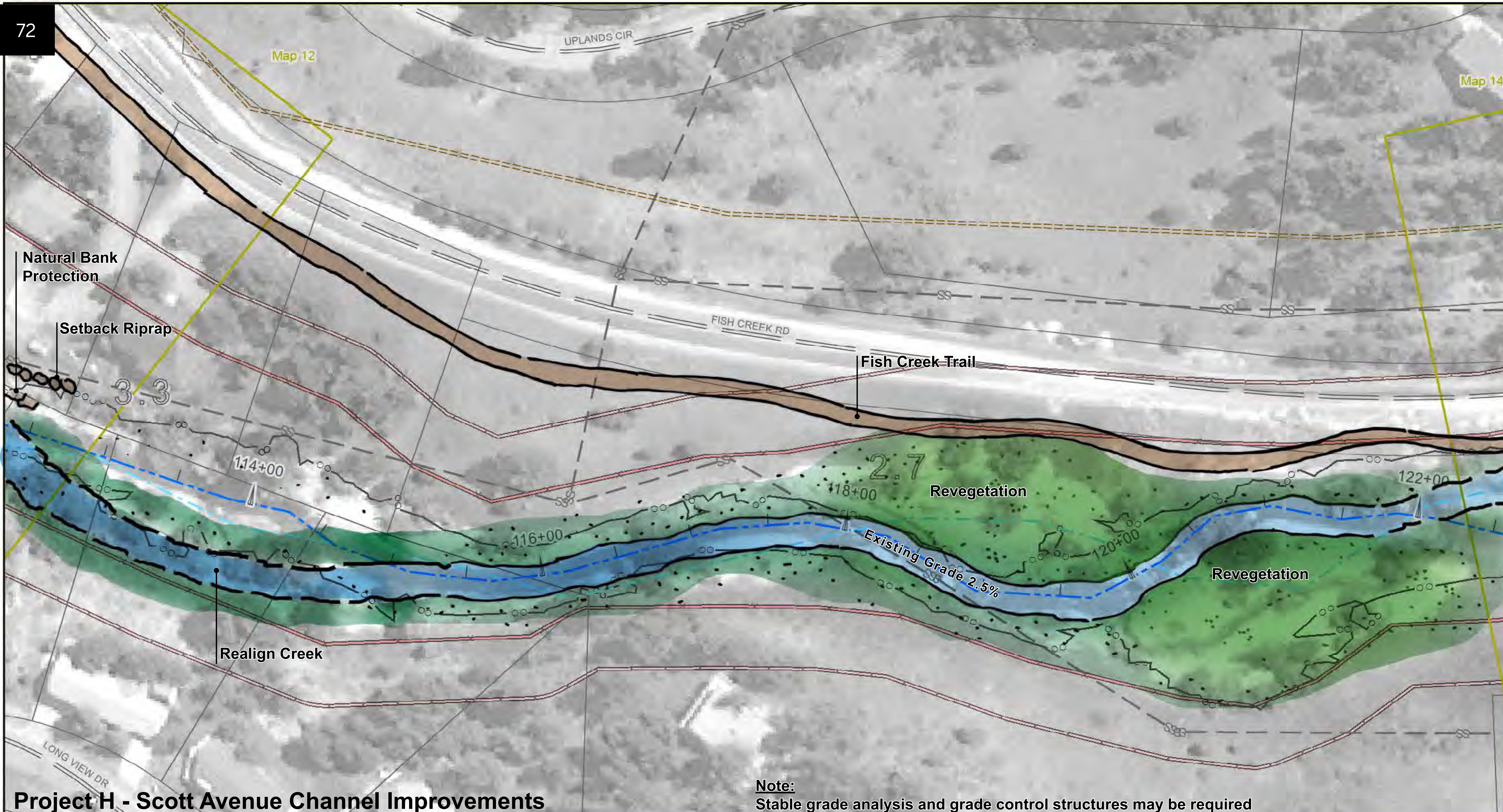
Fish Creek Coalition

**Fish Creek Corridor "Path to Resiliency" Resiliency Ideas**
**Map 12 of 27**




Post Flood Image
Looking Upstream

Fish Creek Cross Section 6.5
Looking Upstream
Not to Scale




# Project H - Scott Avenue Channel Improvements

**Note:**
Stable grade analysis and grade control structures may be required

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1:720
1 inch = 60 feet
0 60
Feet

Pre-Sep 2013 Trail Alignment
Pre-Sep 2013 Road Alignment
Pre-Sep 2013 Sanitary Sewer Alignment
Estimated Parcel Boundary (See Notes)
Adjacent Map
Post-Sep 2013 (ca. Nov. 2013) Creek Alignment
Pre-Sep 2013 Creek Alignment

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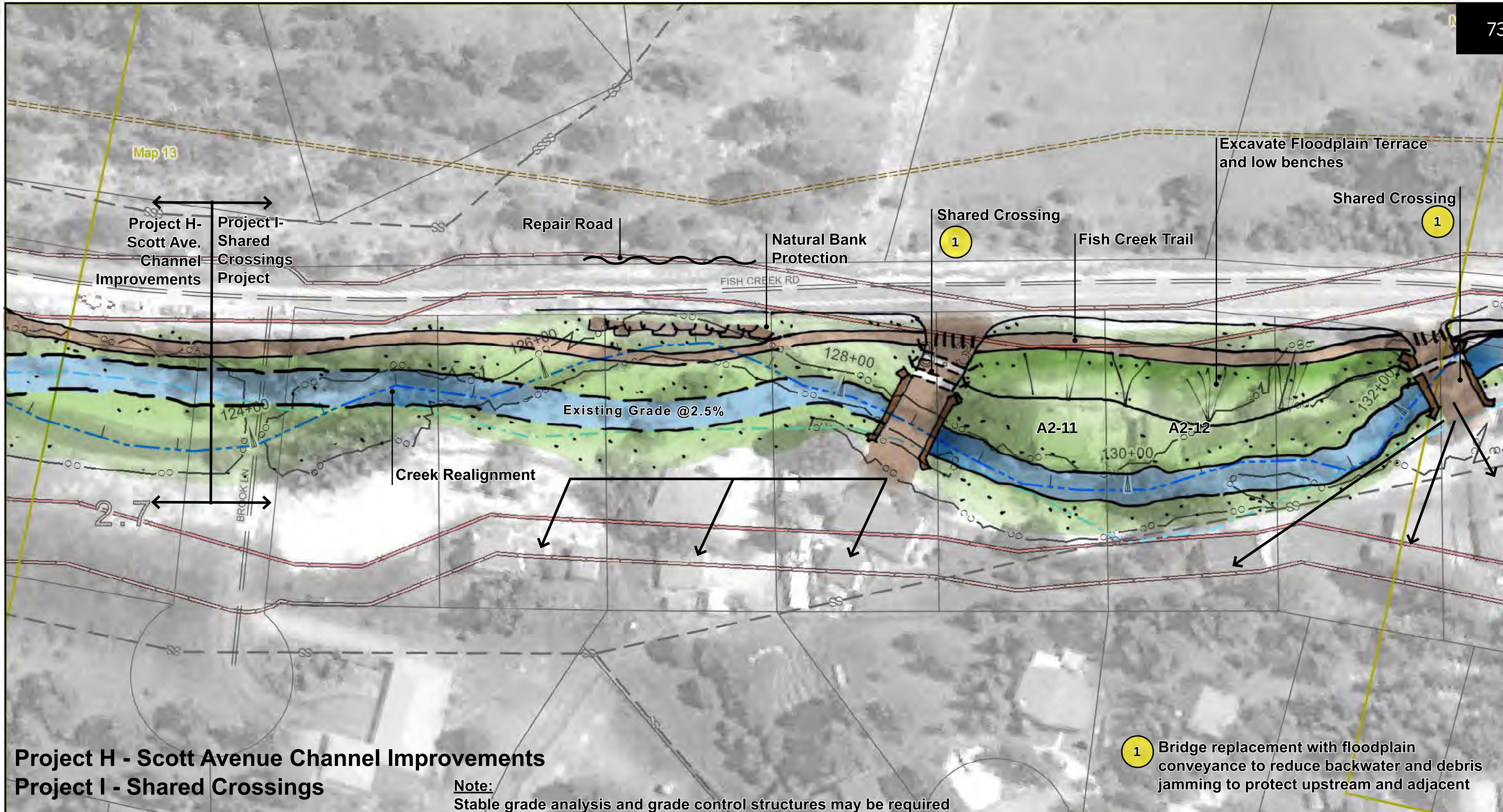
*Preliminary 100-Year Floodplain
*Planning-Level Channel Migration Zone (pCMZ)
High Hazard Areas
Additional Hazard Areas

*** See IMPORTANT details on Floodplain or Geomorphic Hazard Mapbooks.**

Fish Creek Coalition

**Fish Creek Corridor "Path to Resiliency" Resiliency Ideas**
**Map 13 of 27**




## Project H - Scott Avenue Channel Improvements
## Project I - Shared Crossings

**Note:**
**Stable grade analysis and grade control structures may be required**

1 Bridge replacement with floodplain conveyance to reduce backwater and debris jamming to protect upstream and adjacent

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1:720
1 inch = 60 feet
0 60
Feet

Pre-Sep 2013 Trail Alignment
Pre-Sep 2013 Road Alignment
SS Pre-Sep 2013 Sanitary Sewer Alignment
Estimated Parcel Boundary (See Notes)
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Pre-Sep 2013 Creek Alignment

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*Preliminary 100-Year Floodplain

*Planning-Level Channel Migration Zone (pCMZ)
High Hazard Areas
Additional Hazard Areas

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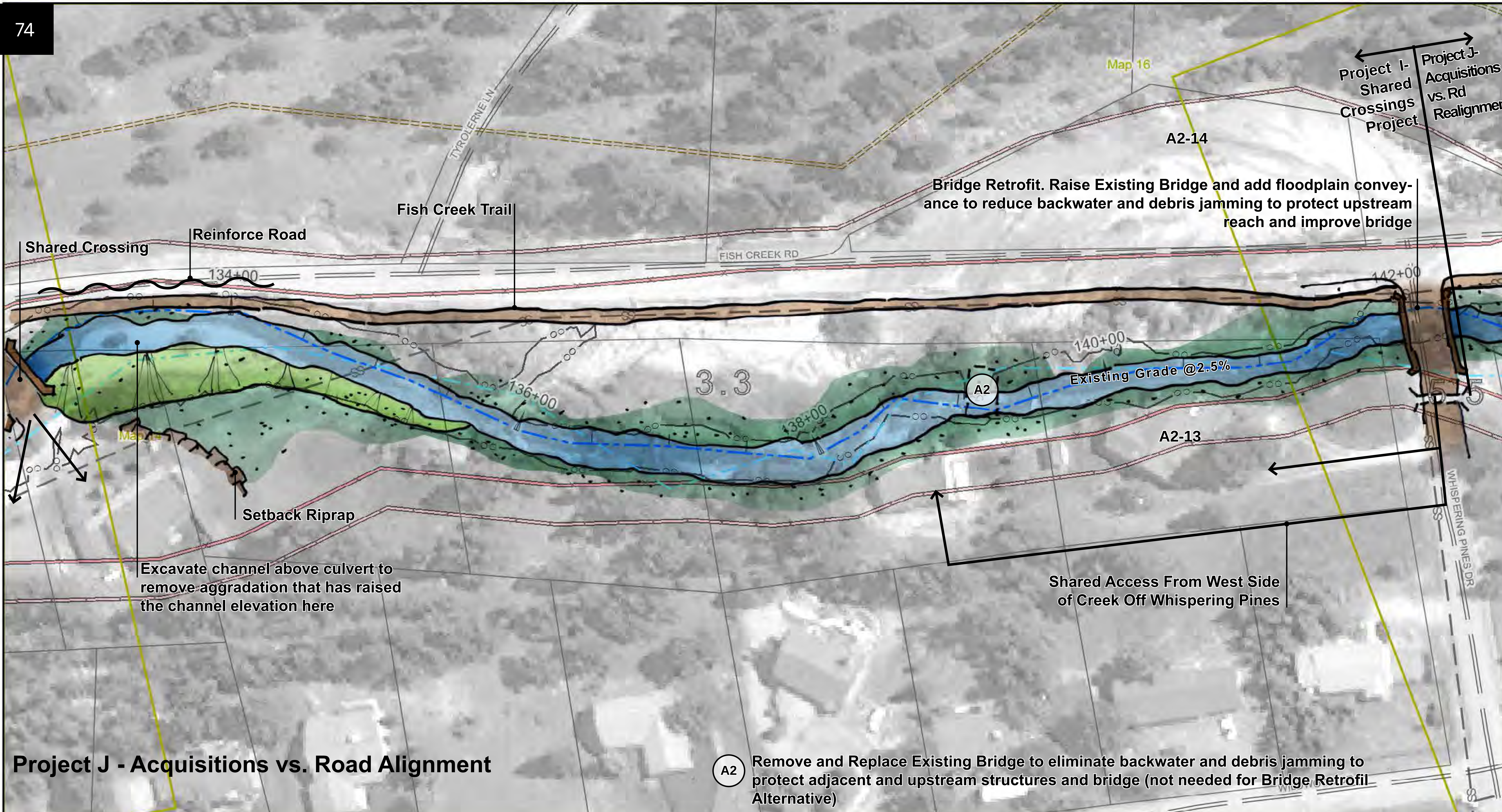
Fish Creek Coalition

**Fish Creek Corridor "Path to Resiliency" Resiliency Ideas**

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1:720
1 inch = 60 feet
0 — 60 Feet

Pre-Sep 2013 Trail Alignment
Pre-Sep 2013 Road Alignment
Pre-Sep 2013 Sanitary Sewer Alignment
Estimated Parcel Boundary (See Notes)
Adjacent Map
Post-Sep 2013 (ca. Nov. 2013) Creek Alignment
Pre-Sep 2013 Creek Alignment

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*Preliminary 100-Year Floodplain

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High Hazard Areas
Additional Hazard Areas

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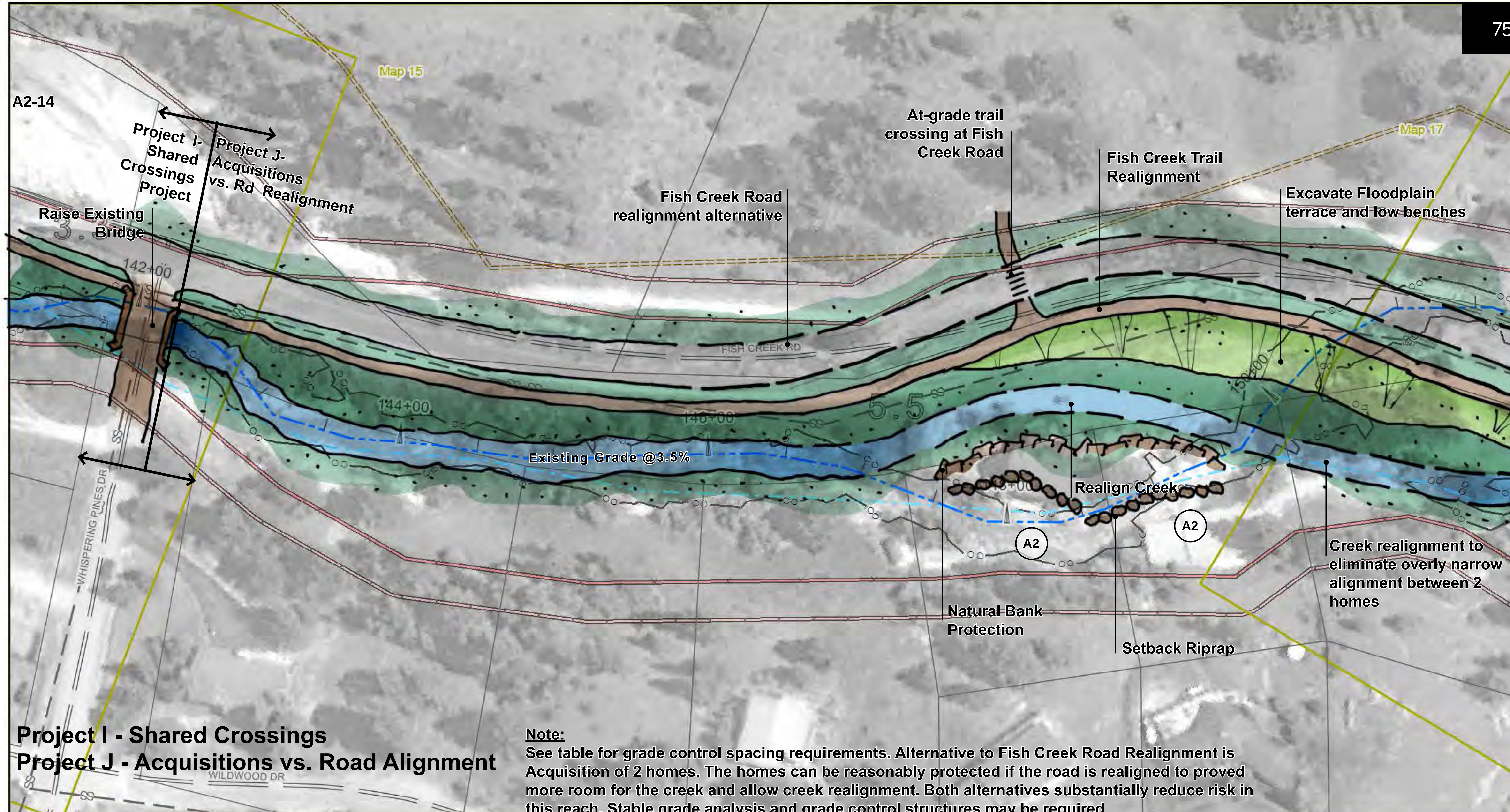
**Fish Creek Corridor "Path to Resiliency" Resiliency Ideas**




## Project I - Shared Crossings
## Project J - Acquisitions vs. Road Alignment

**Note:**
**See table for grade control spacing requirements. Alternative to Fish Creek Road Realignment is Acquisition of 2 homes. The homes can be reasonably protected if the road is realigned to proved more room for the creek and allow creek realignment. Both alternatives substantially reduce risk in this reach. Stable grade analysis and grade control structures may be required**

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FlyWater
Anderson Consulting Engineers
Crane Associates

1:720
1 inch = 60 feet
0 60
Feet

Pre-Sep 2013 Trail Alignment
Pre-Sep 2013 Road Alignment
Pre-Sep 2013 Sanitary Sewer Alignment
Estimated Parcel Boundary (See Notes)
Adjacent Map
Post-Sep 2013 (ca. Nov. 2013) Creek Alignment
Pre-Sep 2013 Creek Alignment

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*Preliminary 100-Year Floodplain
*Planning-Level Channel Migration Zone (pCMZ)
High Hazard Areas
Additional Hazard Areas

*** See IMPORTANT details on Floodplain or Geomorphic Hazard Mapbooks.**

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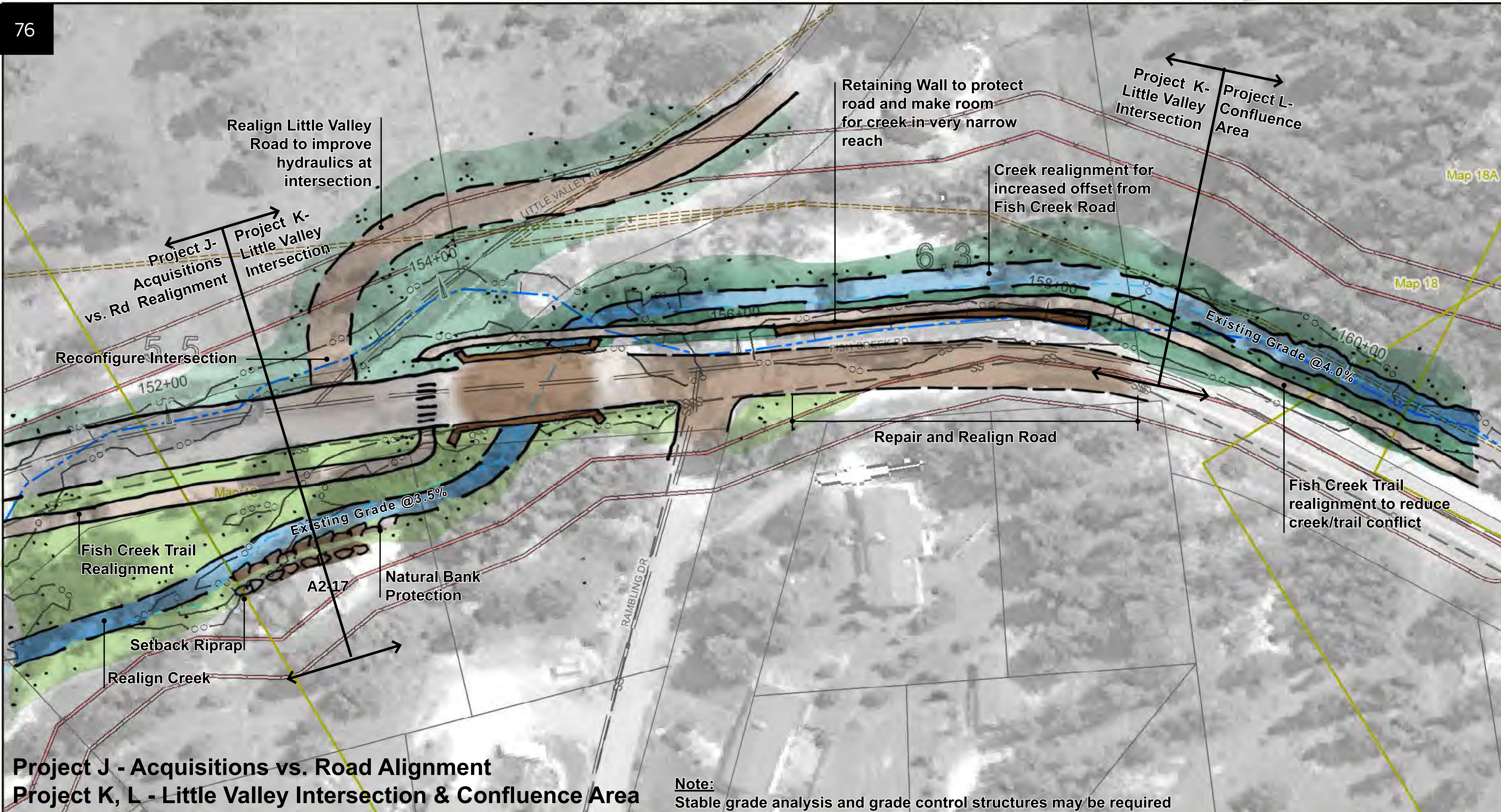
**Fish Creek Corridor**
**"Path to Resiliency"**
**Resiliency Ideas**
**Map 16 of 27**




Pre-Sep 2013 Trail Alignment
Pre-Sep 2013 Road Alignment
SS Pre-Sep 2013 Sanitary Sewer Alignment
Estimated Parcel Boundary (See Notes)
Adjacent Map
Post-Sep 2013 (ca. Nov. 2013) Creek Alignment
Pre-Sep 2013 Creek Alignment

1:720
1 inch = 60 feet
0 60
Feet

4.5 Ecosystem Score

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*Preliminary 100-Year Floodplain

*Planning-Level Channel Migration Zone (pCMZ)
High Hazard Areas
Additional Hazard Areas

*** See IMPORTANT details on Floodplain or Geomorphic Hazard Mapbooks.**

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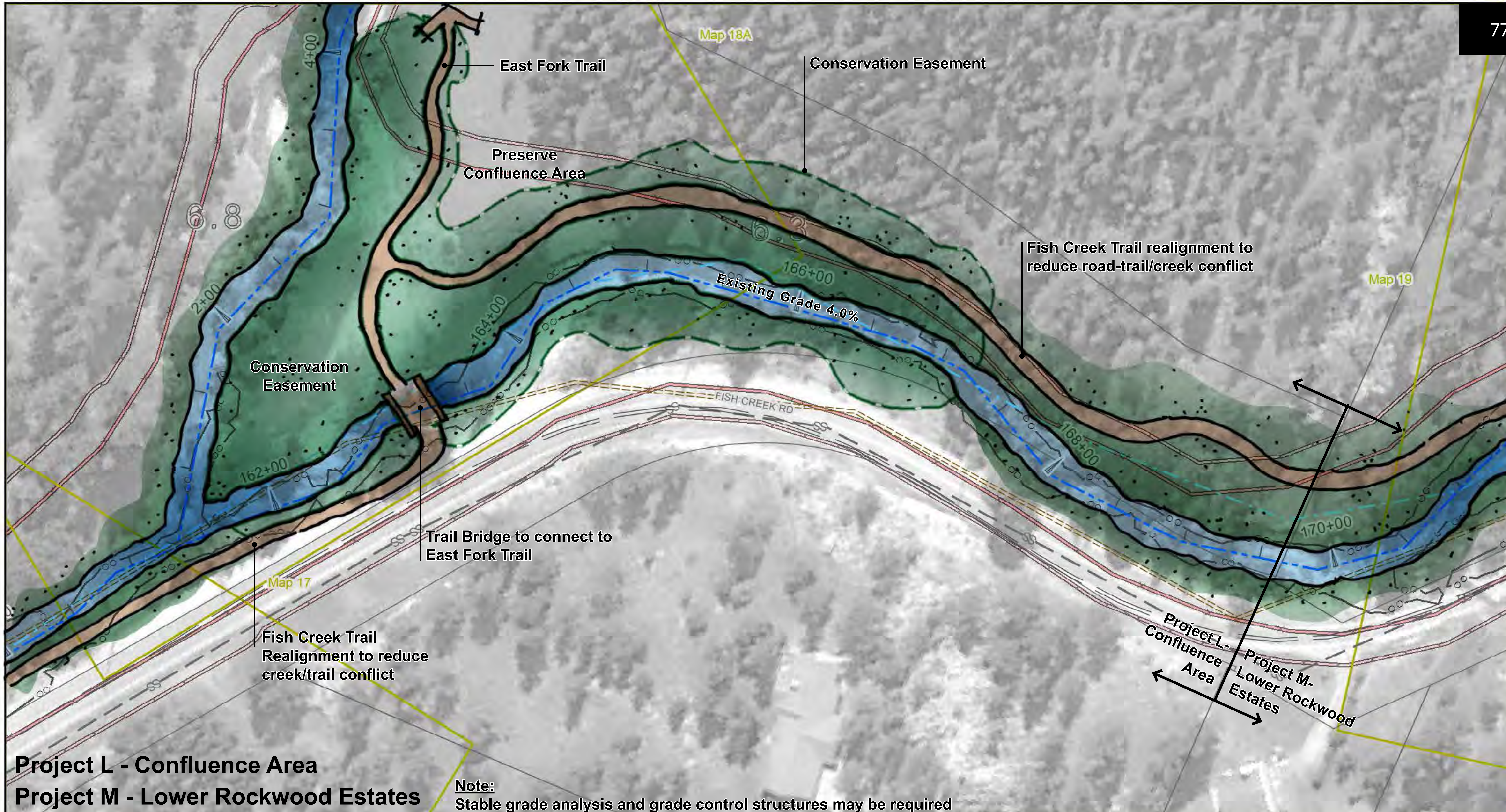
**Fish Creek Corridor**
**"Path to Resiliency"**
**Resiliency Ideas**
**Map 17 of 27**




## Project L - Confluence Area
## Project M - Lower Rockwood Estates

**Note:**
**Stable grade analysis and grade control structures may be required**

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Anderson Consulting Engineers
Crane Associates

1:720
1 inch = 60 feet
0 60
Feet

- Pre-Sep 2013 Trail Alignment
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- SS Pre-Sep 2013 Sanitary Sewer Alignment
- Estimated Parcel Boundary (See Notes)
- Adjacent Map
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Resiliency options include acquisitions/relocation of habitable structure outside of highest hazard area.

**A2** = High Risk/1st, 2nd & 3rd Tier Options:
Resiliency options include acquisition and relocation (1st Tier), large projects with system-wide benefits (2nd Tier), or localized solutions (3rd Tier).

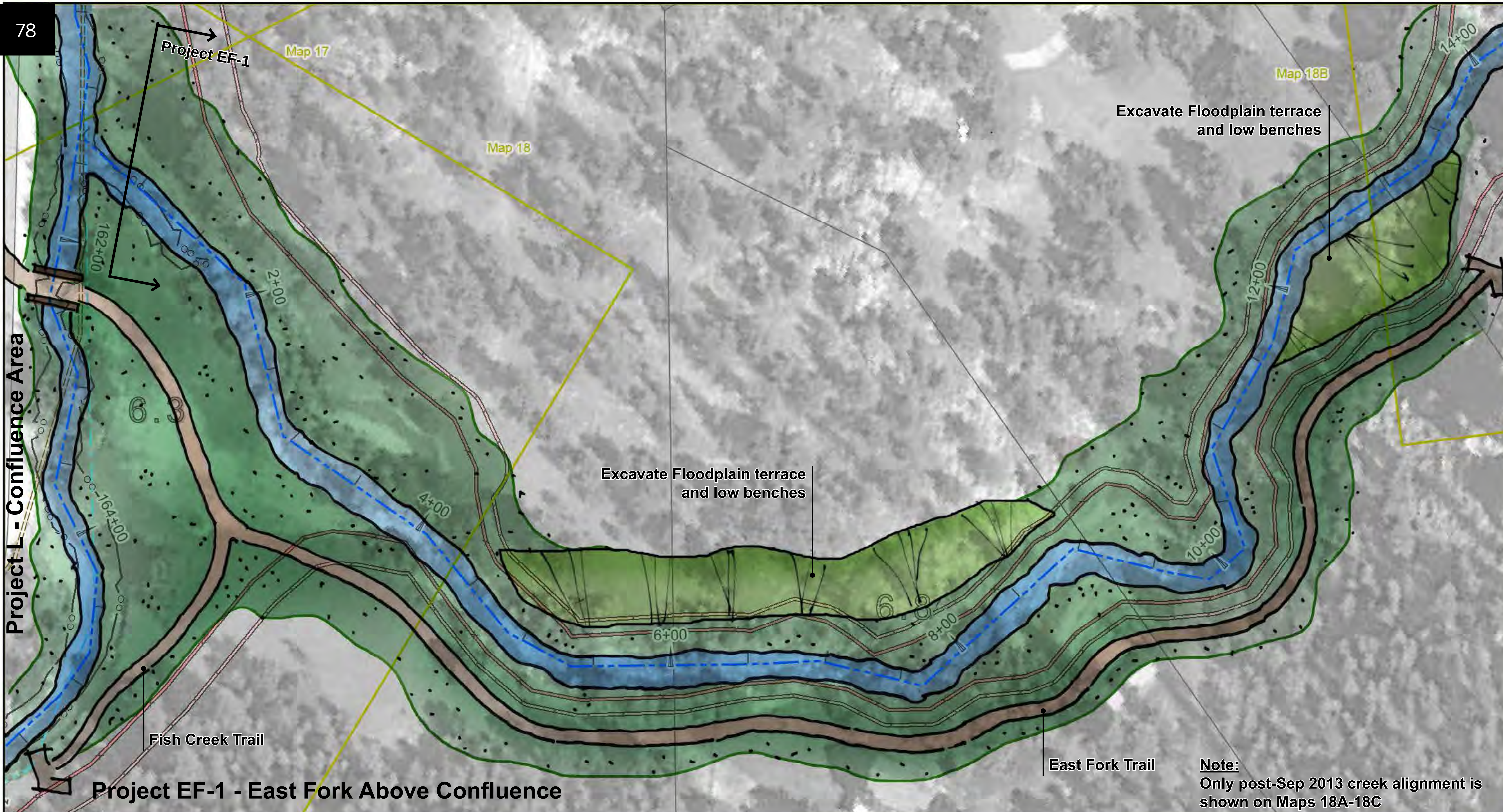
*Preliminary 100-Year Floodplain

*Planning-Level Channel Migration Zone (pCMZ)
- High Hazard Areas
- Additional Hazard Areas

*** See IMPORTANT details on Floodplain or Geomorphic Hazard Mapbooks.**

EP Fish Creek Coalition

**Fish Creek Corridor**
**"Path to Resiliency"**
**Resiliency Ideas**
**Map 18 of 27**




1:720
1 inch = 60 feet
0 60
Feet

Pre-Sep 2013 Trail Alignment
Pre-Sep 2013 Road Alignment
Pre-Sep 2013 Sanitary Sewer Alignment
Estimated Parcel Boundary (See Notes)
Adjacent Map
Post-Sep 2013 (ca. Nov. 2013) Creek Alignment
Pre-Sep 2013 Creek Alignment

4.5 Ecosystem Score

**A1** = Highest Risk/1st Tier Project:
Resiliency options include acquisitions/relocation of habitable structure outside of highest hazard area.

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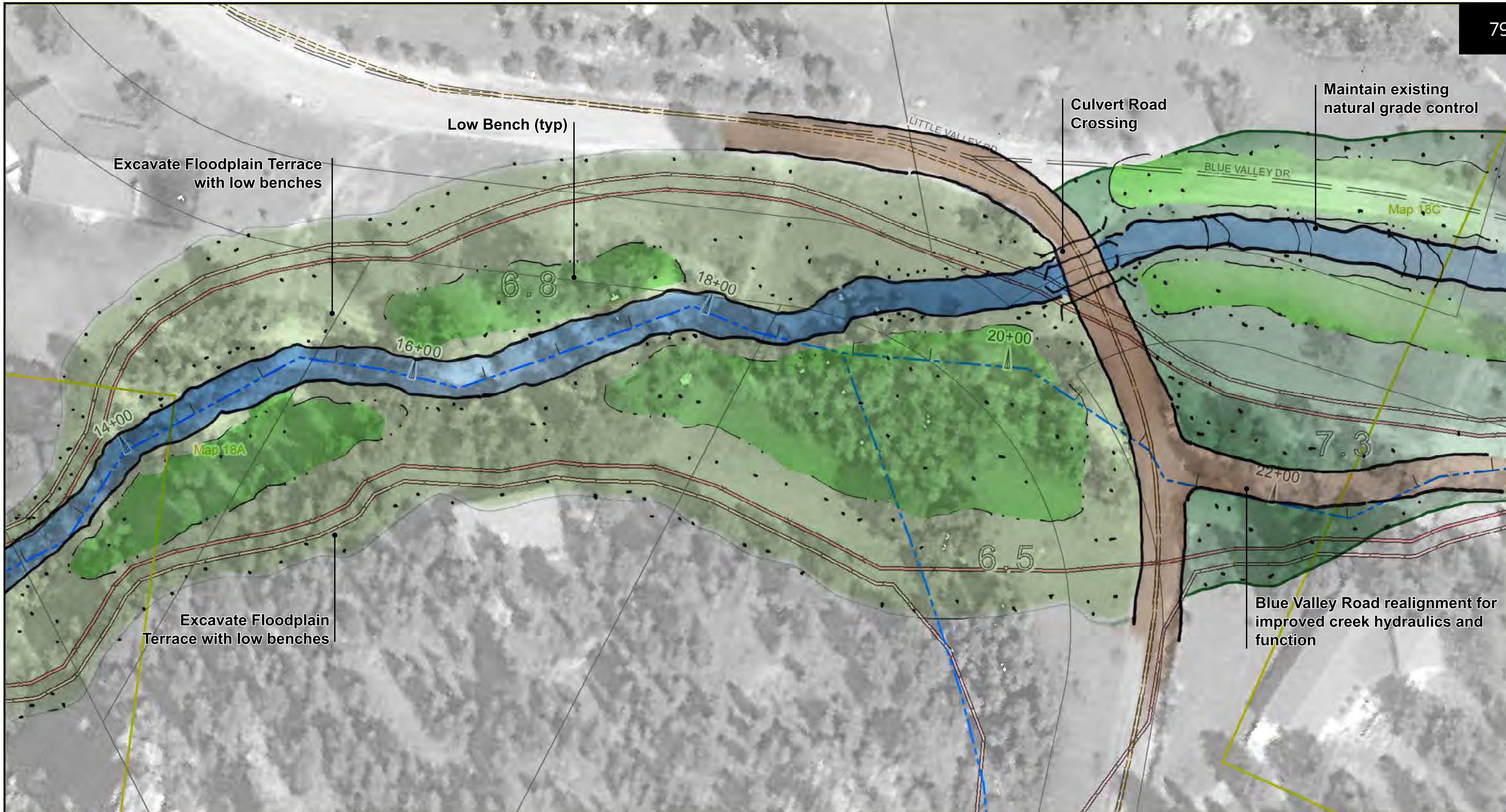
*Planning-Level Channel Migration Zone (pCMZ)
High Hazard Areas
Additional Hazard Areas

*** See IMPORTANT details on Floodplain or Geomorphic Hazard Mapbooks.**

**Fish Creek Corridor**
**"Path to Resiliency"**
**Resiliency Ideas**
**Map 18A of 27**

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1 inch = 60 feet
0 60
Feet

Pre-Sep 2013 Trail Alignment
Pre-Sep 2013 Road Alignment
SS Pre-Sep 2013 Sanitary Sewer Alignment
Estimated Parcel Boundary (See Notes)
Adjacent Map
Post-Sep 2013 (ca. Nov. 2013) Creek Alignment
Pre-Sep 2013 Creek Alignment

4.5 Ecosystem Score

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*Preliminary 100-Year Floodplain

*Planning-Level Channel Migration Zone (pCMZ)
High Hazard Areas
Additional Hazard Areas

*** See IMPORTANT details on Floodplain or Geomorphic Hazard Mapbooks.**

Fish Creek Coalition

**Fish Creek Corridor "Path to Resiliency" Resiliency Ideas**
**Map 18B of 27**

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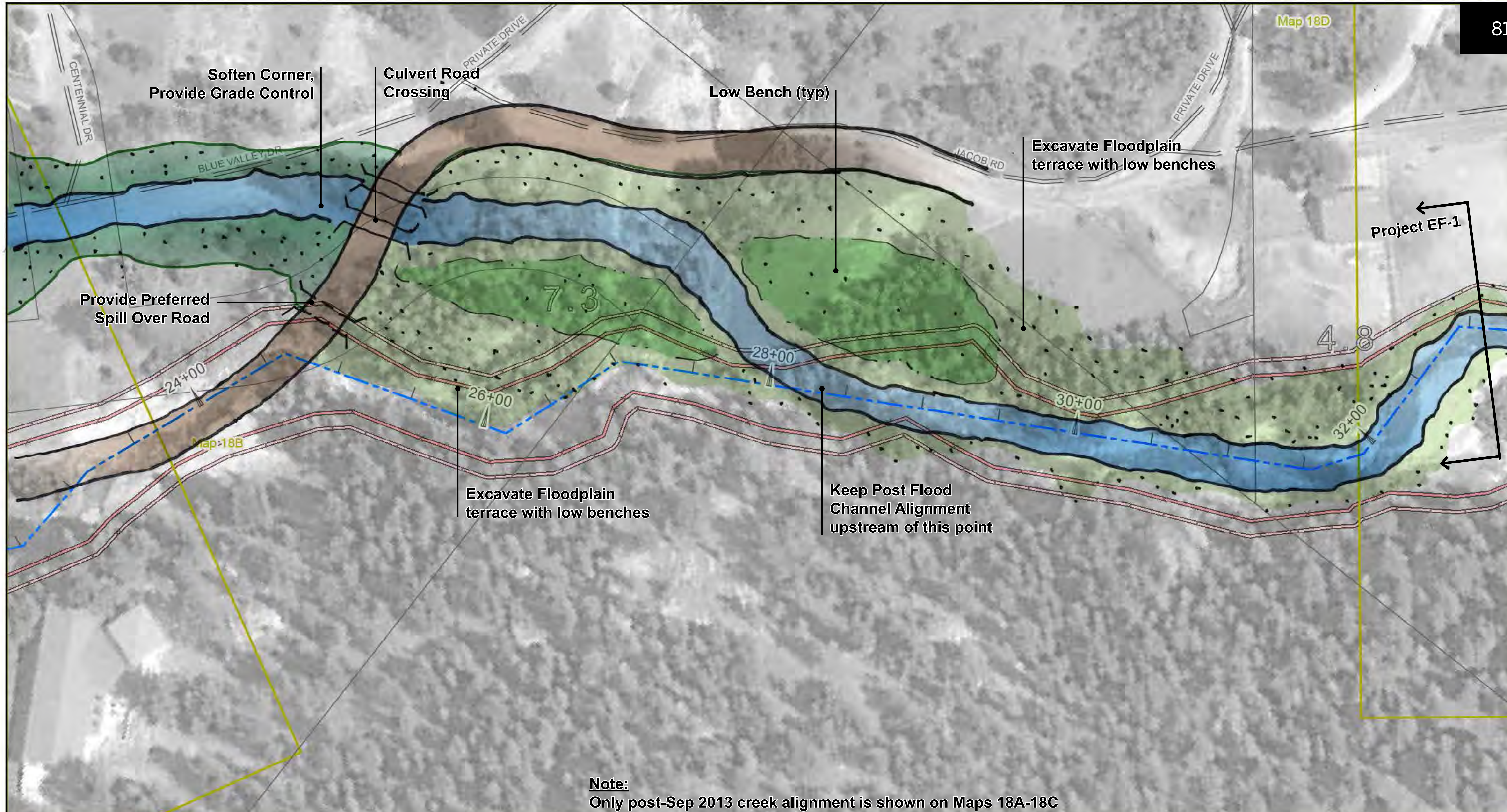


**Note:**
Only post-Sep 2013 creek alignment is shown on Maps 18A-18C

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Round River Design
FlyWater
Anderson Consulting Engineers
Crane Associates

1:720
1 inch = 60 feet
0 60
Feet

Pre-Sep 2013 Trail Alignment
Pre-Sep 2013 Road Alignment
SS Pre-Sep 2013 Sanitary Sewer Alignment
Estimated Parcel Boundary (See Notes)
Adjacent Map
Post-Sep 2013 (ca. Nov. 2013) Creek Alignment
Pre-Sep 2013 Creek Alignment

4.5 Ecosystem Score

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*Planning-Level Channel Migration Zone (pCMZ)
High Hazard Areas
Additional Hazard Areas

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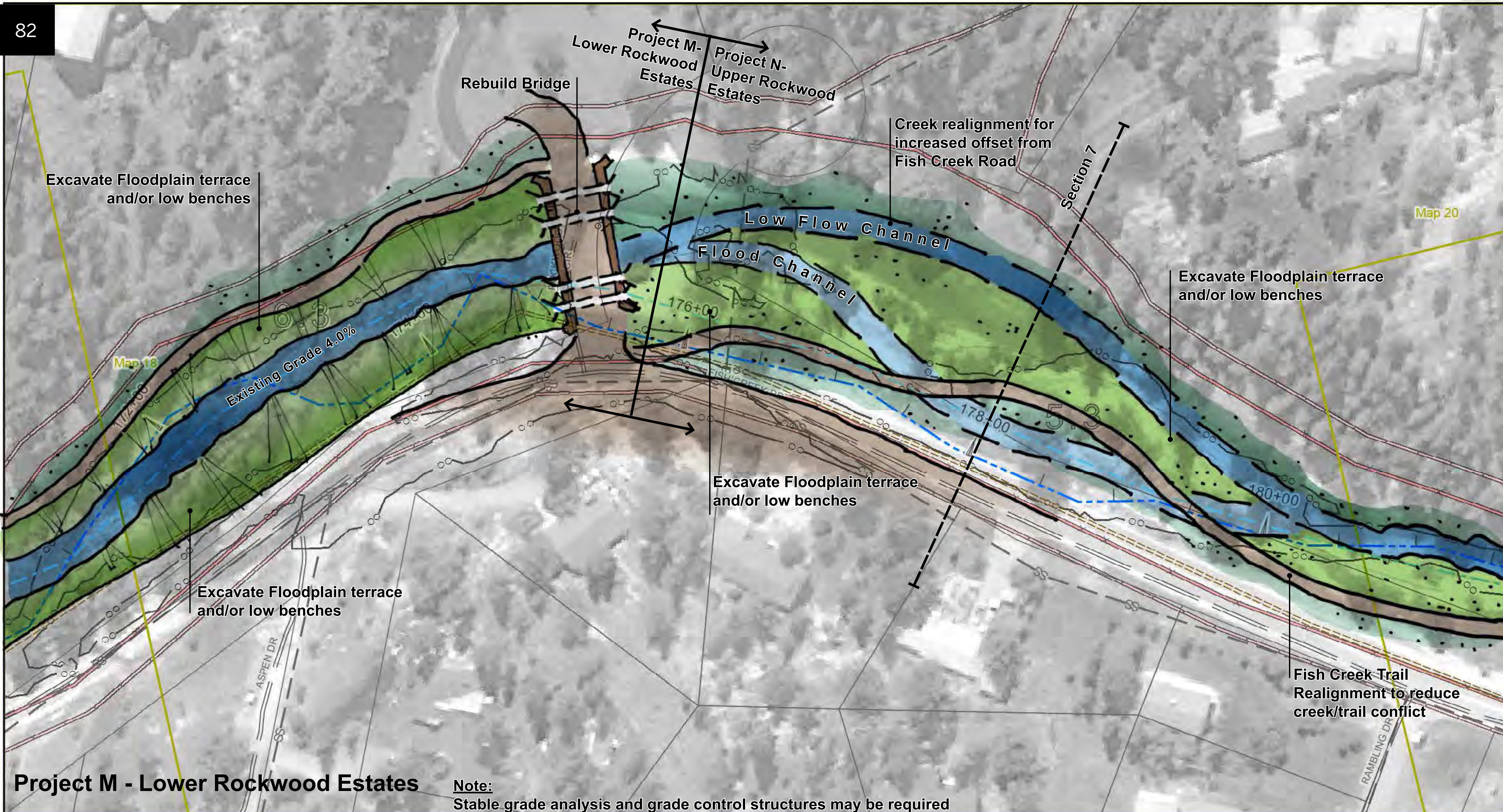
**Fish Creek Corridor**
**"Path to Resiliency"**
**Resiliency Ideas**
**Map 18C of 27**




# Project M - Lower Rockwood Estates

**Note:**
**Stable grade analysis and grade control structures may be required**

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Anderson Consulting Engineers
Crane Associates

1:720
1 inch = 60 feet
0 60
Feet

| Legend | |
|---|---|
| ===== | Pre-Sep 2013 Trail Alignment |
| ===== | Pre-Sep 2013 Road Alignment |
| SS— — | Pre-Sep 2013 Sanitary Sewer Alignment |
| ▭ | Estimated Parcel Boundary (See Notes) |
| ▭ | Adjacent Map |
| — · — | Post-Sep 2013 (ca. Nov. 2013) Creek Alignment |
| — · — | Pre-Sep 2013 Creek Alignment |

4.5 Ecosystem Score

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Resiliency options include acquisitions/relocation of habitable structure outside of highest hazard area.

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*Preliminary 100-Year Floodplain

*Planning-Level Channel Migration Zone (pCMZ)
High Hazard Areas
Additional Hazard Areas

*** See IMPORTANT details on Floodplain or Geomorphic Hazard Mapbooks.**

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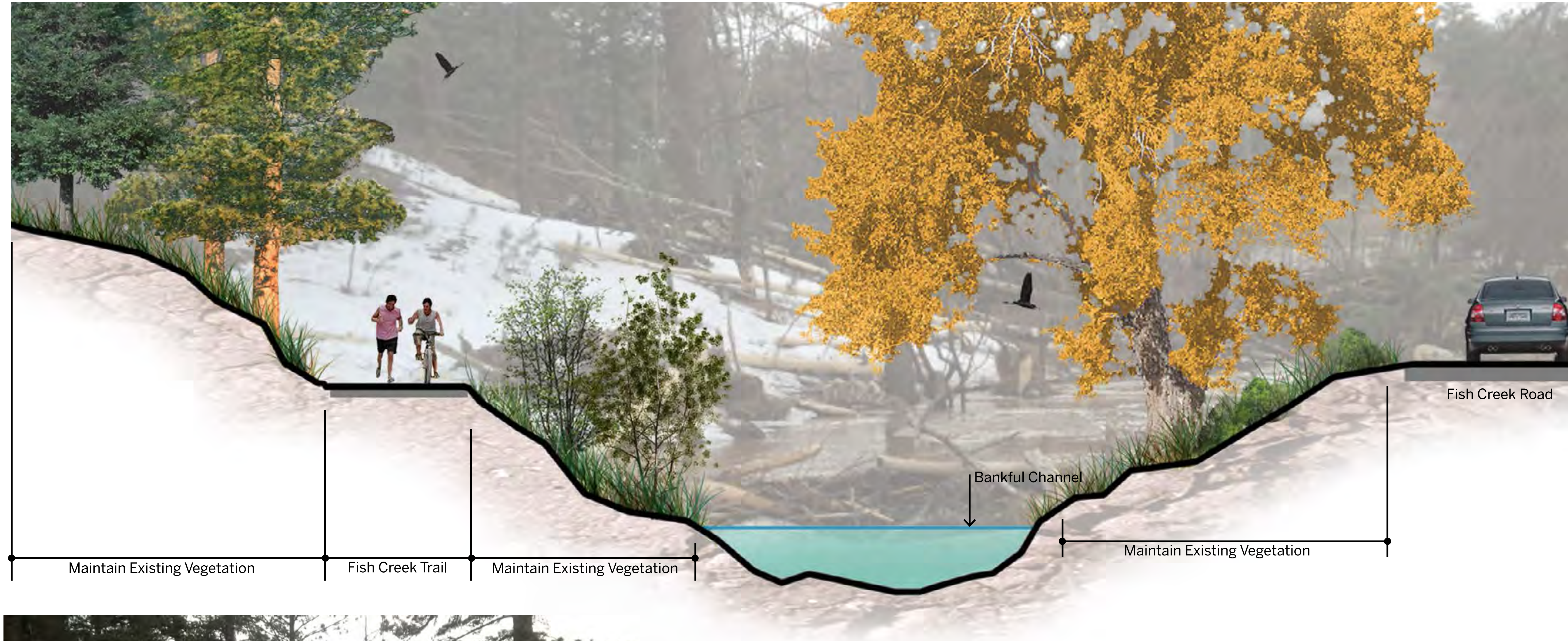
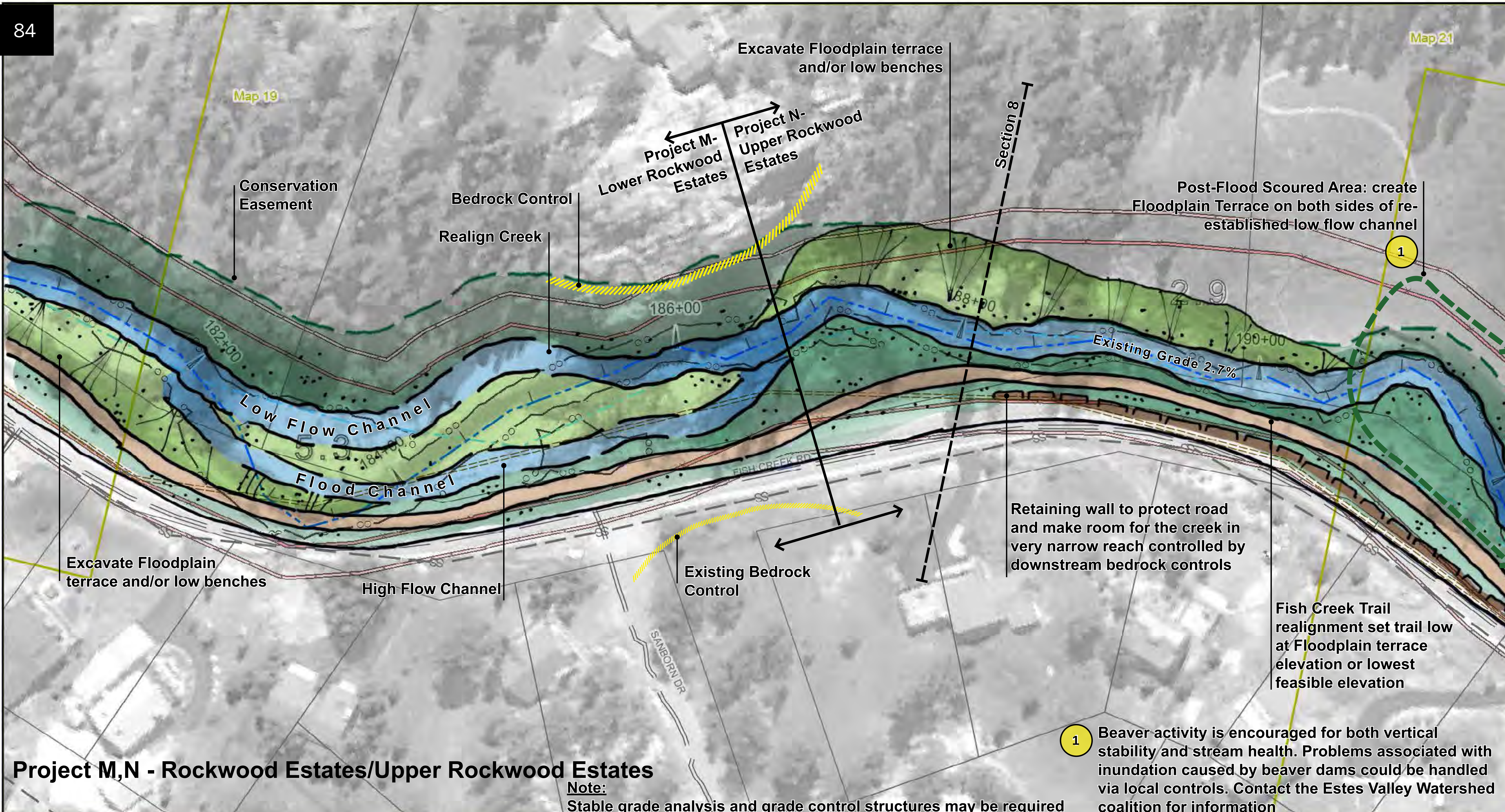
**Fish Creek Corridor**
**"Path to Resiliency"**
**Resiliency Ideas**




Post Flood Image
Looking Upstream

Fish Creek Cross Section 7
Looking Upstream
Not to Scale




## Project M,N - Rockwood Estates/Upper Rockwood Estates

**Note:**
Stable grade analysis and grade control structures may be required

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Anderson Consulting Engineers
Crane Associates

1:720
1 inch = 60 feet
0 60
Feet

Pre-Sep 2013 Trail Alignment
Pre-Sep 2013 Road Alignment
Pre-Sep 2013 Sanitary Sewer Alignment
Estimated Parcel Boundary (See Notes)
Adjacent Map
Post-Sep 2013 (ca. Nov. 2013) Creek Alignment
Pre-Sep 2013 Creek Alignment

4.5 Ecosystem Score

**A1** = Highest Risk/1st Tier Project: Resiliency options include acquisitions/relocation of habitable structure outside of highest hazard area.

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*Preliminary 100-Year Floodplain

*Planning-Level Channel Migration Zone (pCMZ)
High Hazard Areas
Additional Hazard Areas

*** See IMPORTANT details on Floodplain or Geomorphic Hazard Mapbooks.**

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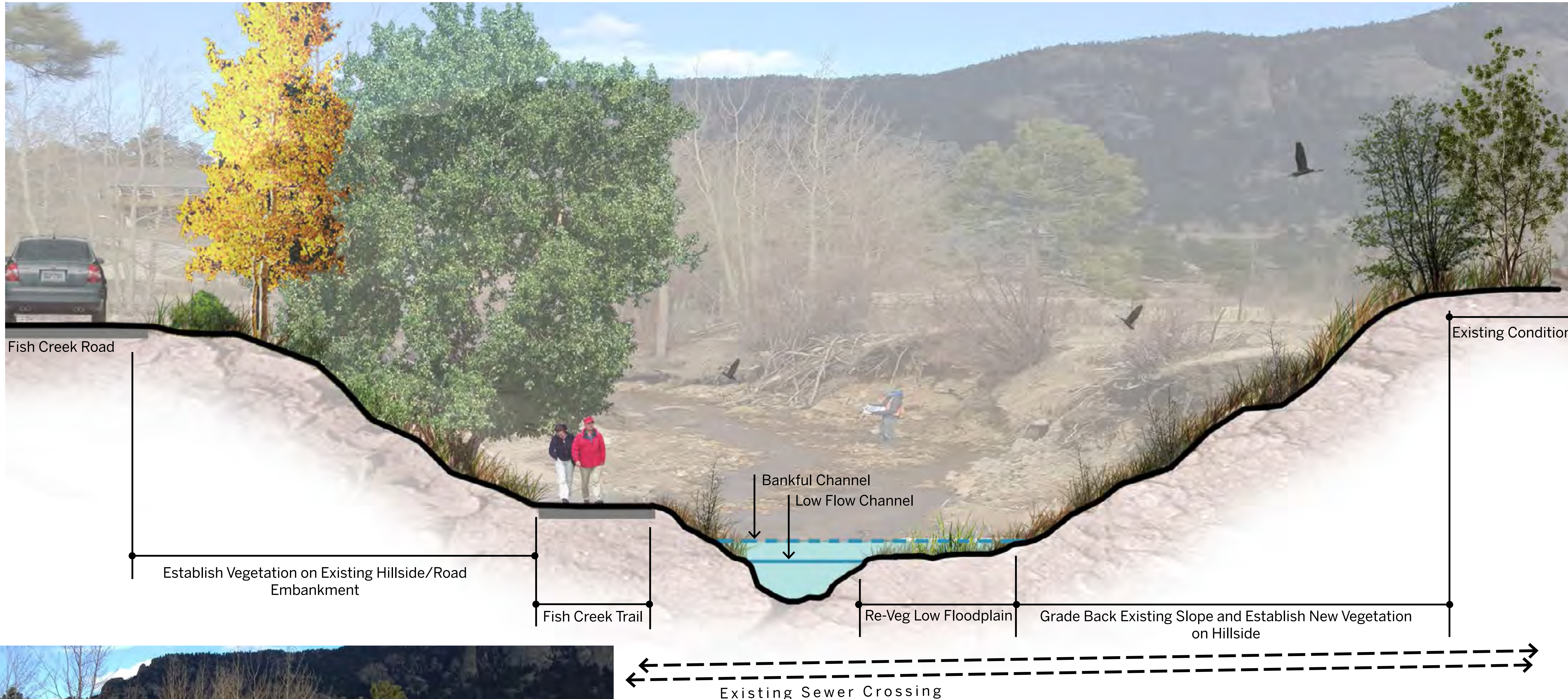
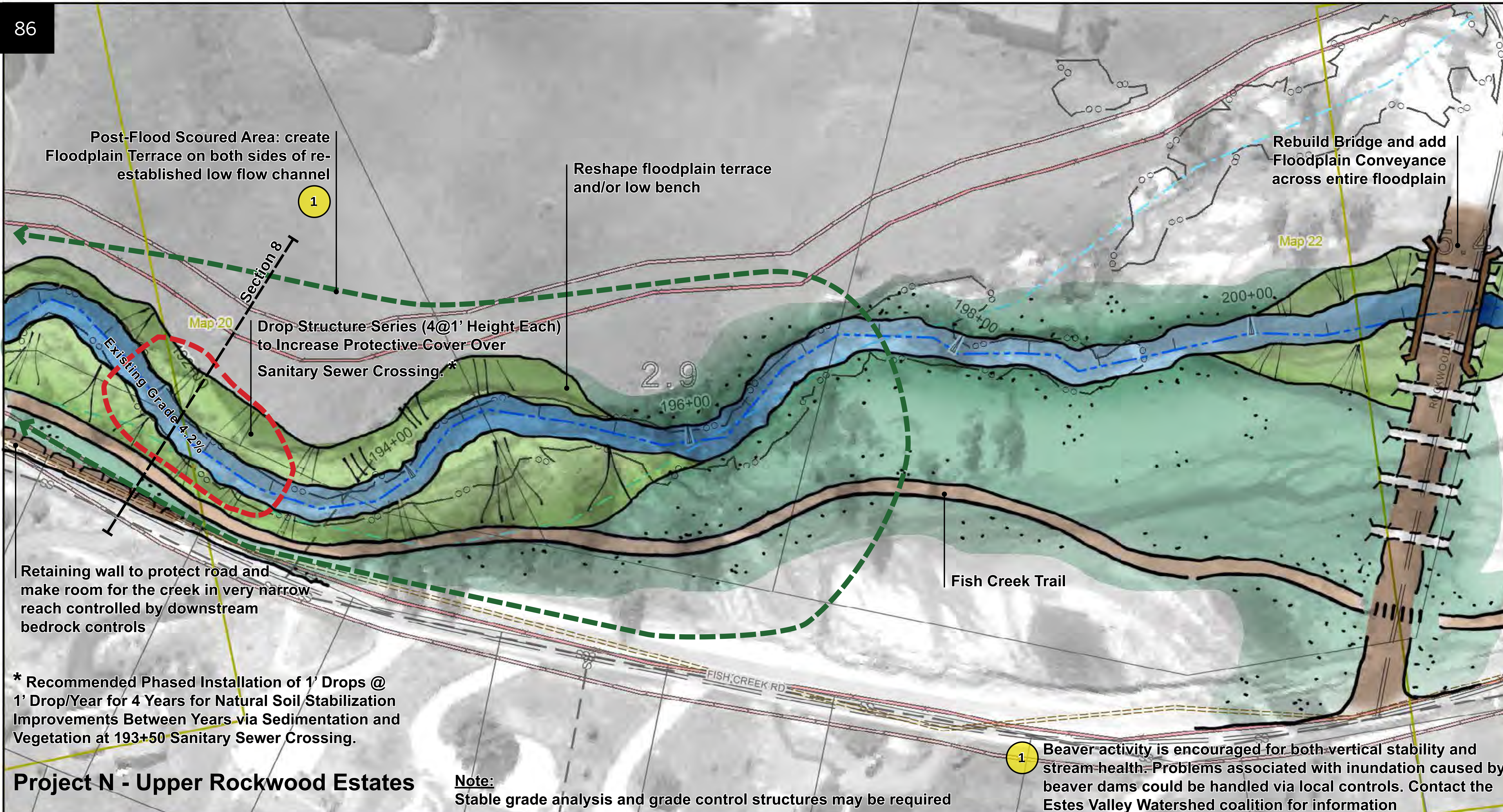
**Fish Creek Corridor "Path to Resiliency" Resiliency Ideas**
**Map 20 of 27**




Fish Creek Cross Section 8
Looking Downstream
Not to Scale

Post Flood Image
Looking Downstream

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1:720
1 inch = 60 feet
0 60
Feet

- Pre-Sep 2013 Trail Alignment
- Pre-Sep 2013 Road Alignment
- SS Pre-Sep 2013 Sanitary Sewer Alignment
- Estimated Parcel Boundary (See Notes)
- Adjacent Map
- Post-Sep 2013 (ca. Nov. 2013) Creek Alignment
- Pre-Sep 2013 Creek Alignment

4.5 Ecosystem Score

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*Preliminary 100-Year Floodplain

*Planning-Level Channel Migration Zone (pCMZ)
- High Hazard Areas
- Additional Hazard Areas

*** See IMPORTANT details on Floodplain or Geomorphic Hazard Mapbooks.**

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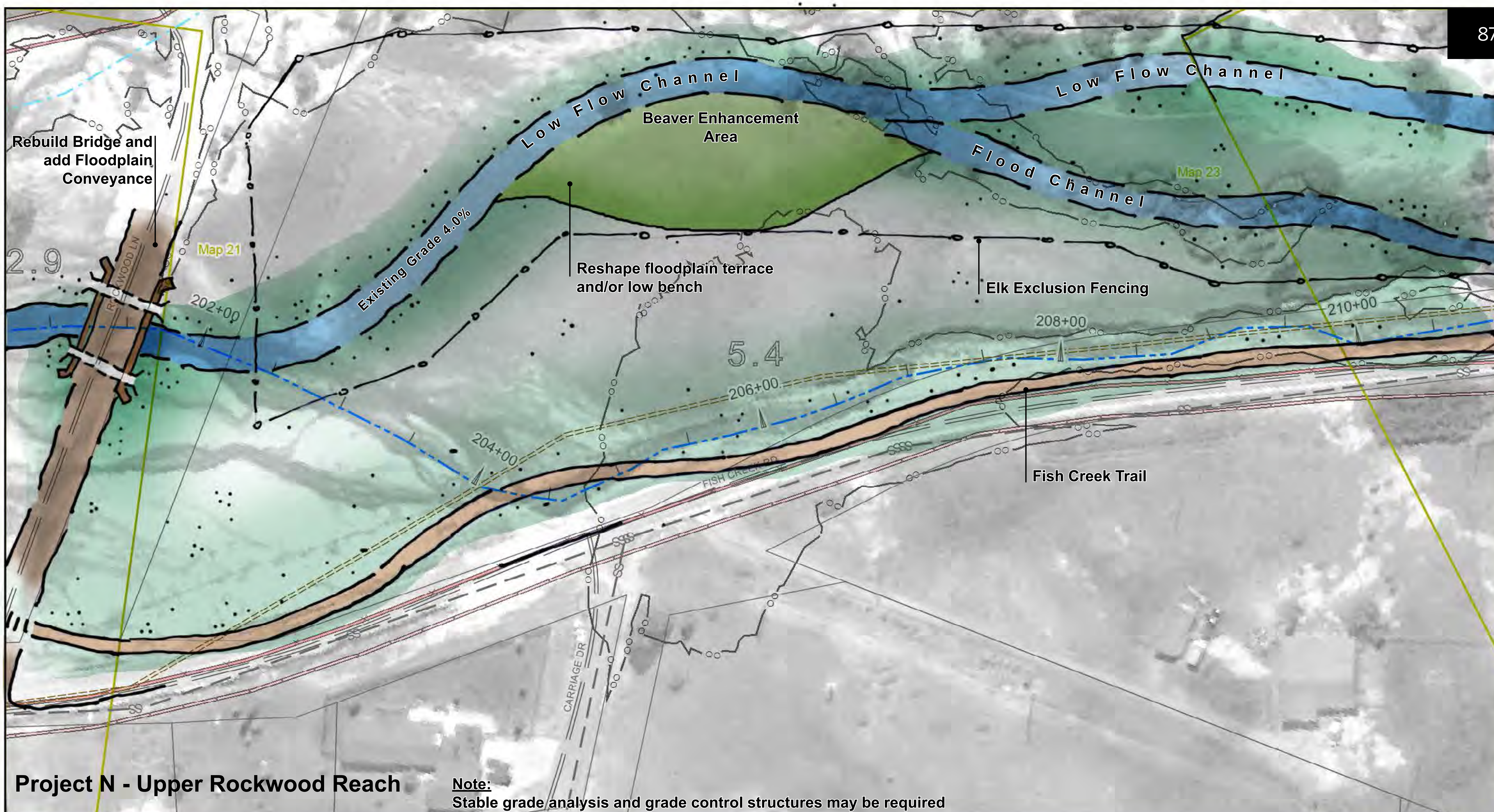
**Fish Creek Corridor "Path to Resiliency" Resiliency Ideas**




## Project N - Upper Rockwood Reach

**Note:**
**Stable grade analysis and grade control structures may be required**

1:720
1 inch = 60 feet
0 60
Feet

Pre-Sep 2013 Trail Alignment
Pre-Sep 2013 Road Alignment
Pre-Sep 2013 Sanitary Sewer Alignment
Estimated Parcel Boundary (See Notes)
Adjacent Map
Post-Sep 2013 (ca. Nov. 2013) Creek Alignment
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4.5 Ecosystem Score

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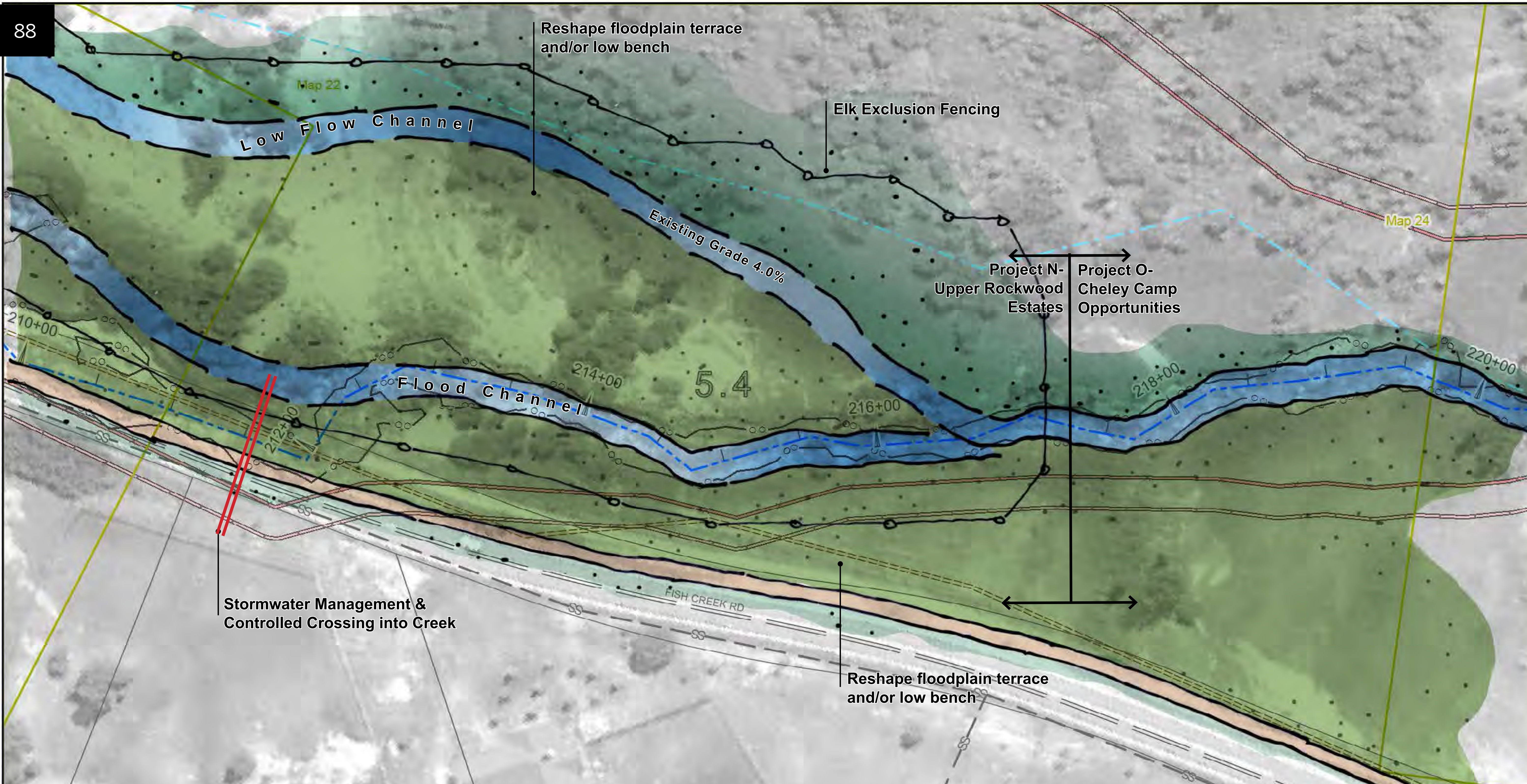
*Preliminary 100-Year Floodplain

*Planning-Level Channel Migration Zone (pCMZ)
High Hazard Areas
Additional Hazard Areas

*** See IMPORTANT details on Floodplain or Geomorphic Hazard Mapbooks.**

**Fish Creek Corridor**
**"Path to Resiliency"**
**Resiliency Ideas**
**Map 22 of 27**




## Project N,O - Upper Rockwood Reach / Cheley Camp Opportunities

**Note:**
**Stable grade analysis and grade control structures may be required**

1:720
1 inch = 60 feet
0 60
Feet

- Pre-Sep 2013 Trail Alignment
- Pre-Sep 2013 Road Alignment
- SS Pre-Sep 2013 Sanitary Sewer Alignment
- Estimated Parcel Boundary (See Notes)
- Adjacent Map
- Post-Sep 2013 (ca. Nov. 2013) Creek Alignment
- Pre-Sep 2013 Creek Alignment

4.5 Ecosystem Score

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*Preliminary 100-Year Floodplain

*Planning-Level Channel Migration Zone (pCMZ)
- High Hazard Areas
- Additional Hazard Areas

*** See IMPORTANT details on Floodplain or Geomorphic Hazard Mapbooks.**

Fish Creek Coalition

**Fish Creek Corridor**
**"Path to Resiliency"**
**Resiliency Ideas**
**Map 23 of 27**

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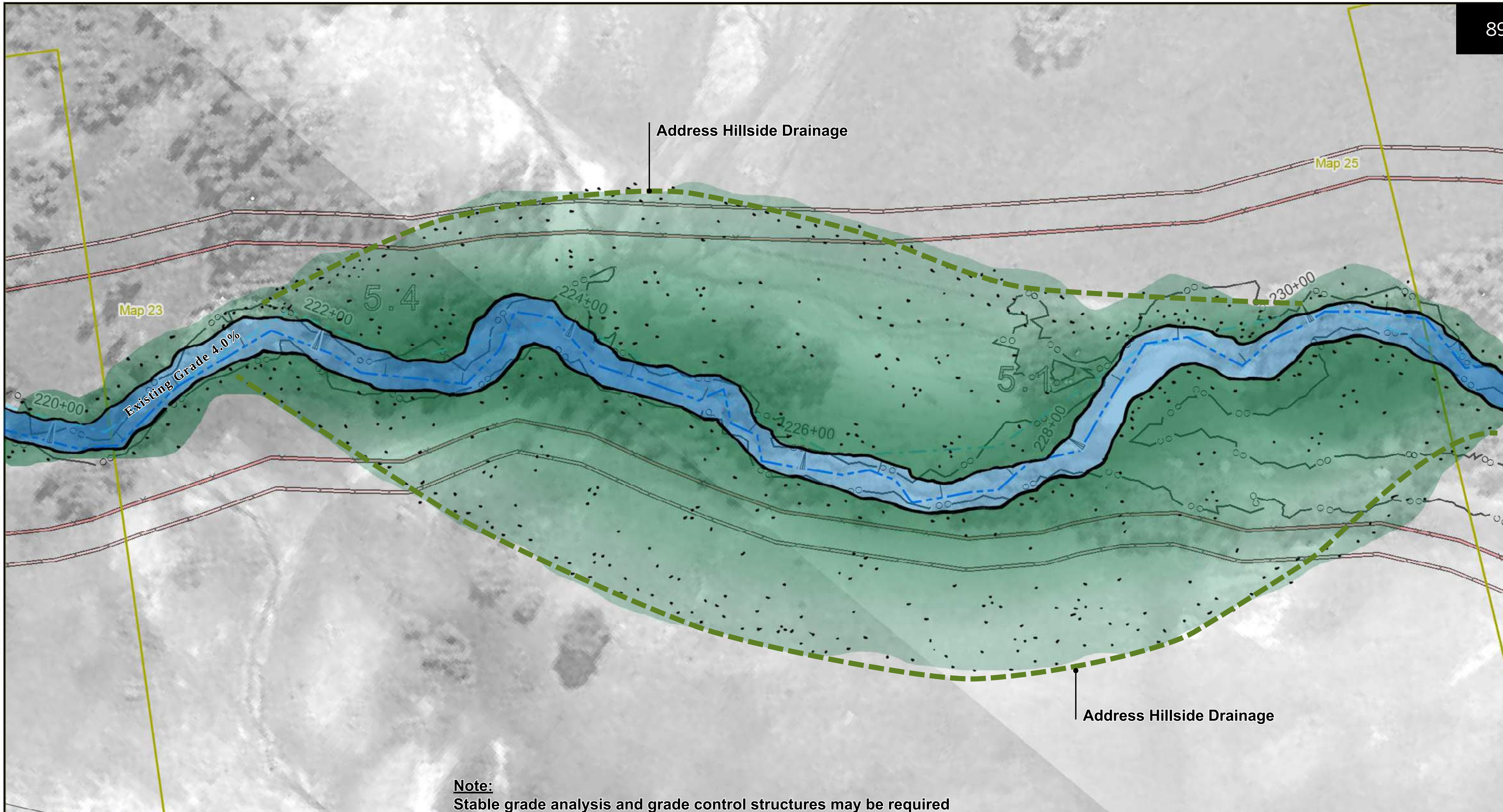
Anderson Consulting Engineers
Crane Associates




**Note:**
**Stable grade analysis and grade control structures may be required**

1:720
1 inch = 60 feet
0 60
Feet

Pre-Sep 2013 Trail Alignment
Pre-Sep 2013 Road Alignment
Pre-Sep 2013 Sanitary Sewer Alignment
Estimated Parcel Boundary (See Notes)
Adjacent Map
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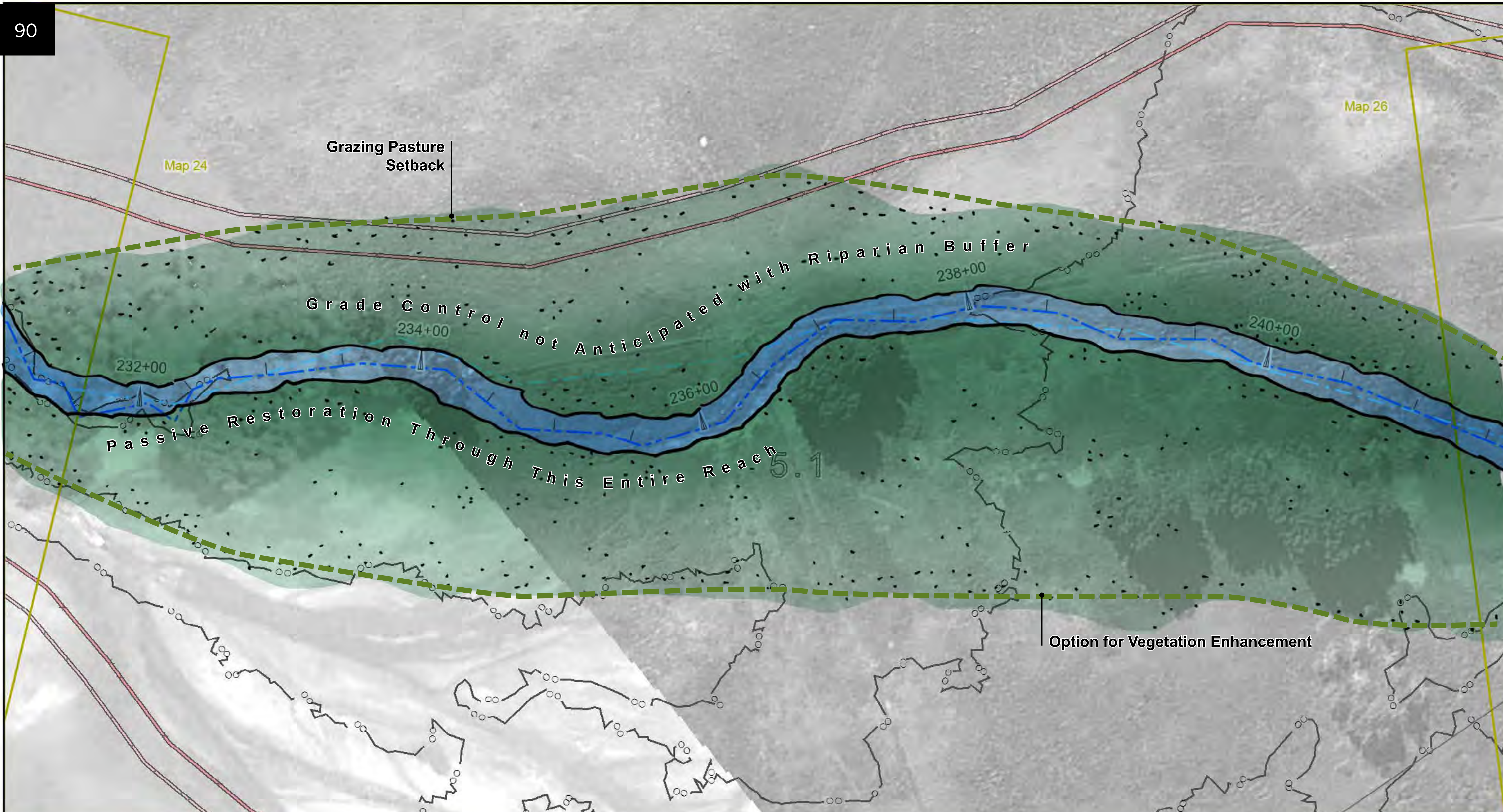
*Planning-Level Channel Migration Zone (pCMZ)
High Hazard Areas
Additional Hazard Areas

*** See IMPORTANT details on Floodplain or Geomorphic Hazard Mapbooks.**

**Fish Creek Corridor**
**"Path to Resiliency"**
**Resiliency Ideas**
**Map 24 of 27**




Robert Peccia & Associates
Walsh
Round River Design
Great Outdoors Consultants
FlyWater
Anderson Consulting Engineers
Crane Associates

1:720
1 inch = 60 feet
0 60
Feet

| Legend | |
|---|---|
| ===== | Pre-Sep 2013 Trail Alignment |
| ——— | Pre-Sep 2013 Road Alignment |
| SS— — | Pre-Sep 2013 Sanitary Sewer Alignment |
| ☐ | Estimated Parcel Boundary (See Notes) |
| ☐ | Adjacent Map |
| - · - | Post-Sep 2013 (ca. Nov. 2013) Creek Alignment |
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*Planning-Level Channel Migration Zone (pCMZ)
High Hazard Areas
Additional Hazard Areas

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EP Fish Creek Coalition

**Fish Creek Corridor "Path to Resiliency" Resiliency Ideas**
**Map 25 of 27**


1:720
1 inch = 60 feet
0 60
Feet

| | |
|---|---|
| ===== | Pre-Sep 2013 Trail Alignment |
| ═══ | Pre-Sep 2013 Road Alignment |
| SS— — | Pre-Sep 2013 Sanitary Sewer Alignment |
| □ | Estimated Parcel Boundary (See Notes) |
| □ | Adjacent Map |
| — · — | Post-Sep 2013 (ca. Nov. 2013) Creek Alignment |
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High Hazard Areas
Additional Hazard Areas

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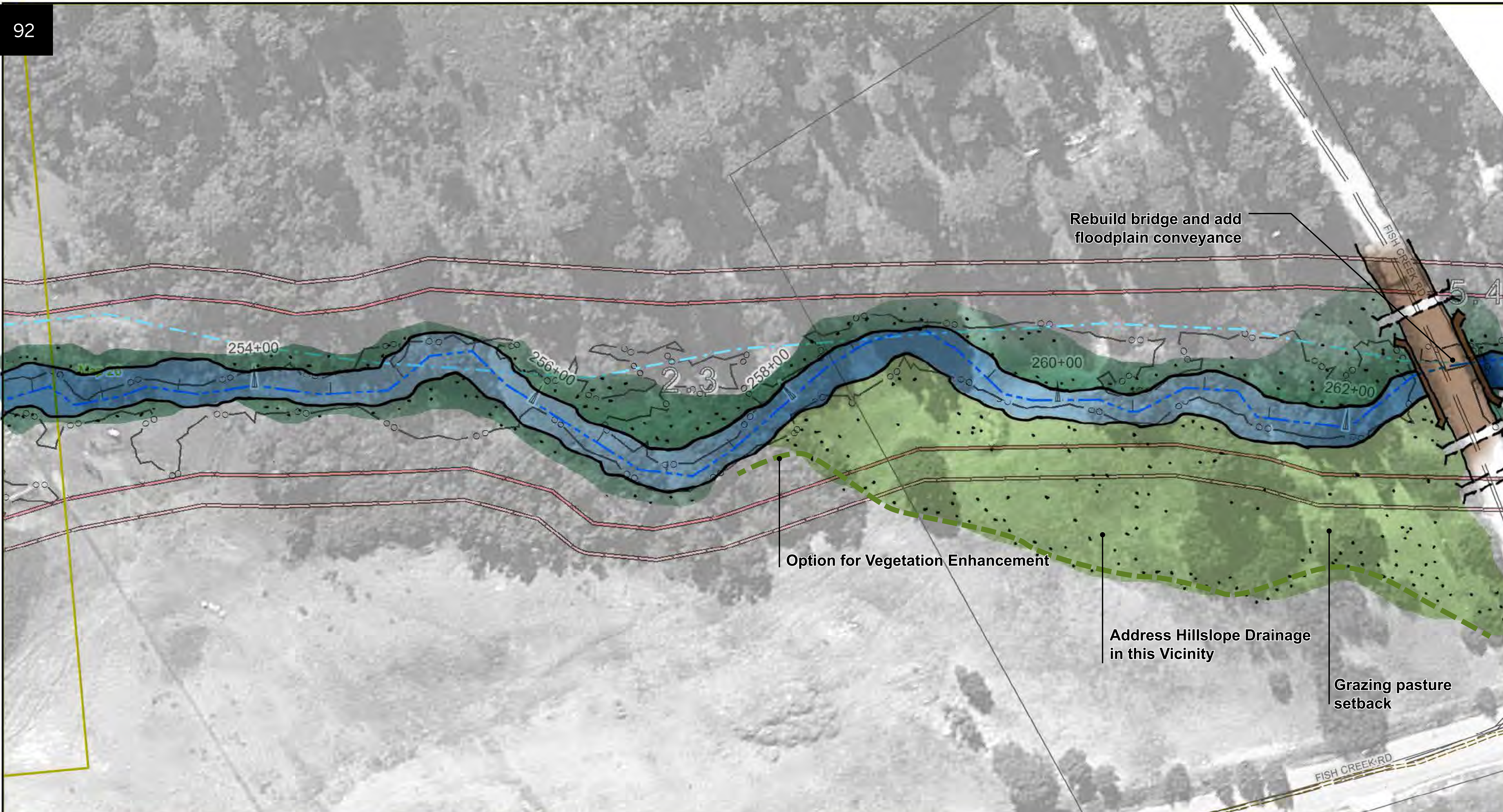
Fish Creek Coalition

**Fish Creek Corridor**
**"Path to Resiliency"**
**Resiliency Ideas**
**Map 26 of 27**

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*Planning-Level Channel Migration Zone (pCMZ)
High Hazard Areas
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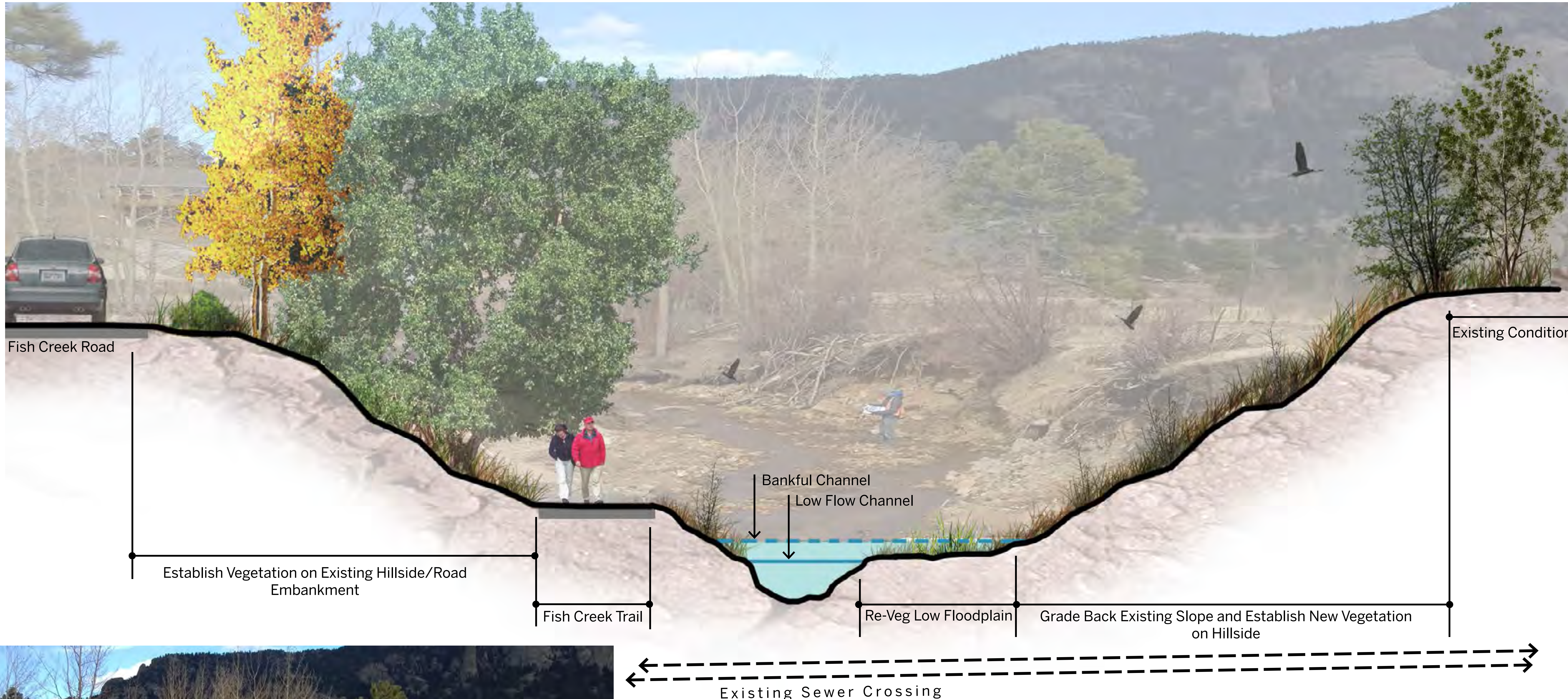
EP Fish Creek Coalition

**Fish Creek Corridor "Path to Resiliency" Resiliency Ideas**
**Map 27 of 27**




Post Flood Image
Looking Downstream

<u>Fish Creek Cross Section 8</u>
Looking Downstream
Not to Scale

Fish Creek Coalition

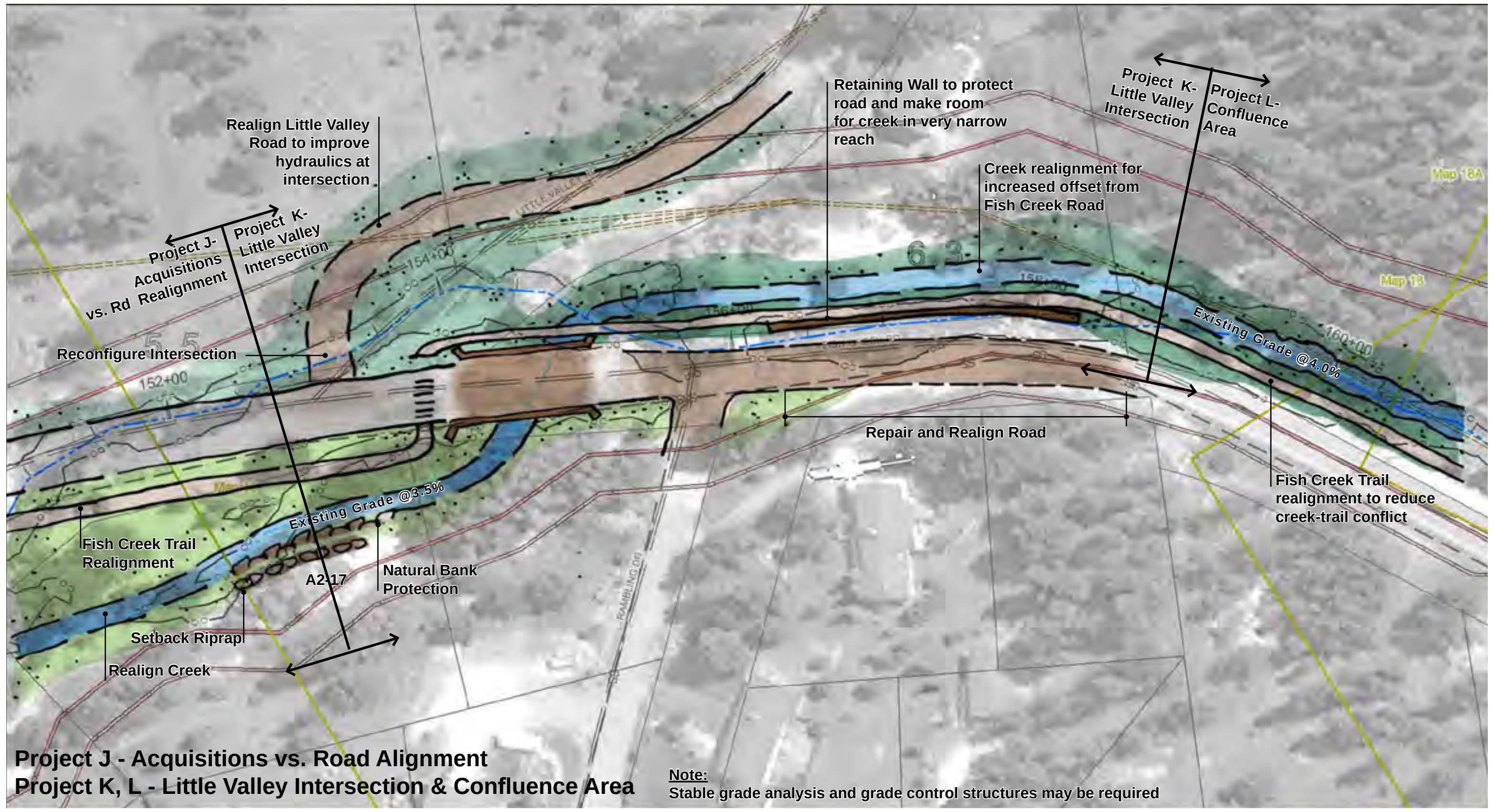
## 7.3.2 Recommended Project Matrix

Each recommended project is evaluated in the recommended project matrix which allows for comparison of the projects against each other. The matrix evaluates the existing ecological condition, flood risk, and geomorphic risk. It states if the recommended project will effect change locally in that reach or on a larger scale in the river. To compare the feasibility of the recommended projects, they are evaluated for the relative

| ID | Evaluation Criteria | Ranking | Options Evaluation | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Potential Project A: Delta Park (sheets 1 & 2) | Potential Project B: Van Horn Reach (sheets 3, 4 & 5) | Potential Project C: Stonebridge Reach (sheets 5, 6 & 7) | Potential Project D: Creekside Reach (sheet 8) | Potential Project E: Brook to Country Club (sheets 8, 9 & 10) | Potential Project F: Sediment Mitigation @Industrial Zone (sheets 10 & 11) | Potential Project G: Carriage Hills/ Scott Ponds (sheets 11A-11D) | Potential Project H: Scott Avenue Channel Improvements (sheets 12, 13 & 14) | Potential Project I: Shared Crossings Project (sheets 14 & 15) | Potential Project J: Acquisitions vs Road Realignment (sheets 16 & 17) | Potential Project K: Little Valley Intersection (sheets 17) | Potential Project L: Confluence Area (sheet 17 & 18) | Potential Project EF-1 East Fork above Confluence (sheets 18A to 18C) | Potential Project M: Lower Rockwood Estates (sheets 18, 19 & 20) | Potential Project N: Upper Rockwood Estates (sheets 20, 21, 22 & 23) | Potential Project O: Cheley Camp (sheets 23, 24, 25, 26 & 27) |
| | **OPPORTUNITIES** | | | | | | | | | | | | | | | | | |
| | Existing Conditions: | | | | | | | | | | | | | | | | | |
| | *Ecologic score* | | 2.71 *severely degraded* | 2.65 to 2.71 *severely degraded* | 2.65 *severely degraded* | 2.65 *severely degraded* | 2.5 *severely degraded* | 3.33 *poor* | --- | 2.67 to 3.33 *severely degraded to poor* | 3.25 *poor* | 3.25 *poor* | 5.5 *fair* | 6.25 *fair* | 4.8 to 7.3 *poor to good* | 5.3 to 6.3 *fair* | 2.9 to 5.4 *severely degraded to fair* | 2.3 to 5.4 *severely degraded to fair* |
| | *Flood hazard (based on preliminary 100-yr mapping)* | | *No new structures potentially in 100-yr* | *New structure potentially in 100-yr* | *New structures potentially in 100-yr* | *No new structures potentially in 100-yr* | *New structures potentially in 100-yr* | *No new structures potentially in 100-yr* | *No new structures potentially in 100-yr* | *New structures potentially in 100-yr* | *New structures potentially in 100-yr* | *New structures potentially in 100-yr* | *New structures potentially in 100-yr* | *No new structures potentially in 100-yr* | *no preliminary mapping* | *No new structures potentially in 100-yr* | *No new structures potentially in 100-yr* | *New structures potentially in 100-yr* |
| | *Geomorphic hazard* | | *HIGH: road and trail below Brodie in MVB structures, road, and trail in EHA* | *HIGH: road and trail in MVB structures, road, and trail in EHA* | *VERY HIGH: structures, road, trail in MVB golf course, structures, road, trail in EHA* | *VERY HIGH: structures, trail, golf course in MVB golf course, structures, road, trail in EHA* | *VERY HIGH: structures, trail in MVB structures, road, and trail in EHA* | *HIGH: road, trail, industrial operations in MVB structures, road, and trail in EHA* | *LOW: ponds in MVB* | *VERY HIGH: many structures in MVB more structures, road in EHA* | *VERY HIGH: many structures, road in MVB more structures, road in EHA* | *VERY HIGH: many structures, road, trail in MVB more structures, road, trail in EHA* | *VERY HIGH: many structures, road, trail in MVB* | *LOW: road, trail in MVB road, trail in EHA* | *MEDIUM: road in MVB structure (barn) in EHA* | *LOW: road, trail in MVB road, trail in EHA* | *LOW: road, trail in MVB road, trail in EHA* | *VERY HIGH: structures, driveway, Cheley entrance in MVB; more structures, driveway in EHA* |
| | Problems & Constraints: | | *Potential higher consequence of bridge failure here, emergency access for school, habitat and restoration potential, pre-flood this delta was wetland habitat, BOR owner, preliminary investigations into potential contaminated materials in depositional zone, currently high algal growth due to infiltration/ minimal draining (WQ)* | *avoiding risk tactics, including efforts to keep hgiher risk parcels undeveloped* | *flood widened the corridor, so don't undo it! significant opportunity here to widen corridor, avoid constricting again via hard stabilization along main channel, compound channel, 2-tiered stabilization, trail is proposed high next to road in this reach, opportunity for greater recreation access within widened corridor, break-away bridge for controlled failure (breaks left!), opportunity for kid fishing ponds, push river left off of infrastructure, very strong on multiple benefits* | *alternative access to home on river left (Golf Course responsible for access), alternative to skinny the cul-de-sac, another alternative to shift cul-de-sac downstream where more room on river left exists, conversations on access to river left home have included a crossing off of the cul-de-sac, opportunity to solve dual problems* | *2-tiered stabilization, change from deposition zone (Sep 2013) to transport reach to protect assets downstream, major wetland restoration potential* | *opportunity to trap sediments upstream of long reach of developed area, excavate large wedge on river left to make room for river, possible to maintain industrial operations, potential resale of deposited sands/ gravels, recurrence interval for cleanup is a design detail* | *dams pose a threat to life and safety downstream, may be cost prohibitive to properly stabilize (technially and regulatorily), remove 2 dams and re-establish riparian corridor, excellent wildlife habitat (beaver, moose, ducks, more), wetland complex for stability and habitat, biggest opportunity to get closest to historic, healthy, functional Fish Creek system, historic moose habitat* | *constraints are sewer and homes right against channel biggest challenge due to lack of room, river needs much more space, highly constricted reach with homes close on both sides (B-L higher), 2-tiered stabilization: setback riprap embankment, front line of natural stabilization, compound channel/ bench and terrace* | *road alignment acceptable, landowners here more vulnerable than road on river right, big picture that no crossings on Fish Creek survived Sep floods* | *extremely pinched corridor here, road/ home trade-off, trail and channel shift with road, landowners here more vulnerable than road on river right* | *Potential higher consequence of road failure here, only access for East Fork, switch to infrastructure focus (vs sediment transport upstream), minor road shift to benefit houses, keep trail low concept* | *alluvial fan/ high geomorphic risk, need to preserve confluence area/ keep assets out* | | *similar to N, very highly constricted reach, increased geomorphic risk to structures (EHA) vs N, trail as good inundation zone, pull road off river, offset hardening, trail up on hillslope* | *Potential higher consequence of road failure here, only access for Rockwood, highly mobile reach/ high avulsion potential, propose mainstem with controlled high flow, good beaver area* | *stabilize onsite sediments in-place to protect downstream reaches* |
| | System-wide vs Localized Benefits | | **Systemic** *sediment deposition area to protect Lake Estes, power plant operations* | **Localized** | **Localized** | **Localized** | **Localized** | **Systemic** *sacrificial sediment deposition area to protect long reach of residences downstream* | **Systemic** *reduce breach threat, stabilize onsite sediments to protect long reach of residences downstream* | **Localized** | **Localized** | **Localized** | **Systemic** *reduce potential for road to capture overflows* | **Localized** | **Systemic** *sediment control from mass wasting area, sediment source control in upper watershed to protect downstream* | **Systemic** *sediment attenuation and water quality improvements in upper watershed to protect downstream* | **Systemic** *sediment attenuation and water quality improvements in upper watershed to protect downstream* | **Systemic** *sediment attenuation and water quality improvements in upper watershed to protect downstream* |
| | **COST CATEGORY** | | | | | | | | | | | | | | | | | |
| | Design/ Permitting/ Implementation ($) low end cost range (under $100K) ($$) medium cost range ($100K to $500K) ($$$) high end cost range (over $500K) ($$$$) over $1M | | $$ | $$$ acquisitions, bridge | $$$ acquisitions, bridge | $ | $$$ acquisitions, bridge | $$ | $$$ dam removal | $$$ acquisitions | $$$ acquisition | $$$ acquisitions or road work | $$$ acquisition and road work | $$ | $$ | $$$ road, bridge, conservation easement | $$$ road, bridge, conservation easement | $ |
| | **PROJECT PARTNERS** | | | | | | | | | | | | | | | | | |
| | Funding Partner Potential (improved via conservation esmt.) | | Best (BOR, systemic benefit) | Better selling or transfer of development rights as potential match money - and moves habitable from high to low risk area | Better recreation potential, EVRPD, homeowner interest | Fair | Best (conservation esmt. Potential/ recreation potential) | Best (systemic benefit, potential aggregate sales, transfer development rights, recreation potential) | Best (dam safety, systemic benefit) | Fair | Better (innovative, CDBG-DR interest in funding fewer crossings, transportation-based funding) | Fair | Best (transportation partners, systemic benefit) | Fair | Fair | easement??? | easement??? Recreation??? | easement/ recreation potential |
| | Number of Owners | | Low | low | medium | medium HOA not organized | medium | low | low high on stakeholders | high | medium | high | high | medium | medium | medium | low | low |
| **ID** | **PERSONAL VALUES** *Ranked from survey response* | **Ranking** | | | | | | | | | | | | | | | | |
| 2 | Important for wildlife habitat | 8 | Better | Fair | Fair | Fair | Better | Fair | Best | Fair | Fair | Fair | Fair | Better | Better | Better | Better | Best |
| 1 | Soothing natural aesthetic | 7 | Best | Fair | Fair | Fair | Better | Better | Best | Fair | Fair | Fair | Fair | Better | Better | Better | Better | Best |
| 4 | Supports healthy, native plant communities | 7 | Best | Fair | Fair | Fair | Best | Better | Best | Fair | Fair | Fair | Fair | Better | Fair | Better | Better | Best |
| 8 | Important for water quality, air quality, groundwater replenishment, soil stabilization | 7 | Best | Fair | Fair | Fair | Best | Best | Best | Fair | Fair | Fair | Fair | Better | Best | Better | Best | Best |
| 3 | Bird watching, wildlife viewing | 6 | Better | Fair | Fair | Fair | Better | Better | Best | Fair | Fair | Fair | Fair | Better | Better | Better | Better | Best |
| 9 | Protection/ expect it to not threaten my property | 6 | Fair | Fair | Fair | Fair | Fair | Fair | Fair | Fair | Fair | Fair | Fair | Fair | Fair | Fair | Fair | Fair |
| 7 | Hike along it, fish it, wade in it, skip rocks, build sandcastles, and more | 4 | Fair | Fair | Fair | Fair | Better | Fair | Fair | Fair | Fair | Fair | Fair | Fair | Fair | Fair | Fair | Best |
| 5 | Socializing, source of community pride | 1 | Fair | Fair | Fair | Fair | Fair | Fair | Fair | Fair | Fair | Fair | Fair | Fair | Fair | Fair | Fair | Best |
| 10 | Other: *Road access to Fish Creek Road/ Use of the bike path WRITE IN COMMENT - NOT RANKED* | 1 | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail |
| 11 | Other: *It's home?????? AVOID CAUSING OFFENSE* | 1 | Fair | Fair | Fair | Fair | Fair | Fair | Fair | Fair | Fair | Fair | Fair | Fair | Fair | Fair | Fair | Fair |
| 6 | Important draw for business | 0 | Fair | Fair | Fair | Fair | Fair | Fair | Fair | Fair | Fair | Fair | Fair | Fair | Fair | Fair | Fair | Fair |
| | **EVALUATION CRITERIA** *Ranked from survey response* | | | | | | | | | | | | | | | | | |
| 4 | Allow continued utility service during construction | 135 | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail |
| 6 | Increases river stability, reduces future erosion | 129 | Fair | Better | Better | Better | Better | Best | Best | Better | Best | Better | Better | Better | Better | Best | Best | Best |
| 5 | Reduces flood and geomorphic hazards to reduce future damage | 127 | Fair | Better | Better | Better | Better | Best | Best | Best | Best | Best | Better | Fair | Fair | Better | Better | Better |
| 2 | Restore public access and utility service without restricting access to private properties | 123 | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail |
| 27 | Incorporate input from property owners | 119 | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail |
| 1 | Address safety of the public and residents | 114 | Fair | Best | Best | Fair | Best | Best | Best | Best | Best | Best | Better | Fair | Fair | Fair | Fair | Fair |
| 7 | Improve stream health | 113 | Fair | Better | Better | Better | Best | Better | Best | Better | Best | Fair | Better | Better | Better | Better | Best | Best |

cost, funding partner potential, and number of owners in that reach. A project with funding partner potential and fewer owners is expected to be easier to implement. Finally, the projects are evaluated for their potential to meet the community values, and evaluation criteria which were ranked through the community survey.

| ID | Evaluation Criteria | Ranking | Options Evaluation | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Potential Project A: Delta Park (sheets 1 & 2) | Potential Project B: Van Horn Reach (sheets 3, 4 & 5) | Potential Project C: Stonebridge Reach (sheets 5, 6 & 7) | Potential Project D: Creekside Reach (sheet 8) | Potential Project E: Brook to Country Club (sheets 8, 9 & 10) | Potential Project F: Sediment Mitigation @Industrial Zone (sheets 10 & 11) | Potential Project G: Carriage Hills/ Scott Ponds (sheets 11A-11D) | Potential Project H: Scott Avenue Channel Improvements (sheets 12, 13 & 14) | Potential Project I: Shared Crossings Project (sheets 14 & 15) | Potential Project J: Acquisitions vs Road Realignment (sheets 16 & 17) | Potential Project K: Little Valley Intersection (sheets 17) | Potential Project L: Confluence Area (sheet 17 & 18) | Potential Project EF-1 East Fork above Confluence (sheets 18A to 18C) | Potential Project M: Lower Rockwood Estates (sheets 18, 19 & 20) | Potential Project N: Upper Rockwood Estates (sheets 20, 21, 22 & 23) | Potential Project O: Cheley Camp (sheets 23, 24, 25, 26 & 27) |
| **OPPORTUNITIES** | | | | | | | | | | | | | | | | | | |
| Existing Conditions: | | | | | | | | | | | | | | | | | | |
| 9 | Complete the reconstruction while lowering risk to permanent infrastructure and the public | 102 | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail |
| 24 | Enhance neighborhood & community livability | 99 | Best | Fair | Fair | Fair | Better | Best | Best | Fair | Better | Best | Best | Fair | Fair | Fair | Fair | Best (natural amenity, recreational access?) |
| 8 | Complete projects in the shortest time possible | 98 | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail |
| 37 | Limits maintenance costs | 90 | Fair | Fair | Fair | Fair | Fair | Fair (sediment removal costs) | Best (eliminates dam maintenance, inspection) | Fair | Best | Best | Best | Fair | Fair | Fair | Fair | Best |
| 21 | Enhances *local* natural outdoor recreational opportunities such as trails (hiking ,biking, and equestrian) and fishing | 88 | Fair | Fair | Fair | Fair | Better | Fair | Better | Fair | Fair | Fair | Fair | Fair | Fair | Fair | Fair | Best (recreational access?) |
| 36 | Provides the corridor with multiple benefits (e.g. flood mitigation, habitat enhancements, recreation and public access) | 87 | Best | Better | Better | Better | Best | Best | Best | Better | Best | Best | Best | Better | Better | Best | Best | Best |
| 14 | Incorporates new flood flow/ rainfall information | 85 | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail |
| 20 | Enhances access to neighborhoods | 85 | Fair | Better | Better | Better | Better | Fair | Fair | Better | Best | Fair | Fair | Fair | Fair | Fair | Best | Fair |
| 25 | Enhance neighborhood & community aesthetics | 84 | Best | Better | Better | Better | Best | Best | Best | Better | Best | Fair | Fair | Better | Better | Better | Better | Better |
| 10 | Create infrastructure investments that are reasonable to construct | 83 | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail |
| 12 | Meet Federal and Local standards for design | 83 | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail |
| 11 | Projects with the best value for their life cycle | 82 | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail |
| 13 | Effectively uses undamaged infrastructure | 81 | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail |
| 34 | Protect and enhance stream corridor vegetation | 80 | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail |
| 35 | Enhances water quality | 80 | Best | Better | Better | Better | Best | Best | Best | Better | Fair | Fair | Fair | Fair | Best | Best | Best | Best |
| 28 | Incorporate input from the community | 77 | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail |
| 39 | Uses environmentally friendly processes | 77 | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail |
| 3 | Provide access to recreational amenities, schools, and businesses | 76 | Best (school access) | Better (Van Horn business) | Fair | Fair | Best (recreation) | Fair | Best (recreation) | Fair | Fair | Fair | Fair | Fair | Fair | Fair | Fair | Fair |
| 31 | Protect and enhance fish habitat | 71 | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail |
| 19 | Enhances access to community facilities, and neighborhoods | 67 | Fair | Better | Better | Better | Better | Fair | Fair | Fair | Better | Fair | Best (East Fork access) | Fair | Fair | Fair | Best (Rockwood access) | Fair |
| 32 | Protect and enhance avian habitat | 67 | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail |
| 16 | Provides neighborhood and reach scale solutions requiring multiple land owners to come to consensus | 66 | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail |
| 38 | Uses locally available materials | 63 | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail |
| 29 | Incorporate input from conservation and environmental organizations | 61 | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail |
| 22 | Enhances *regional* natural outdoor recreational opportunities | 59 | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail |
| 15 | Is innovative | 53 | Fair | Fair | Fair | Fair | Fair | Fair | Fair | Fair | Best | Best | Fair | Fair | Fair | Fair | Fair | Best (LID options) |
| 26 | Preserve neighborhood & community culture & history | 52 | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail |
| 23 | Enhances community supported recreation opportunities such as golf, camping and water based activities (canoeing, kayaking, stand up paddleboarding, motorboats, waterskiing etc.) | 48 | Fair | Fair | Fair | Fair | Fair | Fair | Fair | Fair | Fair | Fair | Fair | Fair | Fair | Fair | Fair | Fair |
| 33 | Protect and enhance beaver habitat | 37 | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail |
| 30 | Incorporate input from businesses and business leaders | 36 | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail |
| 18 | Enhances access to tourist destinations | 30 | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail |
| 17 | Enhance tourist destinations | 28 | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail |
| 41 | Maintain current property boundaries | 20 | Better | Better | Better | Better | Better | Better | Better | Better | Fair | Better | Fair | Better | Better | Better | Better | Better |
| 42 | No eminent domain acquisitions | 20 | Better | Better | Better | Better | Better | Better | Better | Better | Better | Fair (potential if no road realign) | Better | Better | Better | Better | Better | Better |
| 40 | Preserve or build property values | 10 | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail |
| 43 | Restore Fish Creek Hiking Trail | 5 | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail | design/ construction detail |




Priority Project - Little Valley Intersection

## 7.4 Prioritized Projects

### 7.4.1 Overview

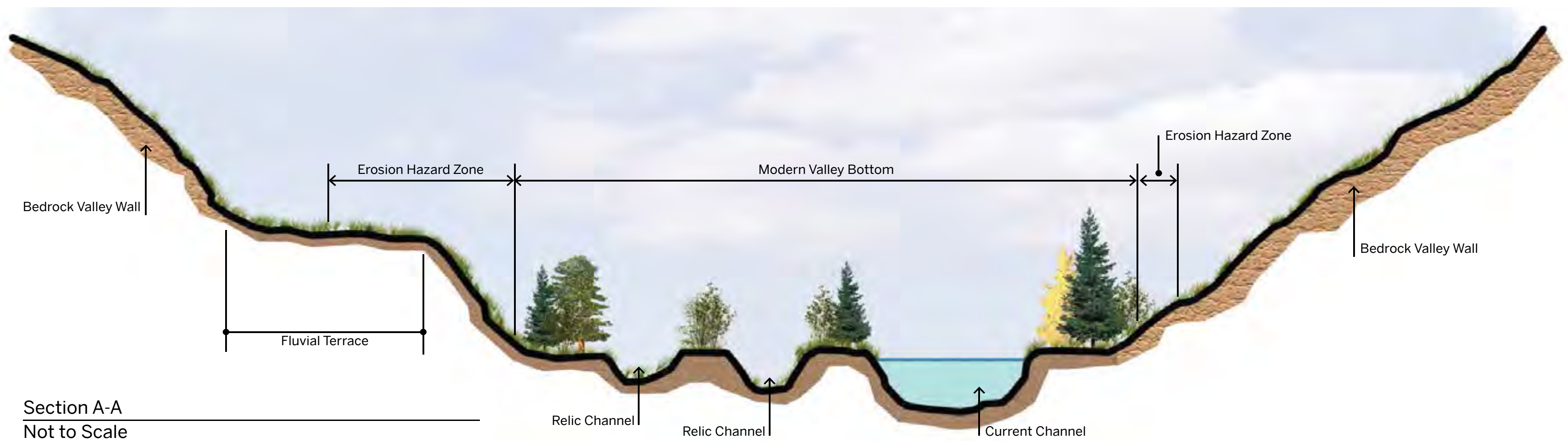
The technical team prioritized the top five projects because they have multiple and large benefits, possibly for the whole river rather than just the specific reach, and also compare favorably in terms of competitiveness for funding and implementation. It should be understood that the technical team recommends implementing all of the projects in order to reduce risk, and increase public and local resident safety. However, as funding is limited the prioritized projects represent the best opportunity to meet the long-term goals for the whole river.

### 7.4.2 Prioritized Project Cut Sheets

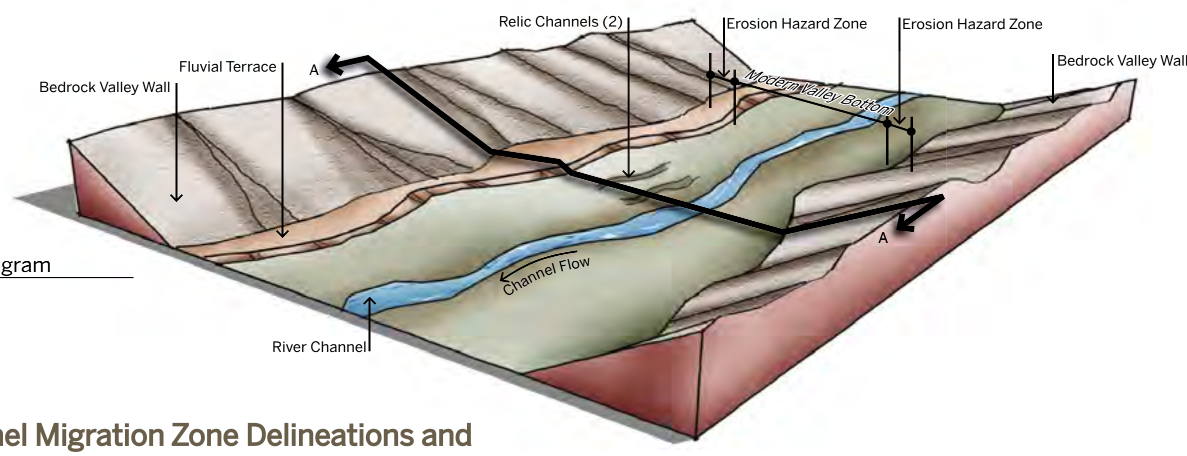
Each prioritized project includes a cut sheet that describes the project in more detail including:

- The objective of the project
- Project benefits for avoided or reduced risk, ecosystem health, and recreation and access
- Implementation and construction strategies
- Permitting requirements
- Construction cost estimate
- Project partners and sponsors (agency, non-profit, landowners, or other)
- Cost-share and funding strategies
- Feasibility and proof of concept analysis

# Project Cut Sheet - CMZ Strategies




Section A-A
Not to Scale




Axonometric Diagram
Not to Scale

### Finalize and Adopt Channel Migration Zone Delineations and Policy

### Objective

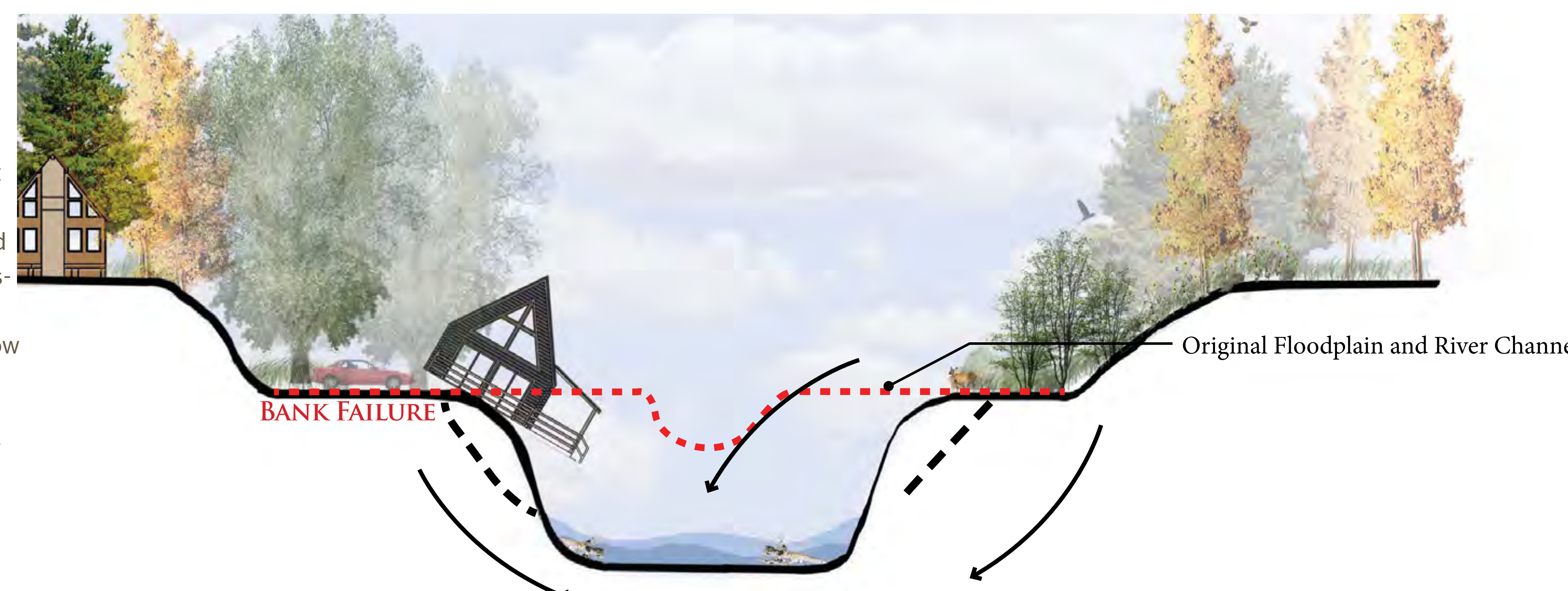
Estes Valley has preliminary Channel Migration Zones delineated for Fall River and Fish Creek. These areas were determined with guidance from the Washington State Department of Ecology's Planning Level Channel Migration Zone Protocol. This project would finalize the delineations, provide a detailed peer-review of the hazard areas, and work with the town of Estes and the Colorado Water Conservation Board to draft and adopt language that influences future development toward low hazard areas.

### Benefits for Avoided or Reduced Risk, Ecosystem Health, and Recreational Access

Limiting investment and asset development within a mapped CMZ hazard area is the most effective strategy to reduce risk and comes with multiple concurrent benefits. See section xx.xxx and section xx.xxxx for details. Identification and management of channel migration zones is intended to reduce flood and erosion damage to public and private infrastructure and homes– all of which may be in jeopardy when and if the channel does meander or avulse. Immediate benefits to the community include providing undeveloped areas for riparian floodplain vegetation and forests to establish. These in turn provide habitat to large mammals such as elk and big horn sheep as well as aquatic species, amphibians, and fish species. They may also provide undeveloped areas for trails and stream access. These areas, under normal runoff conditions may also see overbank flooding which provides measurable benefits to the river system even during times when significant channel movement does not occur.

Management Framework

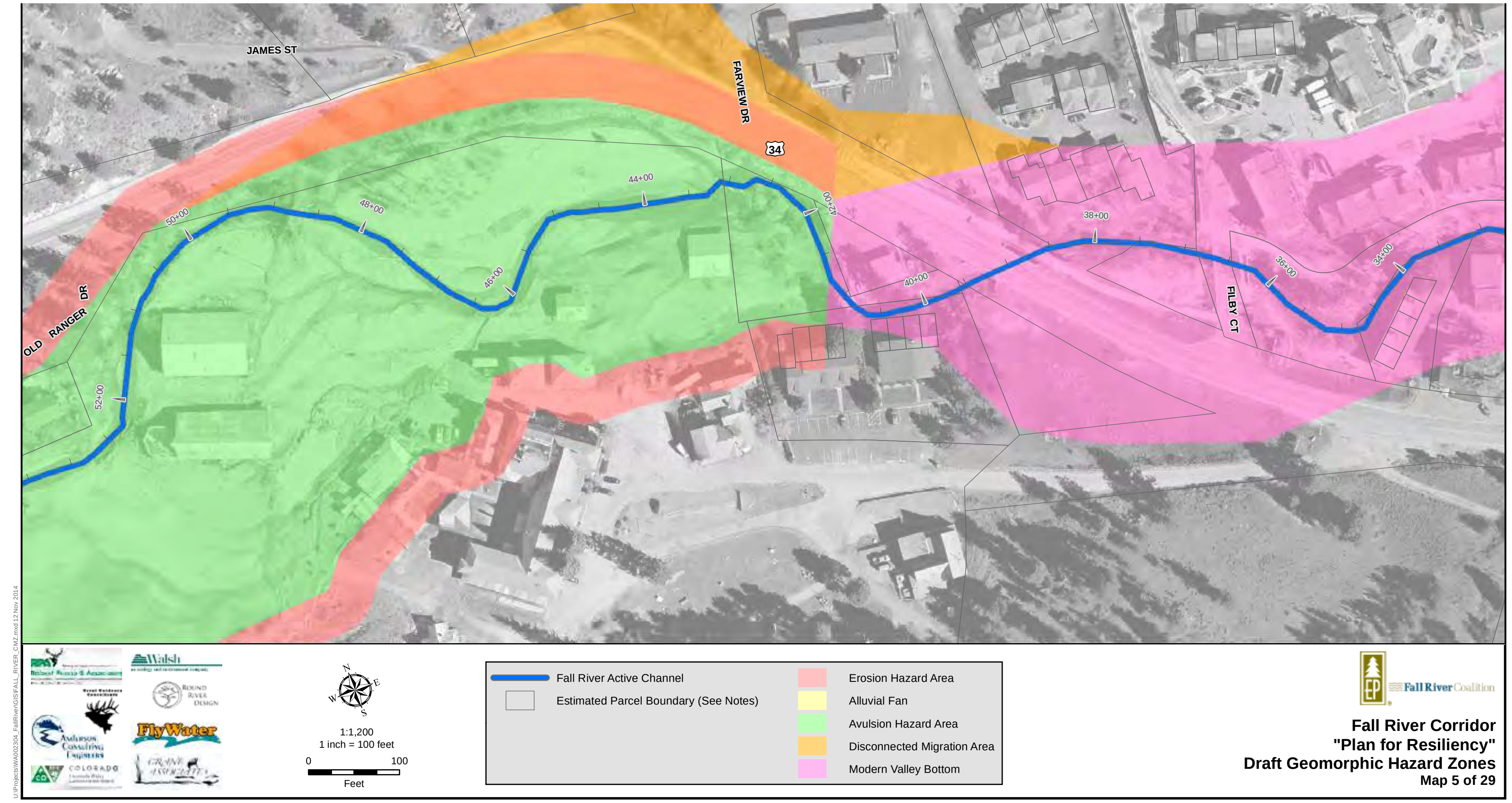
Limiting investment in high hazard zones should be a part of the Town of Estes Park's development code. There may be incentives for the Town of Estes within the National Flood Insurance Program's Community Rating System (see Project xxxx.xx) to adopt and regulate investment in these areas. As applicable, the language can identify characteristics of safe building placement and/or incentives for purchasing flood insurance in



# Project Cut Sheet - CMZ Strategies

1117 Whispering Pines Drive Fish Creek

1117 Whispering Pines Drive Fish Creek




Maintenance, updates, and management of the CMZ maps will be the responsibility of the Town of Estes Park unless otherwise designated to a County or State agency. Public input on the location of the CMZ and its attributes should be solicited for a period of time before adoption but all proposed changes must be reviewed and approved by an experienced river engineer or geomorphologist and the peer review committee. After adoption, further requests to waive conditions set by such a map should be on a case by case basis and require technical review and certification by an experienced river engineer or geomorphologist, any interested state or federal agency, and by the Town itself.

### Project Partners and Sponsors

The State of Colorado's Water Conservation Board will be a key partner in providing technical knowledge to aid in map maintenance and application. There is interest at FEMA and within the Colorado Department of Local Affairs (DOLA) as well as CWCB to use Estes Park as a pilot program for CMZ adoption and regulation which may include technical, policy, and financial support.

### Cost Sharing and Funding Strategies

The State of Colorado's Water Conservation Board will be a key partner in providing technical knowledge to aid in map maintenance and application. There is interest at FEMA and within the Colorado Department of Local Affairs (DOLA) as well as CWCB to use Estes Park as a pilot program for CMZ adoption and regulation which may include technical, policy, and financial support.

### Estimated Cost

The cost to finalize and adopt the channel migration zone mapping is estimated to be approximately 40k-60k.

# Project Cut Sheet - New Flood Insurance Study (FIS)

**Objective and Background**

Floodplain mapping represents an important aspect of the stream restoration master plan, both in terms of informing and regulating development along the river corridor but also in terms of managing risk associated with extreme flood events. The development and utilization of the floodplain mapping products also provide useful information related to the planning and resiliency of the river corridor. The floodplain mapping recommendations associated with this planning project are integrated with channel and overbank improvements to promote the sustainability of the ecological function of the river while minimizing the risk to public infrastructure, adjacent landowners and the public during flooding events.

The effective Larimer County Flood Insurance Study was originally published in 1979 by FEMA and republished on February 6, 2013. Detailed floodplain and floodway mapping along the Fall River within the Town of Estes Park and Larimer County was republished by FEMA with an effective date of December 19, 2013. The effective hydrology data associated with the Flood Insurance Study identified the peak discharge associated with the 100-flood event (1% chance of occurrence) as 680 cfs throughout the length of the study reach.

Following the September 2013 flood event, estimates of the peak discharge in the Fall River were developed in a report for CDOT (Jacobs, August 2014). This information identified a

Fall River Post Flood Damage

Fall River Post Flood Damage

peak discharge of 1,669 cfs for the 100-year flood event. The floodplain mapping associated with this master planning effort reflects the limits of the 100-year floodplain associated with a peak discharge of 1,669 cfs through the study reach and should be considered approximate given the methods and level of detail associated with the work.

**Project Benefits for Avoided Risk, Ecosystem Health, and Recreation and Access**

It is important to identify the risks associated with flooding within the study reach. Utilizing data from the September 2013 flood event along with subsequent reports prepared within the Big Thompson watershed, revised hydrology data and floodplain mapping should be prepared to reflect the limits of the 100-year floodplain associated with: (a) the condition of the channel that presently exists, (b) improvements to the channel subsequent to the flooding event; and (c) improvements proposed by this planning effort, as necessary.

In general, the revised floodplain information combined with the improvements identified in this planning effort will provide benefits to the adjacent landowners and the community as indicated below:

- Awareness of the risk associated with flooding and through knowledge of these risk, benefits accrued to the health, safety and welfare of the landowners, residents in the community as well as visitors will be generated.
- Benefits related to federal flood insurance for those structures located within the 100-year floodplain.
- Location of public infrastructure to promote flood resiliency and avoidance of risk.
- Identification of improvements to connect the channel to the floodplain that also integrate opportunities to increase the ecological function and potential recreation opportunities (trails, fisheries, etc.) along the river corridor.
- Reduction in flood risk associated with improvements in the conveyance capacity of river crossings thereby increasing the safety associated with private or public access.
- Planning and administration of proposed improvements along the floodplain will be facilitated to reduce the flood risk.

**Project Plan (finalize hydrology, HEC-modeling, adoption, etc.)**

As stated previously, revisions to the hydrology data and floodplain mapping will be required to accomplish the objectives associated with the planning document and provide a more flood resilient river corridor within the community. This will include, but not be limited to:

a. Completion of a hydrology study to develop revised data that can be utilized to map the 100-year floodplain along

# Project Cut Sheet - New Flood Insurance Study (FIS)

a. the river corridor.

b. Completion of a floodplain mapping study to illustrate the limits of the revised 100-year floodplain and regulatory floodway along the river corridor. It is assumed that processing of the existing LIDAR mapping will be necessary to meet FEMA criteria along with collection of additional surveying data for channel cross sections and structures.

c. Revisions to information contained in the effective Flood Insurance Study as it pertains to the Fall River.

d. Development of revisions to the digital flood insurance rate maps (DFIRMs).

It is anticipated that a Physical Map Revision will be submitted to support the revisions to the floodplain and floodway. This submittal will include the information described above and will be reviewed and approved by CWCB, and FEMA in accordance with the procedures and regulations established by the State of Colorado and FEMA. Following the approval of the information by the agencies, an opportunity for the community to review and appeal the results of the revised floodplain information will be provided.

**Project Partners and Sponsors**

The study limits associated with the revised floodplain mapping encompass the jurisdictions within the Town of Estes Park and Larimer County. It is anticipated that both jurisdictions will be involved in the review of the revised floodplain mapping information as well as the implementation of projects along the river corridor.

**Estimated Cost**

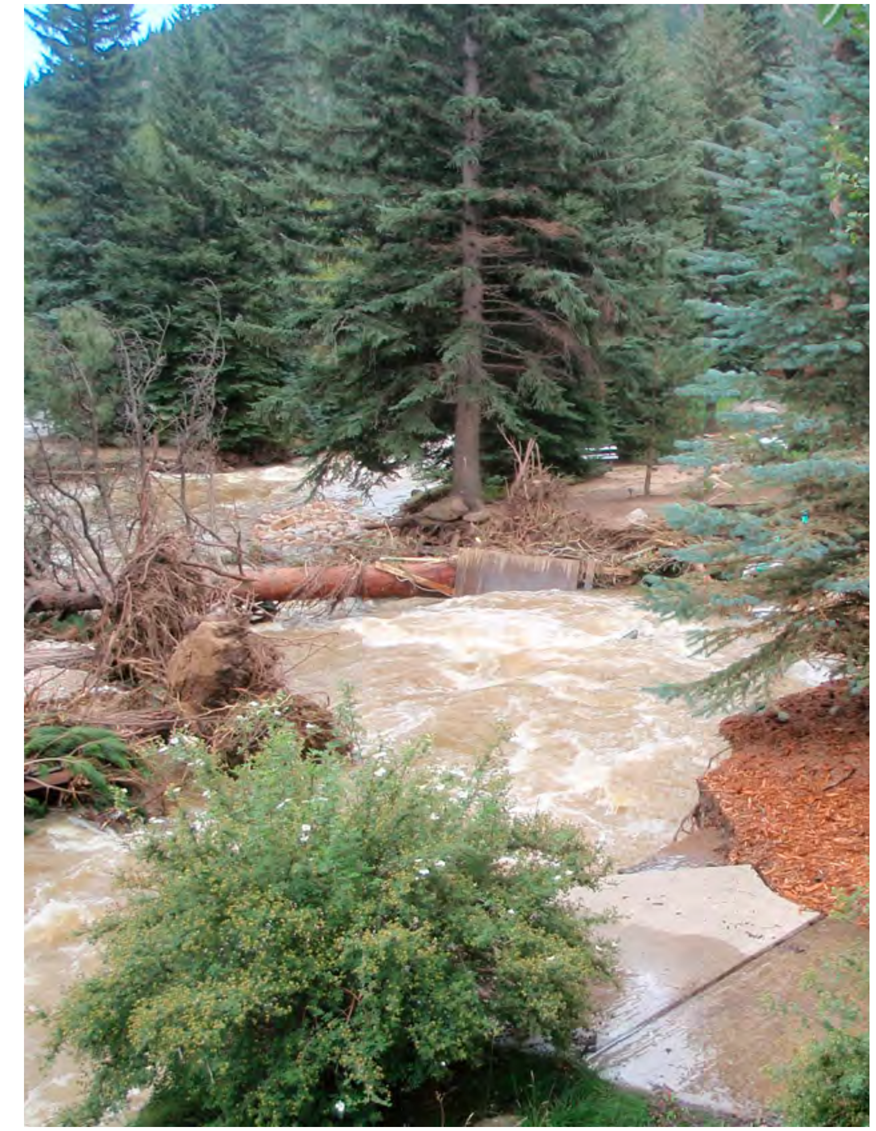
A preliminary cost estimate was prepared to complete the revisions to the floodplain mapping along the Fall River Corridor. It is assumed that the study reach defined by the limits of the effective floodplain mapping (encompassing 5.03 miles) will be revised. The reach can be generally described as the confluence with the Big Thompson River upstream to the Rocky Mountain National Park boundary near Fish Hatchery Road. In this reach, the effective floodplain modeling/mapping includes 35 structures and one overflow path. Based on an initial review of the existing information, additional structures will likely be incorporated into the revised mapping as well as an additional overflow path.

Give the information discussed above, the cost estimate is itemized below:

- Revised hydrology study
  $30,000
- LIDAR processing and mapping/surveying
  $22,000
- Revised floodplain and floodway modeling/mapping
  $50,000
- Revised FIS report/DFIRMs/documentation
  $12,000

**Cost Sharing and Funding Strategies**

Funding for the revisions may include contributions from the Town of Estes Park, Larimer County, and the CWCB. CWCB offers several programs for potential funding which may include: (a) Flood Recovery Grant Program, (b) Flood and Drought Response Fund, and (c) grants related to flood assessment, feasibility, design and planning. FEMA may also be a funding source depending on the availability of funds for new floodplain mapping studies. Other funding sources administered though the Colorado Department of Local Affairs in conjunction with the U.S. Department of Housing and Urban Development may be available (CDBG-DR funds).



Fall River Post Flood Damage

# Project Cut Sheet - River Corridor Strategies

**Create a River Corridor Protection Program**

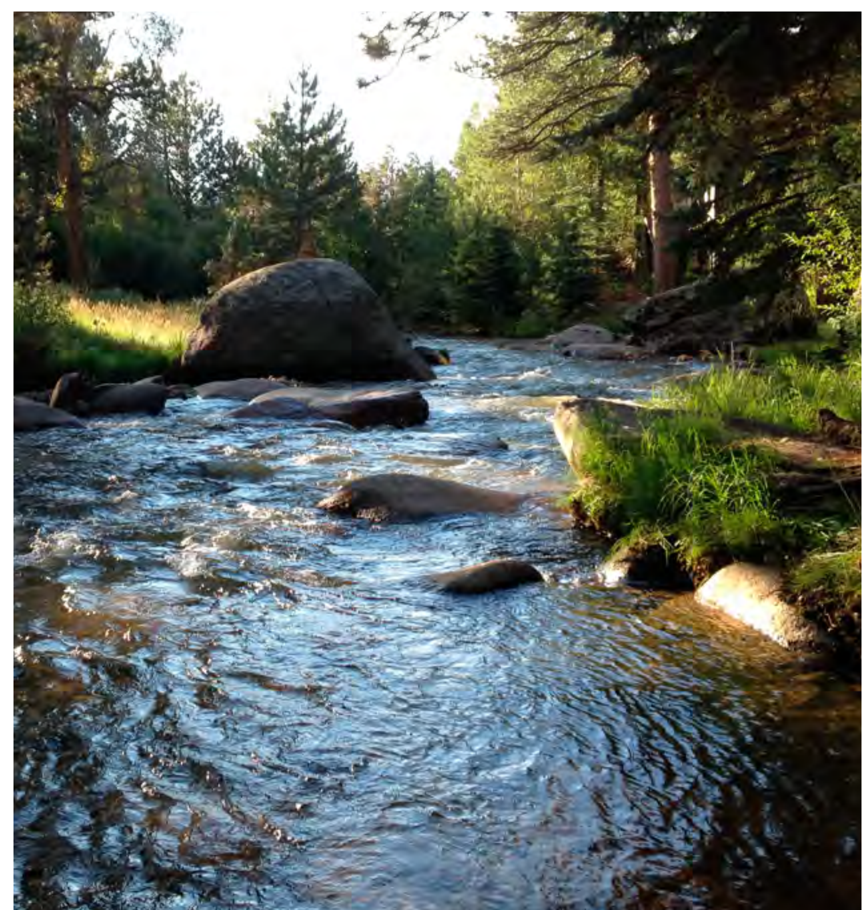
**Objective**
The best means to protect life and property as well as promote healthy riparian ecosystems is to protect and preserve the land that has yet to be developed. A "river corridor" is the swath of land surrounding a river where dynamic system processes, under a broad range of flow conditions, can occur providing for long-term geophysical stability and biological health. The ultimate objective would be to create a continuous, connected river corridor throughout the whole system, including tributaries.

**Benefits for Avoided or Reduced Risk, Ecosystem Health, and Recreational Access**
Limiting investment and asset development, as well as reclaiming assets at the end of their lifespan that currently exist within the river corridor is the most effective means to reduce risk within the river systems. Although primarily intended to avoid future flood damage, the river corridor, will benefit the community immediately by providing undeveloped areas for riparian floodplain forests and habitat. They may also provide undeveloped areas for trails and stream access. These areas, under normal runoff conditions may also see overbank flooding (providing benefits to the river system) during times when significant channel movement does not occur but floodplain/river interactions are none the less important.

**Management Framework**
The river corridor can be approximated by the CMZ delineations; however, it should not be limited to only those high and moderate risk areas. Any property that is adjacent to or within the vicinity of the CMZ delineation should be considered for inclusion under this program.
There are several ways to limit investment in and remove assets from the river corridors within the Estes Valley:
*Conservation Easements*
A "conservation easement" is a legal agreement between a landowner and a land trust or government agency that permanently limits uses of the land in order to protect its conservation values. It allows landowners to continue to own and use their land, and they can also sell it or pass it on to heirs. Conservation easements offer great flexibility. An easement may apply to all or a portion of the property, and need not require public access.

When a conservation easement is donated to a land trust, some of the rights associated are surrendered with the land. For example, you might give up the right to build additional structures, while retaining the right to recreate on the land. The easement is in perpetuity-- future owners also will be bound by the easement's terms. The land trust is responsible for making sure the easement's terms are followed. This is managed through "stewardship" by the land trust which includes annual (or more frequent) site visits to assure that easement terms are being upheld, and corrective actions which can include litigation if violations are detected.

Estes Valley Land Trust has volunteered to host any river corridor conservation easements. The EVLT is a nationally accredited land trust with over 27 years of experience "preserving and protecting open space, valleys, wetlands, streams, ranch lands, and wildlife habitat in the Estes Valley." The proposed conservation easement lands that are included in these Master Plans are well within the mission of the Land Trust. As detail plans and implementation projects are developed, EVLT welcomes the opportunity to work with the implementation teams to protect the critical conservation values of the Estes Valley watersheds.


A Healthy Fall River Corridor

*Transfer of Development Rights*
Section forthcoming.

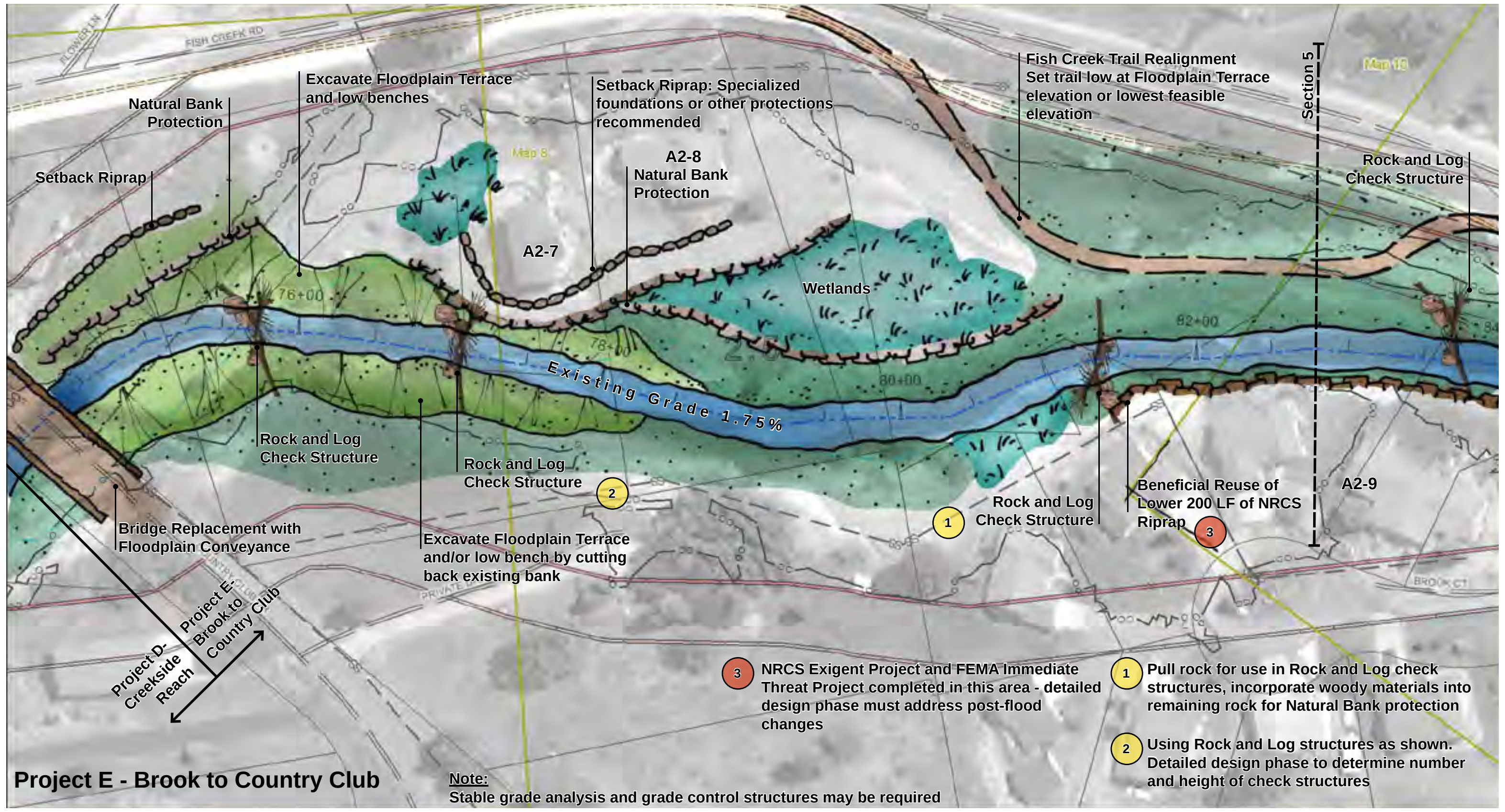
*Voluntary Fee and Title Acquisitions*
Section forthcoming.

**Project Partners and Sponsors**
The River Corridor Program is most likely to succeed if spearheaded by the Estes Valley Watershed Coalition with the Estes Valley Land Trust, the Town of Estes Park and Larimer County as strong partners. Each property that participates in this program will require unique conditions and terms that fit the goals and objectives of the sponsoring entities and the property owners.

**Cost Sharing and Funding Strategies**
It is recommended that the program's administration work be included as a task within the Watershed Coordinator or Watershed Coordinator Assistant job descriptions. Costs to cover properties for inclusion will need to be covered by programmatic grant funding such as DOLA's DR planning grants, HMGP grants, and/or a combination of other grant or general budget funding sources.
**Estimated Cost**

The cost to administer the program is estimated to be approximately $10,000-$20,000 a year. The cost of property inclusion will vary widely depending on the individual property and the legal means that are used to ensure protection. Reclamation, demolition, and/or restoration costs are also expected to vary widely depending upon the individual property's characteristics.

# Project Cut Sheet - Brook to Country Club




Brook to Country Club Reach

### Project Objective

The Brook to Country Club Project objectives are 1) restore lost sinuosity to the channel, which will reduce the overly steep gradient and increase soil saturation for wetlands, 2) create complex channel cross sections, which will include low bench areas for frequent and controlled seasonal floodplain access, 3) re-establish a diverse native vegetation and restore the natural wetland complex located in this area pre-flood, 4) reduce flood and geomorphic hazards to protect adjacent infrastructure and homes by working at outer boundaries of the river corridor to maximize flow and transport conveyance, and 5) enhance the user experience for the Estes Valley Recreation and Park District (EVRPD) Fish Creek Trail in this area by building boardwalk-style trail extensions into the wetlands for a more intimate experience of the riparian area.

Brook to Country Club Reach

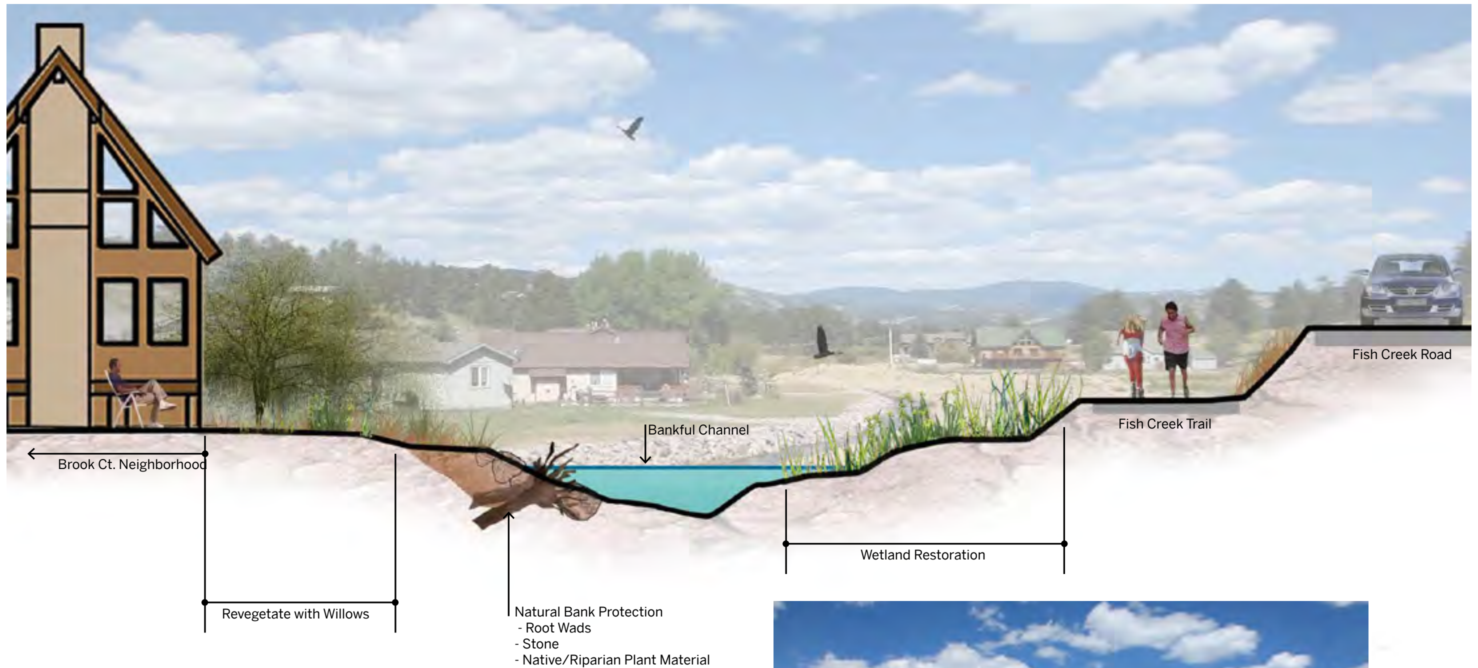
### Physical Layout

This project will realign and restore flow and sediment transport to the Fish Creek corridor reach from Brook Drive to Country Club Drive.

### Project Benefits

This project will start the recovery of the wetland ecosystem in this reach, reduce the flood hazard to the adjacent homes and roads. It will also enhance the recreational experiences in the Fish Creek corridor.

# Project Cut Sheet - Brook to Country Club




Fish Creek Cross Section 5
Looking Downstream
Not to Scale

Post Flood Image
Looking Downstream

Brook to Country Club Reach

**Project Partners**

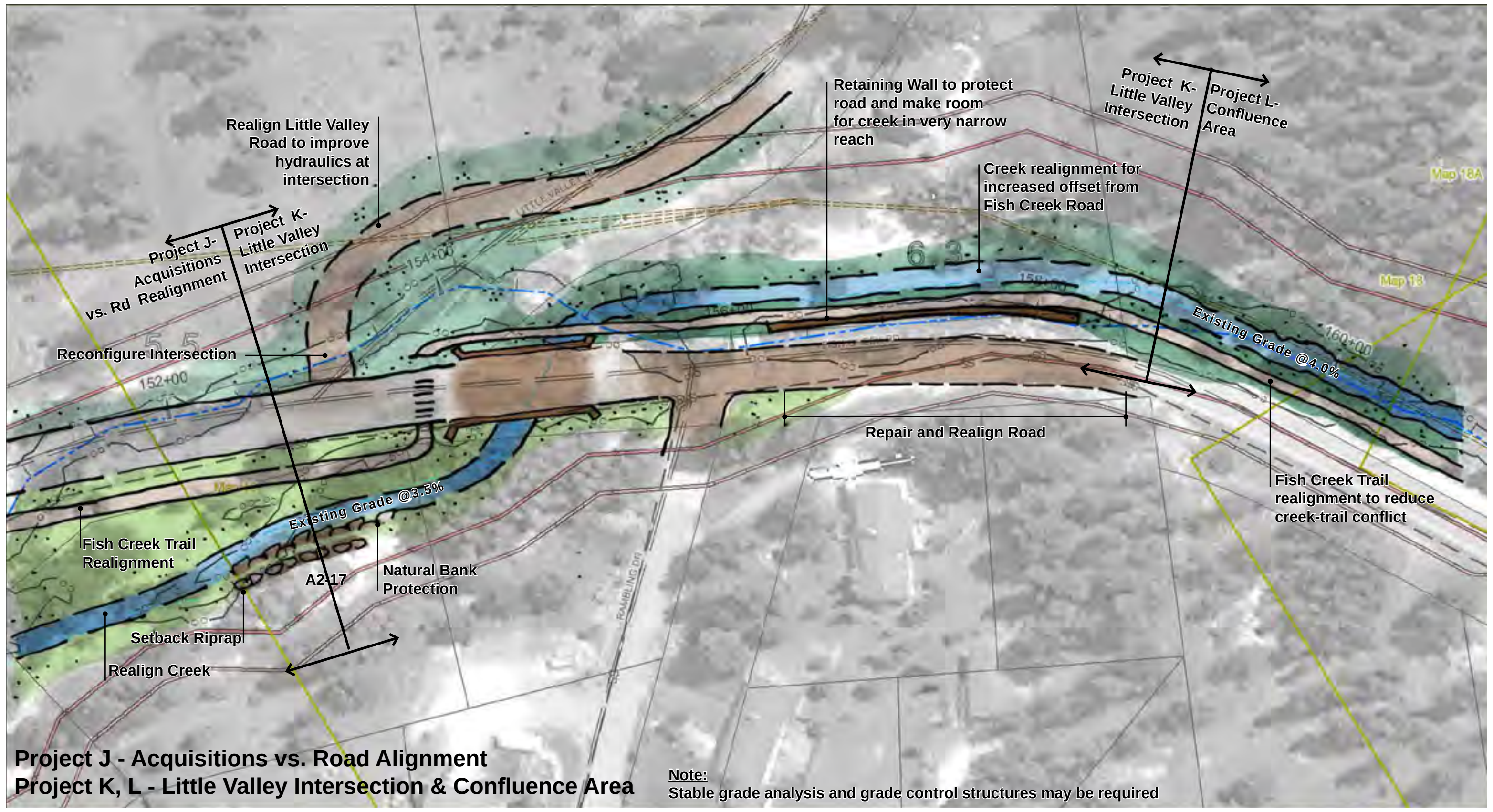
Potential project partners for Brook to County Club are the Town of Estes Park Community Development Department, Estes Valley Land Trust, Estes Valley Recreation and Park District, and the property owners within the reach.
Cost Share and Funding Strategies
This funding for this project can be supported through a variety of local, state, and federal grants, along with financial and in-kind support from the local project partners. Potential funding sources include:

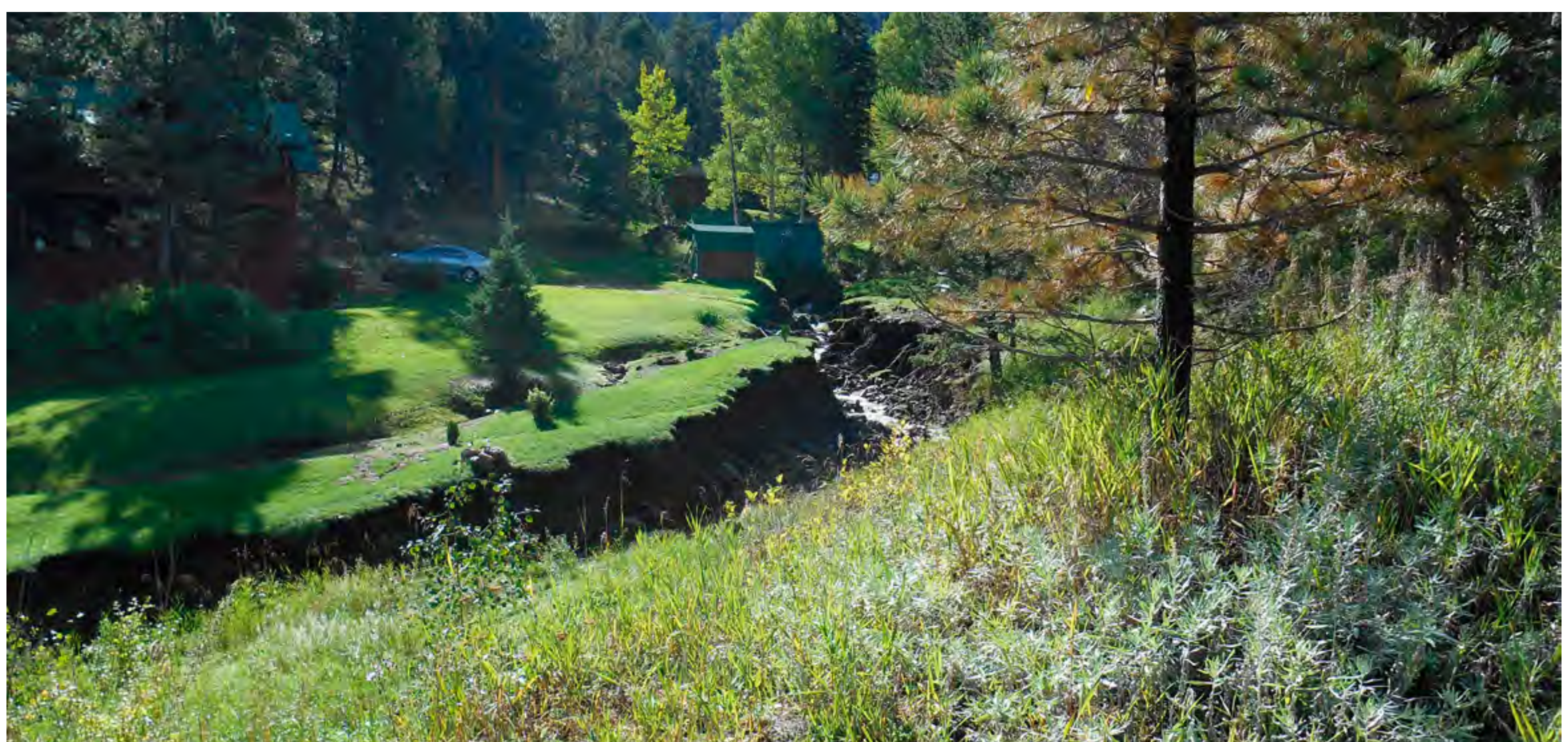
- GOCO Grant- Estes Valley Riparian Restoration Project,
- Community Foundation of Northern Colorado- Flood Recovery Funds
- Funds from Estes Valley Recreation and Park District for Trail Rebuilding
- FEMA Public Assistance to the Town of Estes Park Public Works for Trail Rebuilding Larimer County Open Lands
- GOCO Fall Grant Cycle for Land Conservation and Trails Restoration along Fish Creek
- SB 14- 179 Funding

## Construction Cost Estimate

| | |
|---|---|
| Fish Creek Trail Realignment | $15,000.00 |
| Rock and Log Check Structures | $40,000.00 |
| Wetlands | $15,000.00 |
| Reuse NRCS Rip Rap | $25,000.00 |
| Setback Rip Rap | $40,000.00 |
| Natural Bank Protection | $25,000.00 |
| Bridge Replacement on Country Club Drive w/ Floodplain Conveyance | $2,000,000.00 |
| Excavate Floodplain Terrace/ Low Flow Benches | $40,000.00 |
| Flood Proof Foundations | $150,000.00 |
| **Grand Total** | **$2,350,000.00** |

# Project Cut Sheet - Little Valley Intersection



Little Valley Intersection Club Reach

### Project Objective

The project objective for the Little Valley Intersection project is to create a better alignment with Fish Creek, Fish Creek Rd., and Little Valley Rd. in order to better convey flows, sediment and debris. In turn, this should reduce the hazard to infrastructure and housing during large and small flood events. This area has a particularly poor creek alignment which has the potential to causes systemic damage upstream and downstream. It is a public safety hazard and a severe impediment to emergency services should the creek flank the existing bridge which is likely to occur in its current condition. This project also presents an opportunity to increase stream health by providing the river with a wider corridor. The project specifically recommends:

- Realigning Little Valley Rd. at the intersection with Fish Creek Rd. to improve the hydraulics in the creek and the visibility at the intersection.
- Realigning Fish Creek away from Fish Creek Rd to increase the offset upstream of the bridge.
- Adding a retaining wall between Fish Creek and Fish Creek Rd. Upstream of the bridge.
- Realigning Fish Creek Trail to reduce the creek-trail conflict.
- Realigning Fish Creek downstream and through the bridge to improve local hydraulics and sediment transport.

Little Valley Intersection Reach

# Project Cut Sheet - Little Valley Intersection

Little Valley Intersection Club Reach

Little Valley Intersection Club Reach

**Physical Layout**

The project is located at the intersection of Little Valley Rd. with Fish Creek Rd. The creek stationing is approximately 153+00 through 159+00 shown on Map 17 of the concept designs.

**Project Benefits**

The primary benefits of the project are reduced flood and geomorphic risk to vital road infrastructure in the project area, and improved public safety. The project will provide benefits for the creek by providing a larger and more secure river corridor.

**Project Partners**

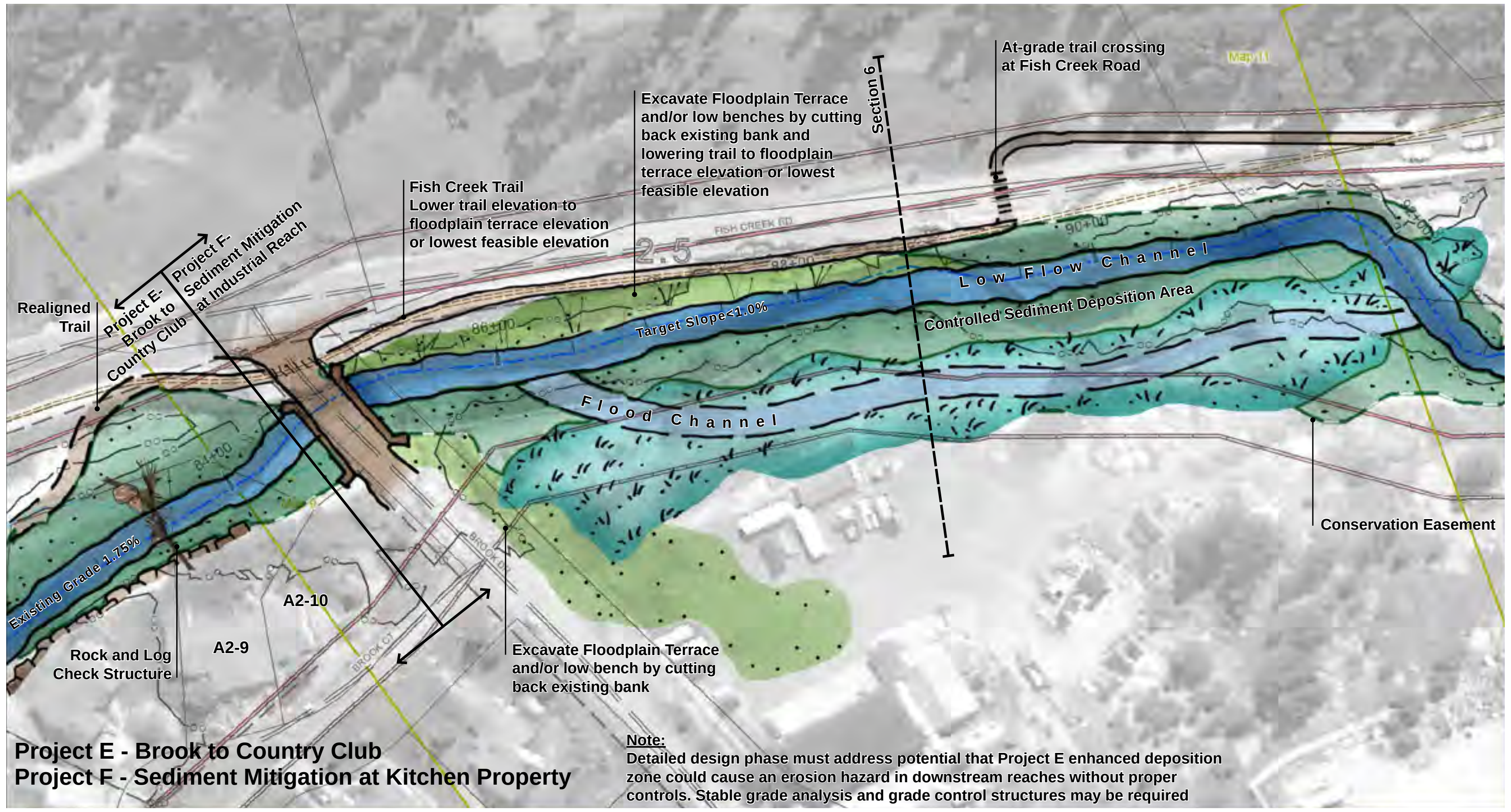
Potential funding partners for Little Valley intersection include city and county transportation entities.

**Cost Share and Funding Strategies**

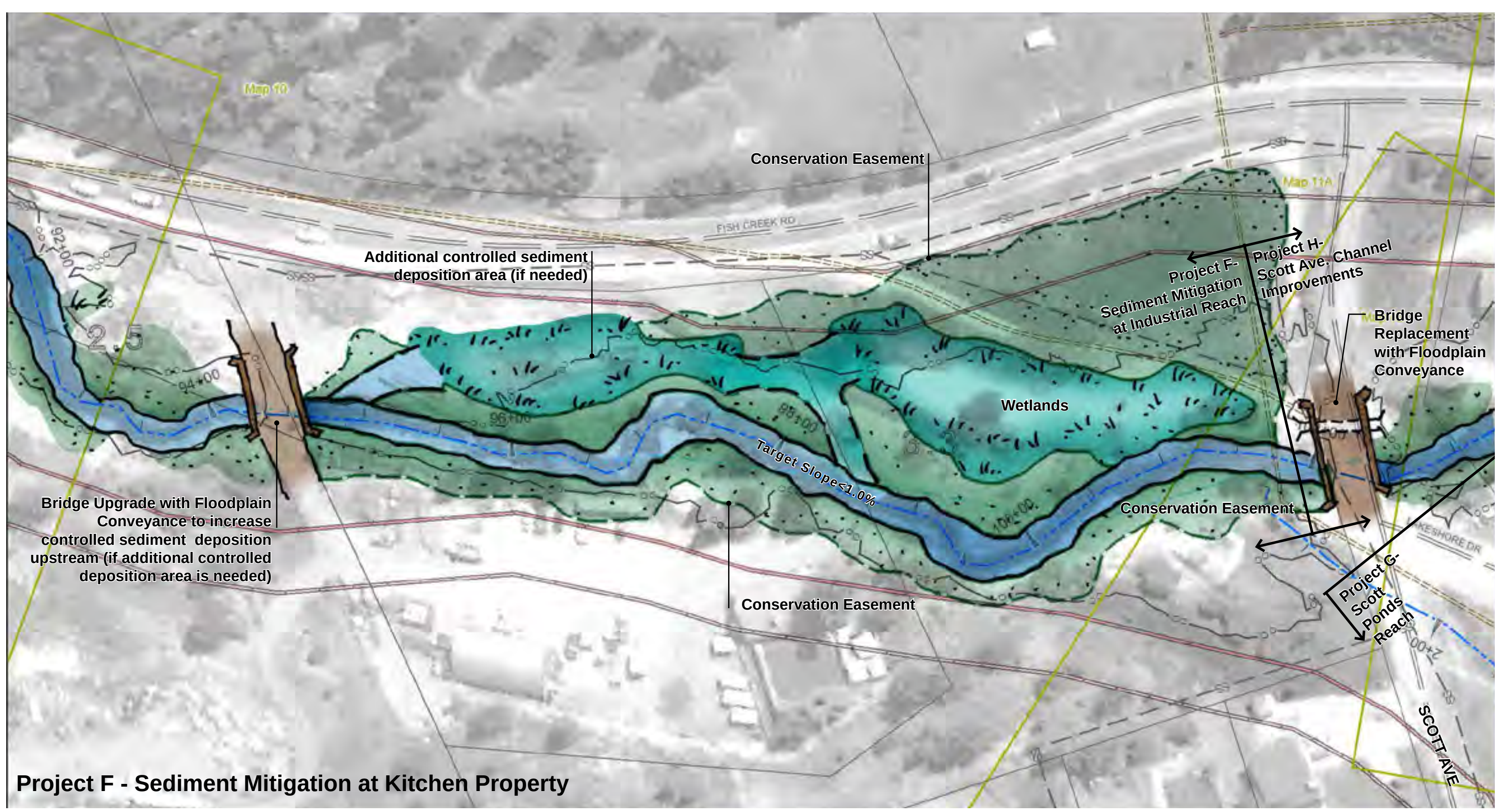
The intersection of Little Valley Road and Fish Creek Road lies within Larimer County and the county would need to be a strong partner in the project. Additionally, Fish Creek Road, which has the bridge that is proposed for an upgrade, is under FHWA jurisdiction which could potentially bring federal funding.

| **Construction Cost Estimate** | |
|---|---|
| Repair and Realign Fish Creek Road | $250,000.00 |
| Realign Little Valley Road | $100,000.00 |
| Reconfigure Intersection | $100,000.00 |
| Additional Bridge for Trail/ Fish Creek Crossing | $150,000.00 |
| Crosswalk on Little Valley Road for Fish Creek Trail | $15,000.00 |
| Realign Fish Creek Trail | $15,000.00 |
| Retaining Wall | $300,000.00 |
| **Grand Total** | **$930,000.00** |

# Project Cut Sheet - Sediment Mitigation at Industrial Site




Sediment Mitigation at Kitchen Property Resiliency Ideas




### Project Objective

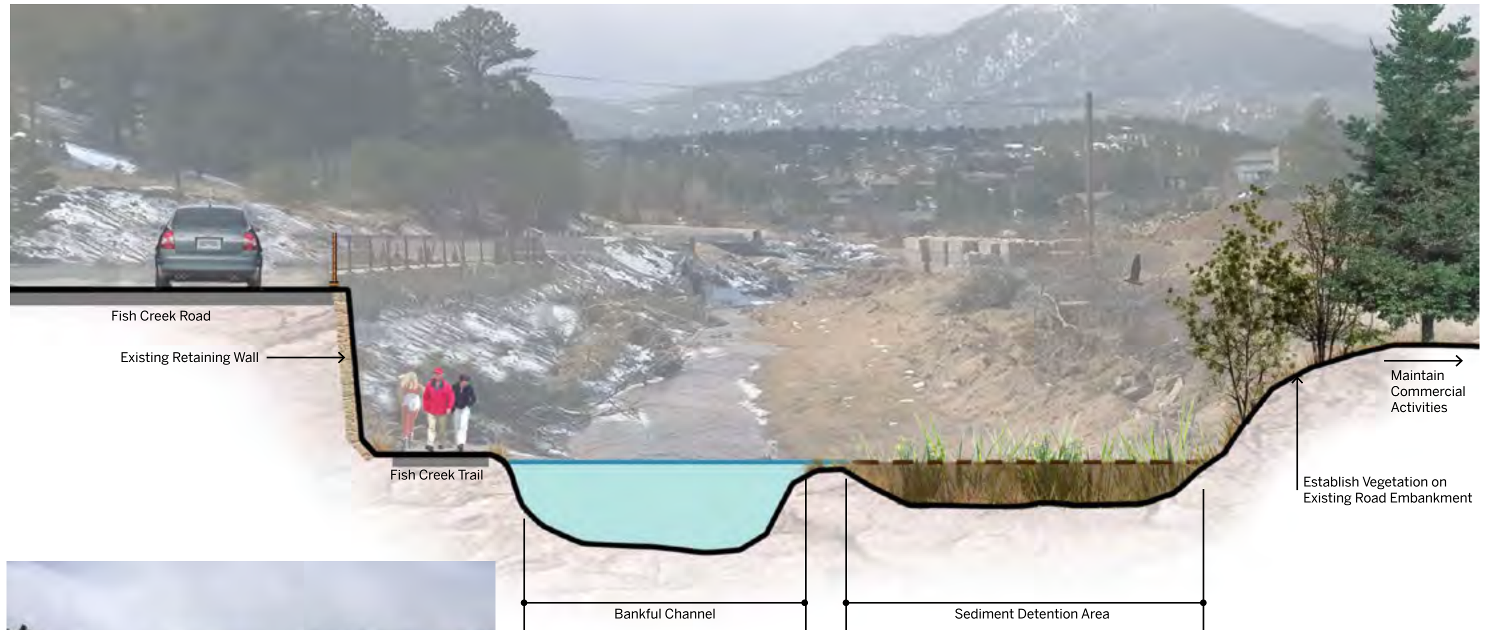
The objective for the Sediment Mitigation at the Industrial Site project is to provide a sediment deposition zone upstream of the long residentially developed reach in order to reduce deposition and loss of flow conveyance capacity in these vulnerable areas. The project includes transferring development rights in the river corridor, adding grade control to promote appropriate sediment deposition, and creating zones for safe sediment deposition. Project elements also include excavation of a floodplain terrace or low benching, the addition of a flood conveyance channel, and increasing flood conveyance for the private bridge to 1901 Fish Creek Road.

### Physical Layout

The project extents are from Scott Avenue Bridge upstream to Brook Drive Bridge downstream, and include the width of the river corridor high hazard area. Scott Avenue Bridge is not included in the project extents. The project will create several sediment holding areas, will flatten grade through the site by increasing sinuosity and building grade control structures, and will increase roughness by re-establishing woody riparian vegetation.

Industrial Lots

# Project Cut Sheet - Sediment Mitigation at Industrial Site




Fish Creek Cross Section 6
Looking Upstream
Not to Scale

Post Flood Image
Looking Upstream

Industrial Lots

### Project Benefits

This project provides system-wide benefits for reducing flood and geomorphic hazards to downstream residential properties. The project will also improve water quality for the reach. The project could also include the resale of deposited sand and gravel in the reach.

### Implementation and Construction Strategies

No specific implementation and construction strategies are available for this project.

### Permitting Requirements

No exceptional permitting requirements are expected.

### Project Partners

Potential project partners include the local property and business owners, and the Town of Estes Park.

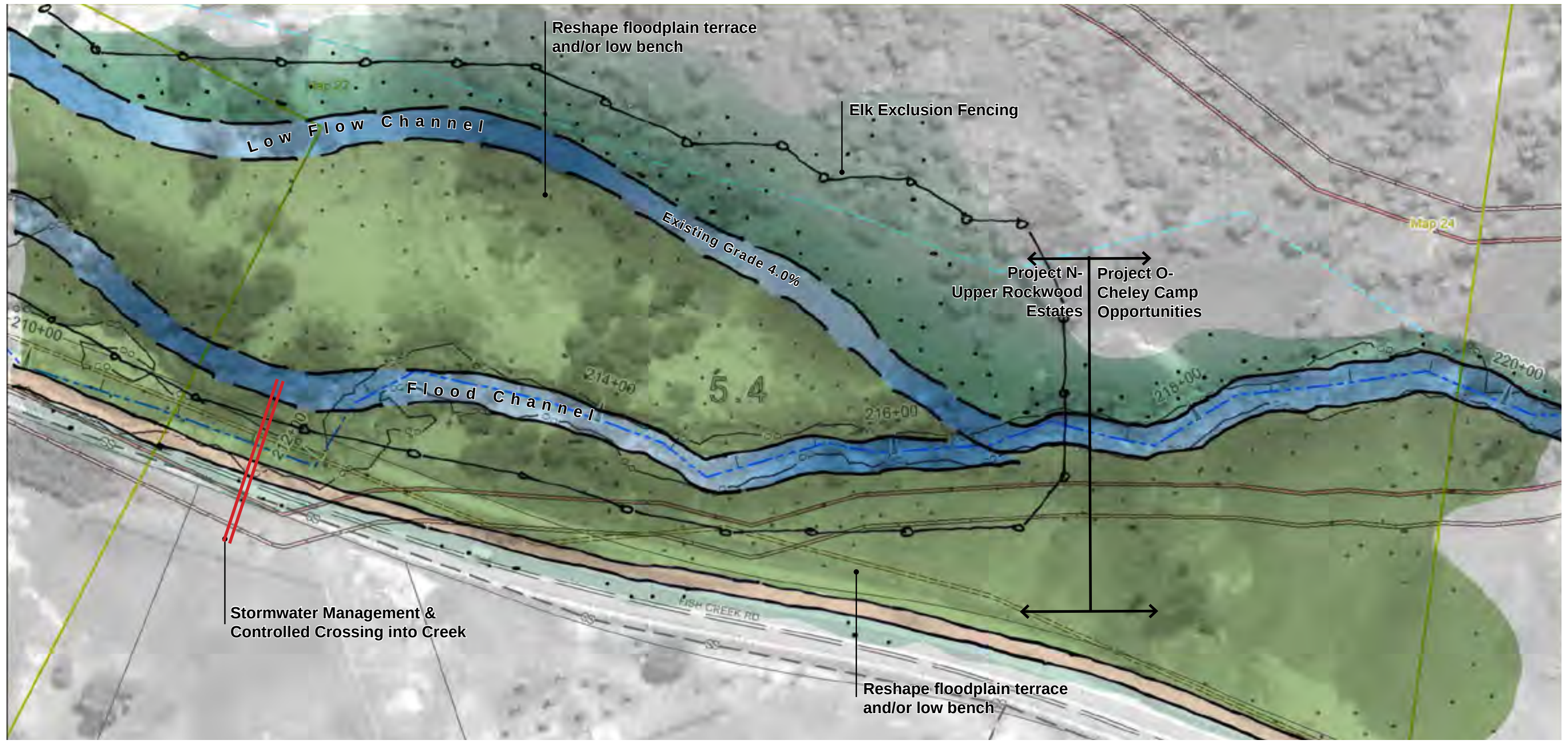
### Cost Share and Funding Strategies

Funding for the project could include a possible conservation easement in the river corridor. And long-term funding could be generated by the resale of deposited sand and gravel in the reach.

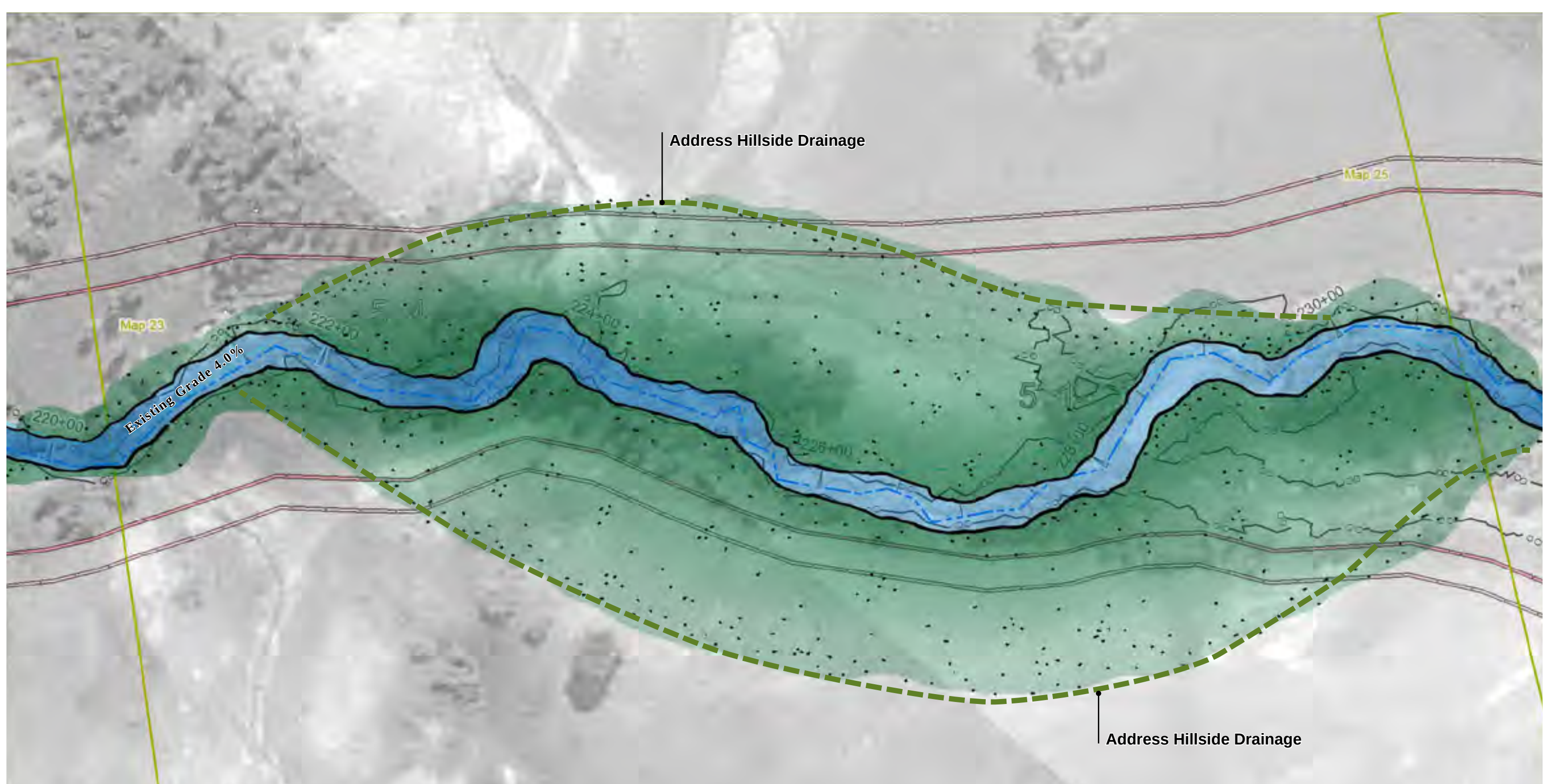
### Construction Cost Estimate

| | |
|---|---|
| Bridge Replacement w/ Floodplain Conveyance on Fish Creek Rd | $2,000,000.00 |
| Bridge Replacement w/ Floodplain Conveyance on Brook Dr | $2,000,000.00 |
| Grade control | $50,000.00 |
| Excavate Floodplain Terrace/ Low Flow Benches | $50,000.00 |
| Low Flow Channel | $65,000.00 |
| Flood Channel | $35,000.00 |
| Conservation easement | |
| Sediment Deposition Area | $200,000.00 |
| Lower Fish Creek Trail to Floodplain Terrace Elevation | $25,000.00 |
| Crosswalk on Fish Creek Road for Fish Creek Trail | $15,000.00 |
| Crosswalk on Brook Drive for Fish Creek Trail | $15,000.00 |
| **Grand Total** | **$4,455,000.00** |

# Project Cut Sheet - Cheley Camp




Cheley Camp Resiliency Ideas




### Project Objective

The Cheley Camp area is an opportunity to provide systemic water quality improvements and geomorphic stability and local habitat benefits in the upper reaches of Fish Creek through relatively low cost techniques. The objectives of the project are to stabilize the existing sediments in place to protect downstream reaches from sediment loading, reduce grazing impacts to improve water quality, and improve the bridge crossing at Rockcreek Road. The specific techniques for the project include:

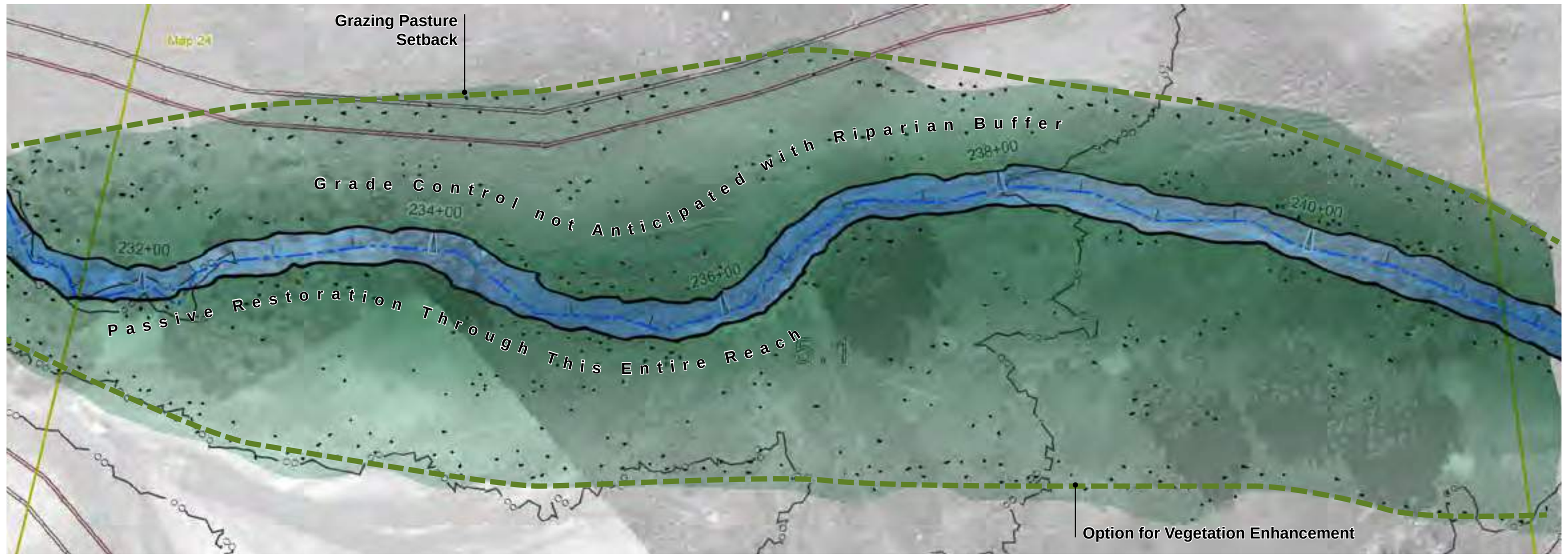
- Adding fencing along Fish Creek to create a grazing pasture setback.
- Adding vegetation to stabilize the banks and onsite sediment.
- Upgrade Rockcreek Bridge.
- Addressing hillside drainage and drainage from the adjacent road-ways.

### Physical Layout

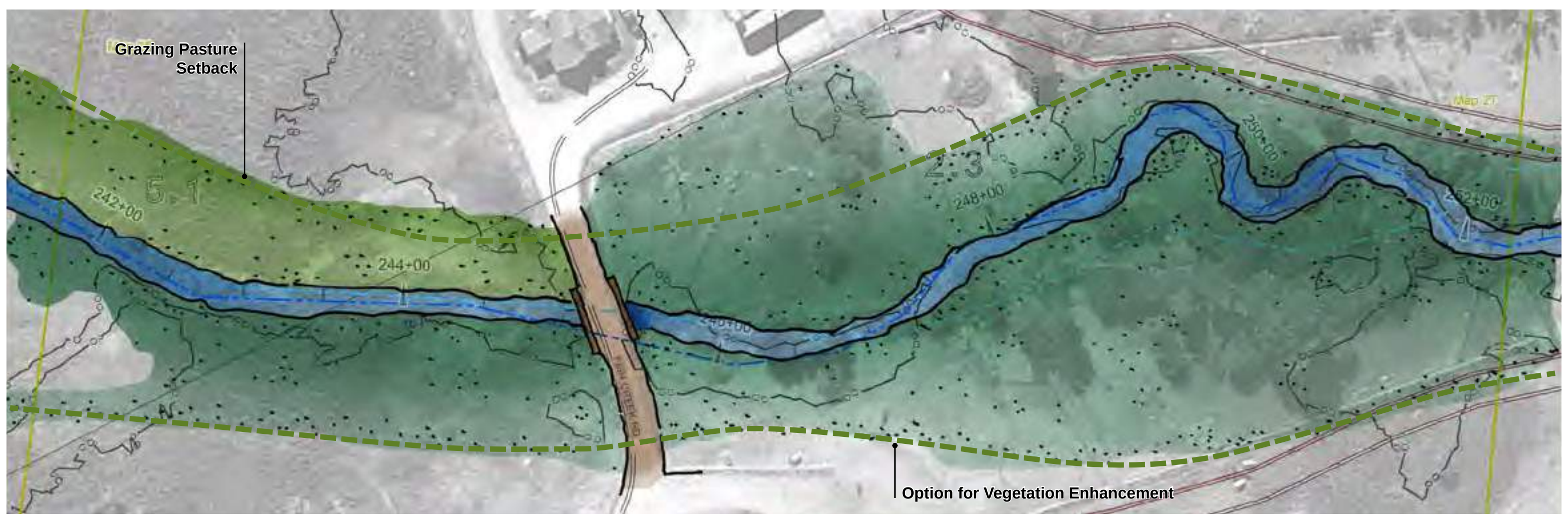
The project boundaries are Fish Creek stations 217+00 to 263+00 (Rockwood Bridge) and includes the surrounding riparian area and portions of the grazing area. The project is shown on Maps 23 through 27 on the concept designs.

Cheley Camp Reach

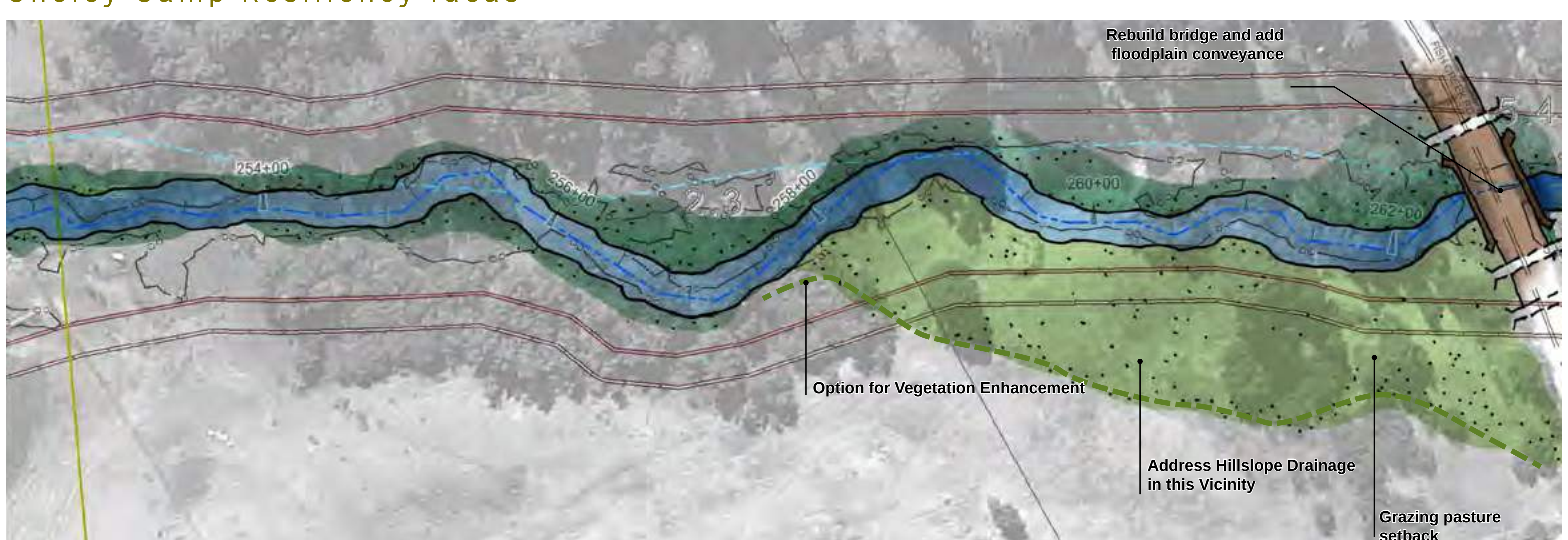
# Cheley Camp- Project Cut Sheet




Cheley Camp Resiliency Ideas




Cheley Camp Resiliency Ideas




**Project Benefits**

The Cheley Camp project provides systemic water quality and sediment control benefits for the downstream reaches. It can also increase stream health and increase wildlife habitat.

**Project Partners**

Local project partners could include city or county entities that are interested in sediment source control to reduce downstream bridge maintenance and Cheley Camp.

**Cost Share and Funding Strategies**

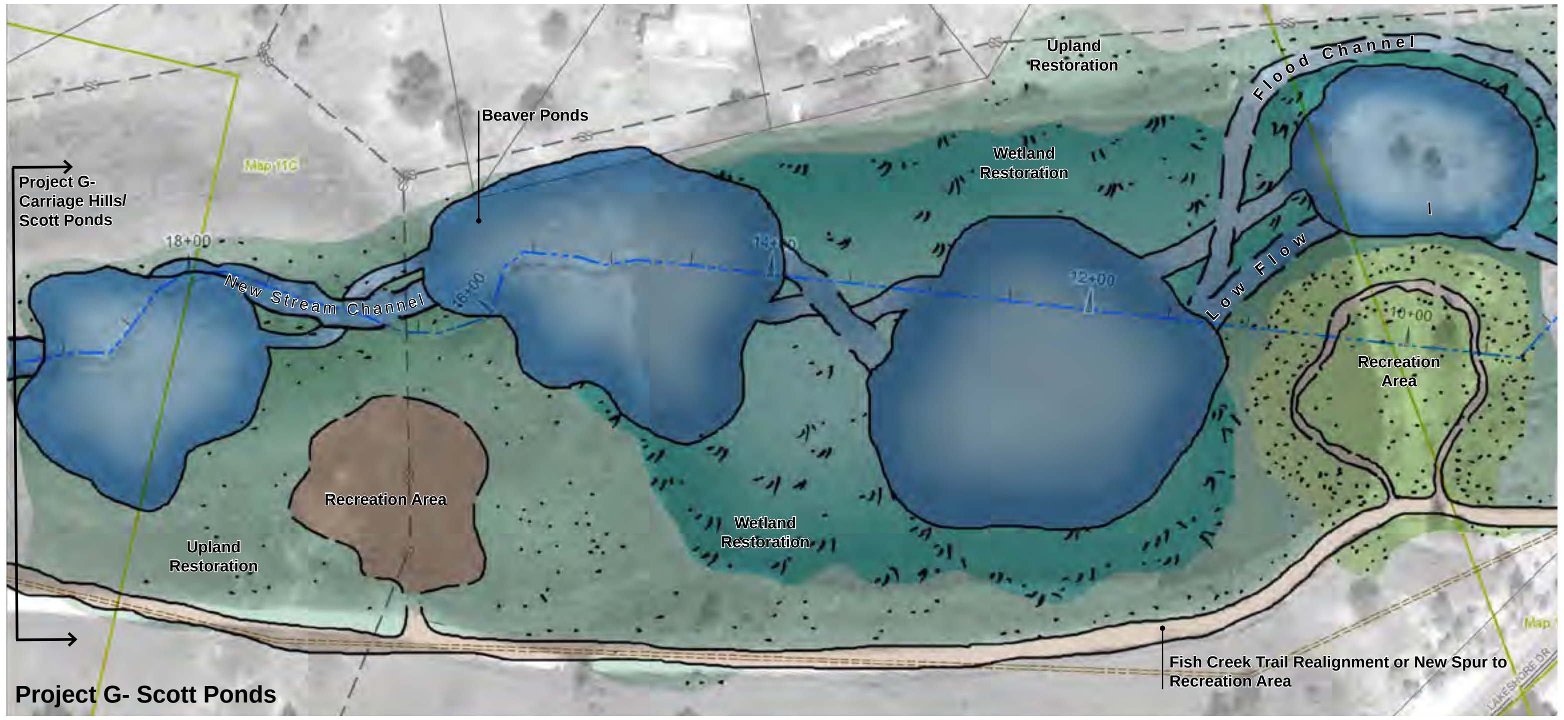
The Fish Creek corridor though Cheley Camp is a potential candidate for a conservation easement—though land use practices may not necessarily need to change.

**Construction Cost Estimate**

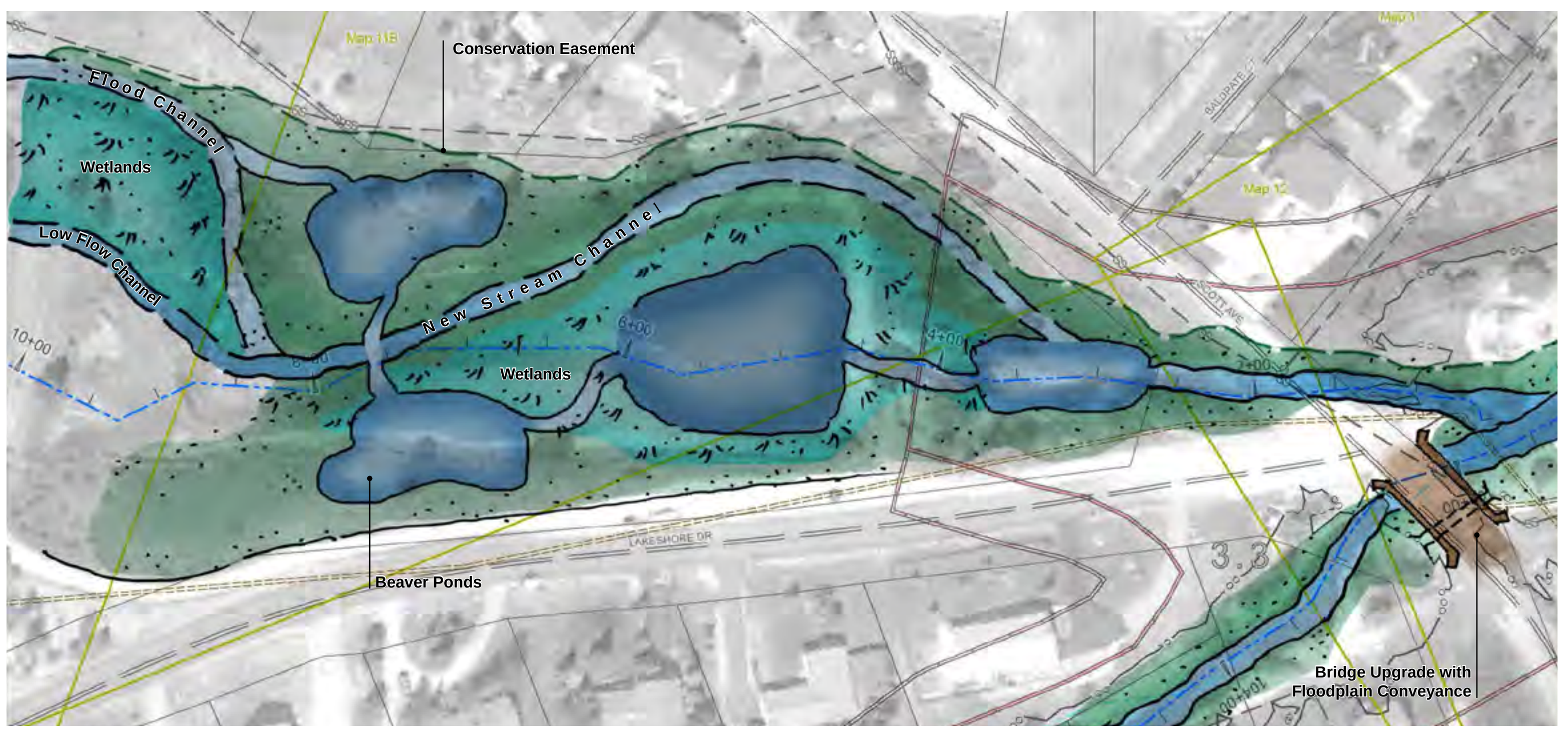
| | |
|---|---|
| Grade Control | $60,000.00 |
| Address Hillside Drainage | $15,000.00 |
| Grazing Pasture Setback | $25,000.00 |
| Vegetation Enhancement/ Revegetation | $30,000.00 |
| Redo Existing Bridge Crossing and add Floodplain Conveyance | $2,000,000.00 |
| **Grand Total** | **$2,130,000.00** |

Cheley Camp Reach

# Scott Ponds - Project Cut Sheet




Scott Ponds Resiliency Ideas




**Project Objective**

The Scott Pond Removal project proposes to remove two dams south of Scott Avenue and restore the area to historic beaver ponds which will promote duck, elk, moose, and other wildlife use and habitat. This project represents the biggest opportunity on Fish Creek to restore a significant portion of the watershed to a laterally and longitudinally connected, healthy, functional ecosystem.

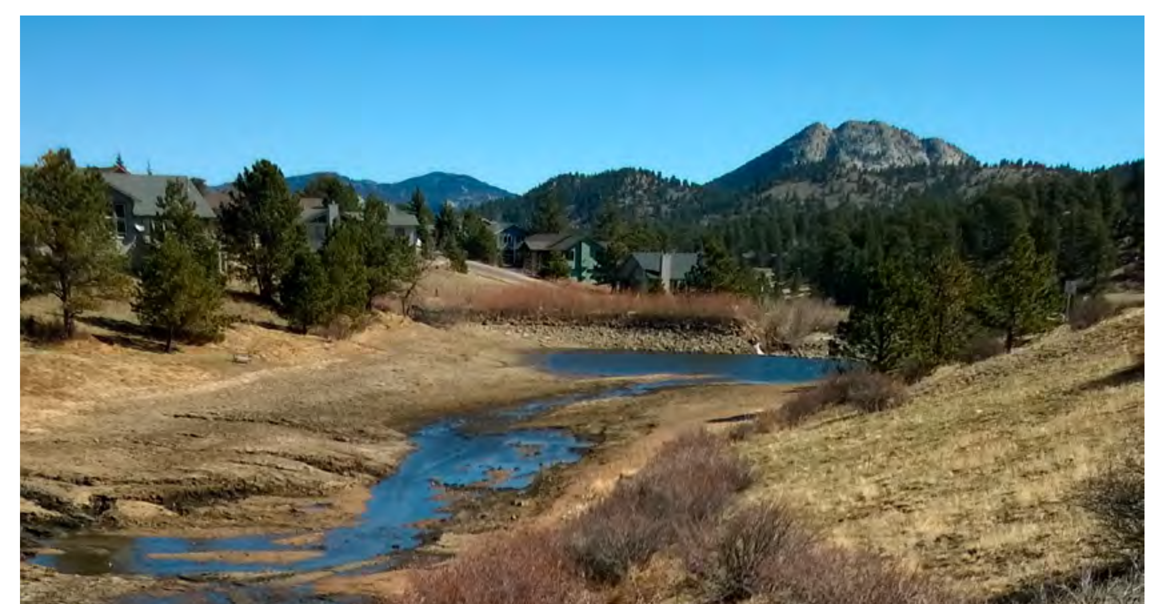
The dams are one of the biggest hazards in the Fish Creek system and in the September 2013 event, the lower dam breached sending a deluge of water and sediment into the lower neighborhoods along Fish Creek. In addition, the existing dams no longer serve their original purpose, and costs associated with safety upgrades and long-term maintenance are likely prohibitive to repair of the existing breach and/or upgrades to current standards. The project includes the creation of beaver ponds, stabilization of the existing sediments, creation of low and flood conveyance channels, the addition of wetlands, trail realignment, added recreation areas, and wildlife enhancements in the river corridor.

**Physical Layout**

The extents of the Scott Pond Removal project are from Fish Creek at Scott Avenue, along the entire tributary to 600 feet upstream of S Saint Vrain Avenue (Colorado Highway 7). The total stream length is approximately 3,800 feet, and the extents include the surrounding river corridor.

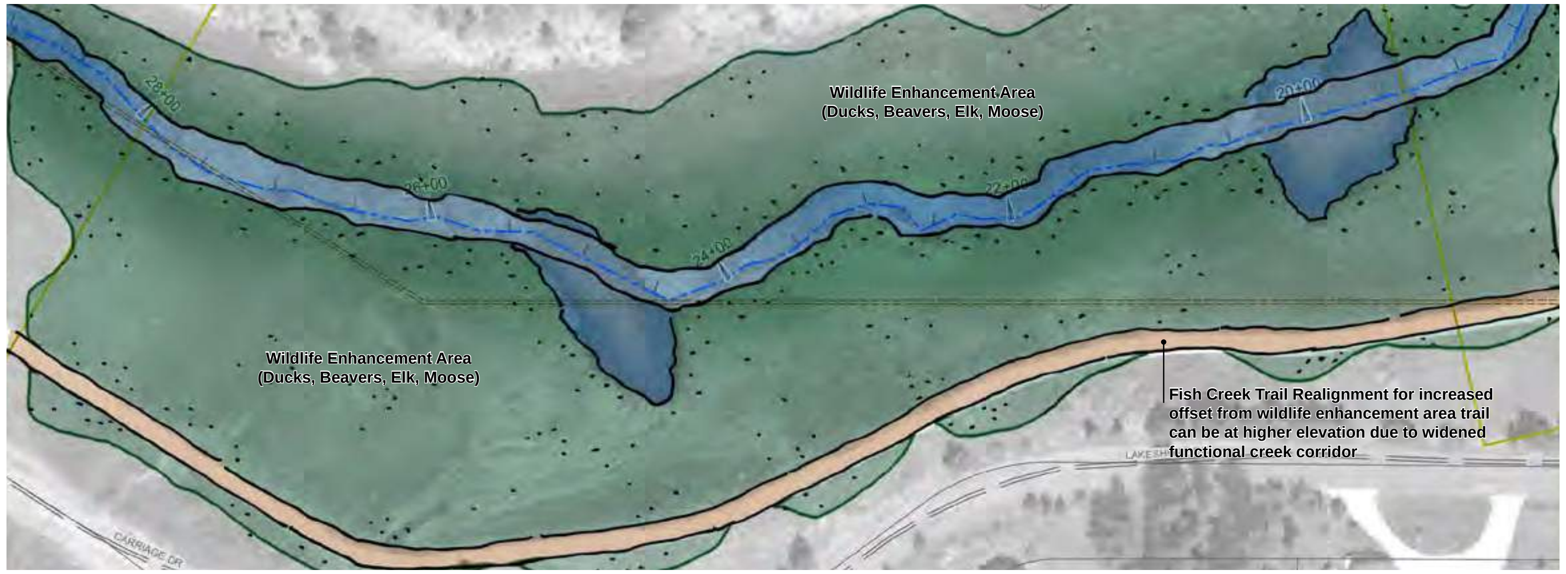
**Project Benefits**

The project benefits for the Scott Pond Removal are system-wide. The most significant benefit from the project is the elimination of risk from a dam breech



Scott Ponds Reach

# Scott Ponds - Project Cut Sheet




Scott Ponds Resiliency Ideas


Scott Ponds Reach

and subsequent reduced flood risk to downstream residential properties. There are also extensive ecosystem, wildlife, and water quality benefits through the reintroduction of beaver ponds and the enhanced wildlife habitat. The project will also increase recreational opportunities in the reach.

**Implementation and Construction Strategies**

No specific implementation and construction strategies are available for this project.

**Permitting Requirements**

Permitting specific to the dam removal may be required.

**Project Partners**

Potential project partners include local and downstream property owners, Estes Valley Parks and Recreation, and the Town of Estes Park.

**Cost Share and Funding Strategies**

State funding related to dam safety may be applicable, and a conservation easement may also provide funding for the project.

**Construction Cost Estimate**

| | |
|---|---|
| Wildlife Enhancement Area | $60,000.00 |
| Upland Restoration | $60,000.00 |
| Wetland Restoration | $90,000.00 |
| Recreation Area | $20,000.00 |
| Picnic/Flexible Outdoor Area | $40,000.00 |
| Existing Dam Removal | $100,000.00 |
| Bridge Upgrade w/ Floodplain Conveyance | $2,000,000.00 |
| Flood Channel | $50,000.00 |
| Low Flow Channel | $100,000.00 |
| Realign Fish Creek Trail | $30,000.00 |
| Beaver Ponds | $80,000.00 |
| **Grand Total** | **$2,630,000.00** |

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Fall River Coalition

Fish Creek Coalition

# 8 Next Steps

## 8.1 Long-term coalition building and engagement

The September 2013 floods caused significant damage to several watersheds on the Northern Front Range of Colorado. Dozens of state and federal agencies along with volunteer organizations galvanized an array of resources to recover from this event. Many of these groups initially responded by undertaking short-term and temporary actions in order to address the damage caused by the flood. While local short-term solutions were being implemented, there was a recognized need for long-term planning on a watershed level.

Colorado's flood-affected communities have been encouraged to come together to create a coordinated, future-oriented framework to restore and create resilience in their watershed communities and ecosystems. In order to begin long-term river and watershed restoration in a thoughtful and coordinated way, the Colorado Water Conservation Board granted funds to flood-affected watersheds to create stakeholder-driven Watershed Master Plans to assess damage and develop a list of prioritized restoration projects. This process has catalyzed communities around their rivers, challenged stakeholders to work hand in hand with their neighbors and set the stage for a long-term recovery process that highlights multiple objectives and promotes resiliency.

Resilience means different things to different communities. According to the National Disaster Recovery Framework, "Resilience incorporates hazard mitigation and land use planning strategies; critical infrastructure, environmental and cultural resource protection; and sustainability practices to reconstruct the built environment, and revitalize the economic, social and natural environments."

The master plans being developed in each flood affected drainage basin are working within a watershed approach framework. A watershed approach is a flexible framework for managing natural resources within specified drainage areas, or watersheds. It is a strategy that provides assessment and management information for a geographically defined watershed, including the analyses, actions, participants, and resources related to developing and implementing the plan. This approach includes stakeholder involvement and management actions supported by sound science and appropriate technology using a series of cooperative, iterative steps to characterize existing conditions, identify and prioritize projects, define management objectives within the prior appropriation system, and implement and adapt selected actions as necessary. The outcomes of this process are documented or referenced in the plan.

One of the key characteristics of the master planning process is the implementation of a plan that is developed by a coalition of stakeholders in the basin. In prior watershed planning processes throughout Colorado, diverse stakeholder input at the beginning stages of planning has generally improved the likelihood of successful implementation. Using a stakeholder involved collaborative approach to selecting management strategies oftentimes will reduce conflicts associated with watershed management and address projects in a holistic manner. This approach will help to expedite cooperative, integrated restoration planning and implementation. It is this reason that funding agencies and organizations will look favorably on applications submitted by collaborative community coalitions.

## 8.2 Master Plan Implementation

As the master plan process concludes, site specific planning and project implementation will be commencing. The State is encouraging each flood-affected watershed to organize a stakeholder coalition and adopt a governance structure that can represent the interests of all stakeholders in the watershed. That includes local governments, special districts (water, sewer, fire, soil conservation, irrigation etc.) business interests, the residential community, state and federal agencies, environmental and recreational concerns and any others that have a stake in developing a resilient economy and environment.

The Colorado Water Conservation Board (CWCB) and the Department of Local Affairs (DOLA) are providing resources to communities to help establish collaborative organizations that can understand and coordinate the specific interests of each stakeholder. Assistance can be provided to navigate the often complicated process of establishing mission/vision statements, fiscal administration procedures and governance structures so government and private funding can legally flow through these organizations to fund local projects. Funding organizations tend to look favorably on organizations that can negotiate and coordinate projects at the local level to develop consensus and leverage local resources that generates cost-effectiveness.

Furthermore, the State recognizes that there is a substantial amount of work required to run these proposed organizations. Oftentimes volunteer community members interested in pursuing the establishment of these groups are quickly overwhelmed with all the fundraising, coordinating, project development and fiscal oversight necessary to maintain a successful organization. With that in mind, the State has developed the Watershed Resilience Pilot Program as a holistic program designed to align watershed restoration and risk mitigation with community and economic development using a collaborative, multi-jurisdictional, coalition-of-partners approach. These watershed program funds will support capacity building through watershed coalition staffing, site specific planning, conceptual design activities, planning for multi-objective uses and project implementation to address long term catalytic watershed system improvements that build resilience. This program will be made available to areas that sustained damage from recent federally-declared flood and fire disasters.

Limited funding will be made available to new coalitions to hire a watershed coordinator and an assistant for 3 years, possibly longer, to successfully carry out projects listed in the Watershed Master Plan. To be competitive for this funding, the position must address disaster impacts and the watershed coalition must consider how this position will help the coalition implement prioritized recovery projects and strengthen the coalition's long-term capacity. Watershed Coordinators and Program Assistants may be coordinated by, and receive assistance and training, from a state program devoted to increase capacity among flood and fire-affected watersheds. Coalitions and/or their stakeholders will be expected to provide matching funds for a this capacity building grant, which can be in the form of indirect and operating costs for items such as office space, computers, telephones, furniture, printers, etc. Indirect, operating and equipment costs are not eligible under this grant.

### 8.2.1 Coalition leadership

These coalitions will only be successful with strong local leadership. Although coordinators will be hired to do the bulk of the project development work, decision-making and fiscal oversight responsibilities will fall to the leadership of the coalition. Governance structures for these types of organizations are as diverse as the organizations themselves and there are many models available depending on the specific needs of the community. Assistance will be offered to help identify the appropriate type of governance structure that will provide the best representation of the different stakeholder groups within a specific watershed.

Once a structure is established the community will need to recruit leaders to sit on a Board or a Steering Committee that will oversee the operation of the organization and the implementation of the master plan. Ultimately, this

Fish Creek - Scott Ponds

Board or Committee will represent the interests of the varying stakeholders in the watershed.

### 8.2.2 Potential funding sources

**Colorado Water Conservation Board**
CWCB has several loan and grant programs related to watershed restoration. Some of these programs 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**
The 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.

**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

### 8.2.3 National Flood Insurance Program

The National Flood Insurance Program (NFIP) is in the process of implementing Congressionally mandated reforms required by the Homeowner Flood Insurance Affordability Act of 2014 that repeal and modify the Biggert-Waters Flood Insurance Reform Act of 2012 (BW-12).
As risks change, insurance premiums also change to reflect those risks. Flood insurance premiums may be going up for some structures; however they may be reduced by building safer, higher, and stronger. The Biggert-Waters Flood Insurance Reform Act of 2012 provides long-term

Fish Creek - Sediment Mitigation at Industrial Site

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changes to the National Flood Insurance Program. Under the new law, rates are likely to increase overall to reflect the true flood risk of buildings and many insurance discounts will be eliminated. Policy rates for all properties could increase based on one or all of the following circumstances:

- Lapse in coverage
- Change in risk
- Substantial damage or improvement to a building

Some changes will depend on external factors such as when flood risk maps are revised, buildings are damaged or improved, or when flood claims are filed. Flood risk can, and does, change over time. Flood risks change for many reasons: new development, improvements in hazard information, and environmental changes, to name a few. As a result, flood hazard maps are periodically updated. These new flood maps, also, known as Digital Flood Insurance Rate Maps (DFIRMs), show flood risk at a property-by-property level.

When new maps are issued, a property's risk classification may have changed along with the flood insurance requirements. If a property is mapped out of a high-risk area, the flood insurance costs will likely decrease. If a property has been mapped into a high-risk area, it will be required to purchase flood insurance if the mortgage is through a federally regulated or insured lender. One can save money with the Preferred Risk Policy Eligibility Extension and through a process known as grandfathering provided by the National Flood Insurance Program. One can take advantage of grandfathering by buying a policy before the new maps take effect. For older structures built before the community's first flood map was issued (known as pre-FIRM buildings), this is the only grandfathering option when they are mapped into a high-risk area.

Fish Creek - Cheley Camp



## 9 References

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