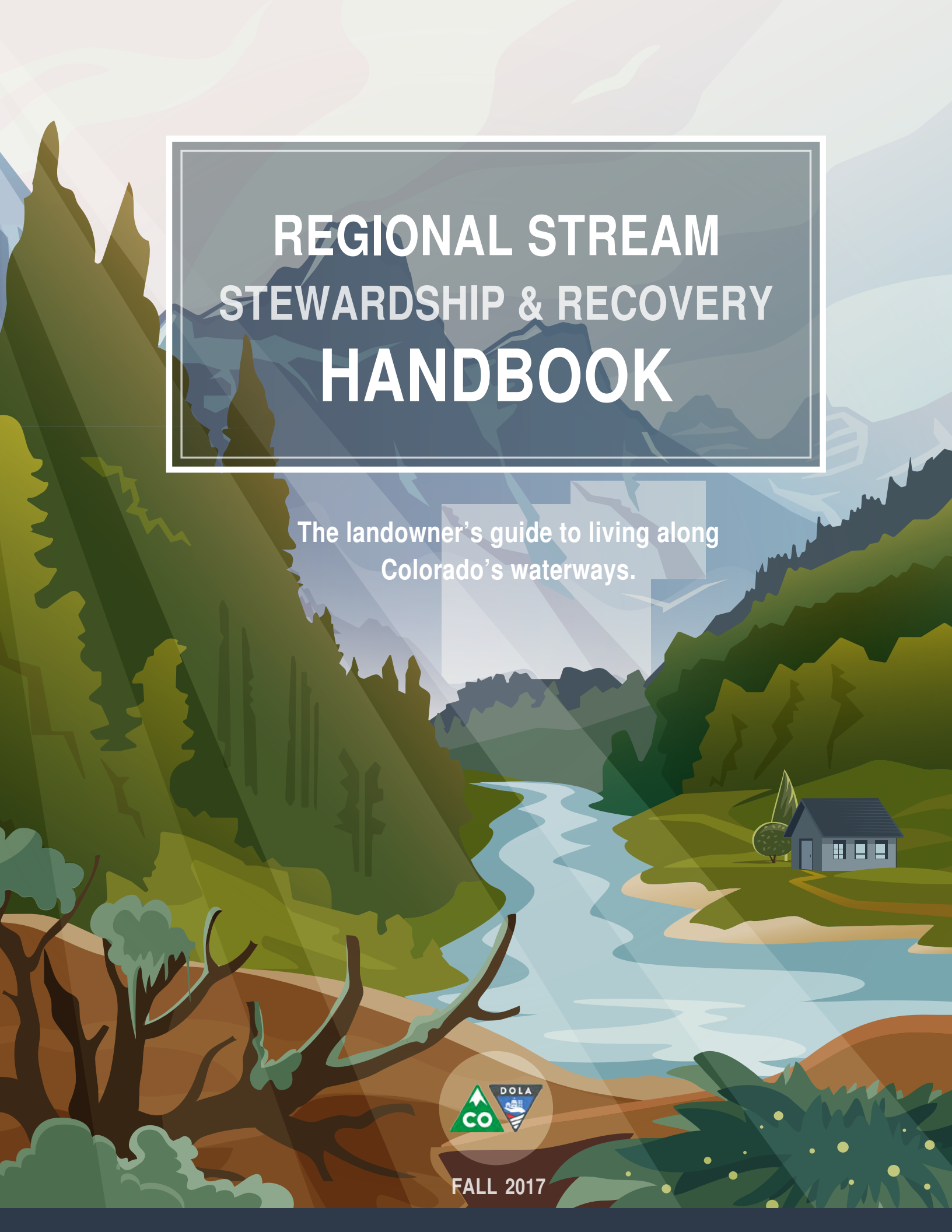
REGIONAL STREAM STEWARDSHIP & RECOVERY HANDBOOK

The landowner's guide to living along Colorado's waterways.



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LEFTHAND WATERSHED oversight group

BIG THOMPSON WATERSHED COALITION

Little Thompson Watershed Restoration Coalition

SAINT VRAIN CREEK COALITION

Acknowledgments:

Steering Committee

Yana Sorokin [1]
Jessica Olson [1]
Shayna Jones [2]
Allison Hamm [3]
Teagan Blakey [3]
Erika Shioya [4]

Project Committee

Greg Ames [5]
Darrell Beck [6]
Edward Bendelow [6]
Jim Blankenship [6]
Matt Booth [6]
Karla Brown [6]
Chris Carroll [5,6,10]
Sean Cronin [5,6]
William Ellis [6]
Laura Emerson [7]
Ken Huson [6]
Chad Julian [3]
Bob Lecoq [7]
Larry Lempka [3]
Dave Levy [6]
Janice Lopitz [12]
Barbara Luneau [6]
Julie McKay [5,6,12]
Terry Parrish [8]
Boyd Shaffer [6]
Ernst Strenge [12]
Leah Treadwell [6]
Pete Wadden [9]

Technical Review Panel

The Technical Review Panel volunteered their time to review this Handbook, as well as provide valuable input that helped to shape the final edition.

Diana Aungst [14]
Michael Blazewicz [15]
Varda Blum [12]
Claudia Browne [16]
Chris Carroll [5,6,10]
Mike Chard [12]
Jane Clary [18]
Jeff Crane [17]
Andrew Earles [18]
Lori Hodges [13]
Tim Katers [19]
Kim Lennberg [20]
Julie McKay [5,6,12]
Jana McKenzie [21]
William Rice [11]
Dave Skoudas [22]
William Spitz [23]
Ernst Strenge [5,12]
Chris Sturm [25]
Luke Swan [24]
Ben Swigle [26]
Pete Wadden [9]

Consultant Team/Authors:

Jon Altschuld, *RLA, ASLA* [27]
Kevin Shanks, *RLA, ASLA* [27]
Brandon Parsons, *ASLA* [27]
Scott Schreiber, *PE* [28]
Drake Ludwig, *EI* [28]
Robert Krehbiel, *PE* [28]
Brittany Gurr [31]
Denise Larson [29]
Jenelle Kreutzer [29]
Corey Engen, *PE* [30]
Parker Scherman, *PE* [30]

1. *Lefthand Watershed Oversight Group (LWOG)*
2. *Big Thompson Watershed Coalition (BTWC)*
3. *Little Thompson Watershed Coalition (LTWC)*
4. *Saint Vrain Creek Coalition (SVCC)*
5. *LWOG Board of Directors*
6. *SVCC Board of Directors*
7. *BTWC Board of Directors*
8. *LTWC Board of Directors*
9. *Town of Vail*
10. *United States Forest Service (USFS)*
11. *United States Fish and Wildlife Service (USFWS)*
12. *Boulder County*
13. *Larimer County*
14. *Weld County*
15. *Round River Design*
16. *Biohabitats*
17. *Crane Associates*
18. *Wright Water Engineers*
19. *Colorado Department of Local Affairs (DOLA)*
20. *Great Ecology*
21. *Logan Simpson*
22. *Urban Drainage & Flood Control District (UDFCD)*
23. *Olsson Associates*
24. *OTAK*
25. *Colorado Water Conservation Board (CWCB)*
26. *Colorado Parks and Wildlife (CPW)*
27. *THK Associates, Inc..*
28. *Matrix Design Group*
29. *ERO Resources Corporation*
30. *Flywater*
31. *Painted Tales Creative*

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Handbook Overview

> *The purpose of the Stream Stewardship and Recovery Handbook is to create an educational resource for private landowners to better understand their streamside properties in the context of the larger watershed, what they can do to practice good stream stewardship and when/how they should engage outside help for stewardship or recovery projects.*
>
> **– Mission Statement, developed by the Handbook Steering Committee**

Why a Landowner Handbook on Stream Stewardship?

The idea for this handbook grew out of the recovery efforts after the 2013 Colorado flood and federally declared disasters. The Lefthand, Big Thompson, Little Thompson and Saint Vrain watersheds were all heavily impacted by the 2013 flood. All four watersheds have since been involved in numerous stream recovery and stewardship projects, many of which were funded by the state of Colorado through the Department of Local Affairs (DOLA) disaster recovery program. The projects included private landowners, government agencies, funding administrators, watershed coordinators, engineers, environmental scientists, landscape architects and river constructors.

Steward | *stoo•erd* | noun

"Someone who takes care of something and protects it."

In the case of a stream steward, someone who takes care of and protects the larger stream corridor and watershed.

Macmillandictionary.com, n.d. [page 188]

Through the course of these projects, everyone involved learned valuable lessons about how streams function during and after a record-breaking flood, as well as how landowners can be good **stewards** of the stream system. From these lessons, the idea of a Handbook meant specifically for private landowners living along streams was born. DOLA funded the project, with the Lefthand (LWOG), Big Thompson (BTWC), Little Thompson (LTWC) and Saint Vrain (SVCC) Watershed Coalitions making up the Handbook Steering Committee.

Handbook Organization

The Handbook is organized into chapters that can be read individually, or all together. Although all of the chapters connect to each other, each one can serve as its own educational resource. In this way, you can choose to read just a chapter or even just a section at a time.

The chapters also have a progression of technical information, with the earlier chapters being more general in nature. As you progress through the Handbook, the information will become more specific and more technical. The chapters will also start to focus more on assessing your property and coming up with projects that fit on your property. Following this, the Handbook will teach you about working with outside help - professional engineers, environmental consultants and scientists, landscape architects and river constructors. You will also learn about many free services and resources that are available to you as a landowner. For those of you who wish to learn even more technical information about how streams function and how professional consultants plan recovery efforts, Chapter 5 discusses two of the most widely-accepted stream classification systems and how they can relate to your property. The final chapter in the Handbook looks at five real-world sites and how the Handbook can be used to plan for the property. The sites are privately-owned properties in the Lefthand, Big Thompson, Little Thompson and Saint Vrain watersheds. Each one has its own unique history, setting and opportunities and constraints.

One of the recurring messages you will notice in this Handbook is the advice to reach out to your local watershed coalition, your neighbors, nonprofit organizations and even professional consultants and constructors when you are unsure of how to proceed. While the aim of this Handbook is to empower and teach you as a streamside landowner, there are certain things that you will need help to complete.

It is also worth mentioning that stream corridors are complicated networks of inter-connected pieces that can change at any time and with very little warning. Many professionals spend their entire career working to better understand how these pieces are connected and how to best protect and restore them. However, they all started by learning the basics and built their knowledge on this foundation.

From the authors: We hope that you find this handbook to be an interesting read and a useful resource. We are a group of landscape architects, engineers, environmental scientists, river constructors and graphic designers who care deeply about Colorado's streams and rivers. We are passing on our knowledge in the hopes that you too, will use these tools to be a good steward of your community's streams and rivers.

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CHAPTER 6

Stewardship Site Plans [page 157]

Real-world examples of how the concepts in this Handbook can be applied to private properties. Each Site Plan has general evaluation and recommendation notes, tied to the Strategy sheets in Chapter 3.

This Handbook is available for download as a hyperlinked PDF.
You can download it by following the QR code or link below:

lwog.org/programs/stewardship

Commonly Used Terms:

Annual High Water Level	The high water mark typically reached on an annual basis within a channel. Also referred to as the Ordinary High Water Mark (OHWM or OHW).
Armoring (bank)	Protective covering, such as rocks, logs, vegetation or engineered materials used to protect and stabilize streambanks.
Avulsion	The sudden change in the course of a river channel (often during a flood), potentially causing the separation of land from one property and its attachment to another.
Bald & Golden Eagle Protection Act (BGEPA)	Federal Regulation which prohibits anyone, without a permit issued by the Secretary of the Interior, from "taking" bald or golden eagles, including their parts, nests, or eggs.
Bankfull	The mark or flow of a stream at which it is about to overtop its banks. Typically, this flow would occur every 1.5 years; therefore, it is sometimes used in reference to a 1.5 year event.
Bank Stabilization	The process by which eroding or failing banks are modified to resist the channel velocities or protect steep slopes with structural aspects such as boulders, logs, retaining walls and/or vegetation.
Bank Stability	The ability of a streambank, including its soils and vegetation, to resist erosion from water flows and gravity.
Bioengineering	Using natural materials, such as boulders, soil, logs and plants to create an 'engineered' solution. In the case of this Handbook, most bioengineering measures are related to bank stabilization.
Biology	The study of living organisms.
Clean Water Act (CWA)	The 1972 amendment to the Federal Water Pollution Control Act of 1948 with the objective to maintain and restore the integrity of the nation's waters by regulating pollutants discharged into them.
Colorado Noxious Weed Act	Under this Act, the Colorado Department of Agriculture (CDOA) has implemented a noxious weed control program. The aim of this program is to prevent the introduction of new invasive species, eradicate species with isolated or limited populations and manage well-established and widespread noxious weeds.

Commonly Used Terms:

Conditional Letter of Map Revision (CLOMR)	FEMA's comment on a proposed project that would, upon construction, affect the hydrologic or hydraulic characteristics of a flooding source and thus result in the modification of the existing regulatory floodway, the effective Base Flood Elevations (BFEs), or the Special Flood Hazard Area (SFHA).
Culvert	A tunnel carrying a stream or open drain under a road or railroad.
Cutbank	A nearly vertical cliff produced by erosion of the banks of a stream.
Deposition	Sediment (including rocks and sand) settling out of moving water and being added to the streambed, bank, or floodplain.
Diversion	The physical removal of water from a stream or lake via an engineered structure. Often used to divert water for irrigation, municipal, industrial, or storage purposes.
Drop Structure	Structures that create vertical or near vertical elevation changes in a stream in order to reduce the slope of the stream upstream and/or downstream of the structure.
Ecosystem	A system, or a group of interconnected elements, formed by the interaction of a community of organisms with their environment.
Endangered Species Act (ESA)	A federal regulation to protects animals and plants that are in danger of extinction (endangered) or are threatened to become endangered (threatened) and the habitat upon which they depend.
Endangered/Threatened Species	Endangered: any species which is in danger of extinction throughout all or a significant portion of its range. Threatened: any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.
Entrenchment	A way of measuring the relationship between a stream and its floodplain. Often measured as a ratio of the width of the flood-prone area to the surface width of the bankfull channel.
Equilibrium	A stream channel in which erosion and deposition are relatively balanced, resulting in little or no change to the channel shape over time.

Commonly Used Terms:

Erosion	The movement of soil or rock by wind, water, or other natural processes.
Fish passage	The capability for a stream section to allow fish to move upstream and downstream through it.
FEMA Flood Insurance Rate Map (FIRM)	The official map of a community on which FEMA has delineated both the special hazard areas and the risk premium zones applicable to the community.
Flood Fringe	The area outside of the floodway, but still within the 100 year floodplain.
Floodplain	An area of low-lying ground adjacent to a river, formed mainly of river sediments and that is subject to flooding. Typically separated into zones based on the probability of flooding frequency.
Floodplain Conveyance	The amount of water that can flow through a floodplain for a given section.
Floodway	The channel of a stream or other watercourse and the adjacent land areas through which flood waters will flow most efficiently.
Fluvial Geomorphology	The study of how a stream interacts with its geologic surroundings.
Geology	The study of the physical properties of the earth.
Geomorphic	Relating to the form of the landscape and other natural features of the earth's surface.
Geomorphology	Study of the characteristics and history of landforms.
Geotextiles	Strong synthetic fabrics used to stabilize loose soils and prevent erosion.
"Good Wood"	Large woody material that does not pose a flood risk and provides a variety of environmental benefits, including habitat, bank stabilization and improved hydraulic function.
Grading	The act of altering the ground surface to a desired grade or contour by cutting, filling, leveling, and/or smoothing.

Commonly Used Terms:

Grade Control	A natural or engineered structure on the channel bed which locally prevents bed erosion, creating a stable channel slope (or “grade”).
Headcut	An erosional feature of some streams where an abrupt vertical drop in the stream bed occurs (also known as a knickpoint). A headcut will typically migrate upstream as it progresses.
Hydric Soil	A soil that formed under conditions of saturation, flooding or ponding long enough during the growing season to develop anaerobic conditions in the upper part. Found in wetlands.
Hydrograph	A graph showing the rate of flow (discharge) versus time past a specific point in a river, or other channel or conduit carrying flow.
Hydrology	The study of water on the earth, in the earth and in the atmosphere.
Hydraulic Engineering	The study and design of how fluids move in relation to their environment.
Impervious	A material that does not allow fluid to pass through it (e.g., concrete).
Incision	When a stream has a cut vertically downward through its bed, and has lost connection with its floodplain.
Large Woody Material (LWM)	Dead trees, branches, limbs or logs, often left behind by flood events.
Letter of Map Revision (LOMR)	FEMA's modification to an effective Flood Insurance Rate Map (FIRM), or Flood Boundary and Floodway Map (FBFM), or both.
Migratory Bird Treaty Act (MBTA)	Federal Regulation which makes it illegal for anyone to take, possess, import, export, transport, sell, purchase, barter, or offer for sale, purchase, or barter, any migratory bird, or the parts, nests, or eggs of such a bird except under the terms of a valid permit issued pursuant to Federal regulations.
Meander	A twist, turn or curve in an active channel of a river, stream or creek. See Oxbow for the historical/past curves of a river.
No-Rise Certification	A hydraulic certification supported by technical data and signed by a registered professional engineer, showing that work in the floodway will result in a zero-rise or a decrease in base flood elevations.

Commonly Used Terms:

Noxious Weeds	Aggressive non-native plants that invade an area, displacing native vegetation and reducing agricultural productivity.
Office of Emergency Management (OEM)	An agency at the local, state or national level that holds responsibility of comprehensively planning for and responding to and recovering from all manner of disasters, whether man-made or natural.
Ordinary High Water Mark (OHWM)	The high water mark typically reached on an annual basis within a channel. Also referred to as Annual High Water Level.
Outfall	The place where an irrigation ditch, drain or sewer pipe empties into a water body.
Overflow Channel	Sections of stream that do not normally carry water during average daily flows, but will become active during larger flow events to carry excess water.
Oxbow	A naturally abandoned or cutoff portion of a historic meander bend; while a meander is part of an active channel, an oxbow is the non-active area remaining after a meander is cut off from the channel.
Plugs (plants)	Individual wetland or riparian plants that are established by a professional wetland plant nursery and installed in predetermined areas along a stream or wetland to expedite plant establishment.
Primary Streambed Material	The most common aggregate found in a streambed; examples include boulders, cobble, gravel and sand.
Rheotactic Salmonids	Fish of the Salmon family (i.e. salmon, trout, char and whitefish) that generally turn to face into an oncoming current.
Reach	A stretch of a stream or river, the boundaries of which are often defined by physical or political changes.
Riparian	Of, relating to, or situated or dwelling on the bank of a river or other body of water.
River Dynamics	How a river function and moves.

Commonly Used Terms:

Scour	The result of swiftly moving water eroding soil, causing a hole or depression in the stream bed.
Sediment	Solid fragments of inorganic or organic material that come from the weathering of rock and are carried and deposited by wind, water, or ice.
Streambanks	Sloped areas alongside streams, creeks and rivers that connect the stream to its floodplain.
Stream Corridor	A stream corridor is an ecosystem that usually consists of three major areas or zones: stream channel, streambank, upland transition.
Stream Slope	The vertical distance that a stream drops over a given horizontal length.
Stream Stewardship	The act of supervising or taking care of the larger stream system.
Stream Steward	Someone who understands and respects the value of a healthy stream system and treats the stream in ways that will benefit the entire stream corridor and watershed.
Stream Restoration	A large variety of ecological, physical, spatial and management measures and practices aimed at restoring the natural state and functioning of a stream or river system in support of biodiversity, recreation, flood management and landscape development.
Toe of Bank	The bottom of a streambank where the bank meets the baseflow water level of a channel.
Upland	Dry areas away from the stream channel.
Velocity	The speed of something in a given direction.
Waterway	A river, canal, or other body of water serving as a route or way of travel or transport.
Watershed	An area of land consisting of a network of streams, rivers and lakes that drains to a single point.

Commonly Used Terms:

Watercourse	A natural or artificial channel through which water flows or a stream of water (such as a river, brook, or underground stream).
Wetland	Area that is inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support, and that under normal circumstances support, a prevalence of vegetation typically adapted to life in saturated soil conditions. Wetlands often need to be identified and delineated by a professional environmental consultant based on the available water, types of soils and types of vegetation.
Width-to-Depth ratio	The ratio of the bankfull surface width to the mean depth of the bankfull channel. The width/depth ratio is key to understanding the distribution of available energy within a channel, and the ability of various discharges occurring within the channel to move sediment.
Xeric	Plant community characterized by, relating to or requiring only a small amount of moisture.

CHAPTER

1

Living Along a Stream

Living along a stream, creek or river places you and your family next to a beautiful natural amenity. Part of that natural beauty is the wildlife, plants, and **ecosystems** that are a part of the area. These are all inter-connected to each other and to how the stream functions. Because streams flow through many other properties, your property is also connected to these other properties. In order to better understand these connections, this chapter will look at considerations that are unique to streamside properties. This will begin with your property and then will move to looking at the longer riparian corridor. After that, you will learn about what your role can be within the larger watershed and what you can do to be a **good stream steward**.

A **good stream steward** is someone who understands and respects the value of a healthy stream system and treats the stream in ways that will benefit the entire stream corridor and watershed. Good stream stewardship also includes the idea that we are all responsible for treating our streams responsibly.

Another important part of living along a stream is understanding the flood risks associated with your property. High seasonal flows and large floods are a natural function of streams and rivers. As a landowner, there are ways you can prepare both your property and your family for when these events occur. In this chapter, you will learn ways to be prepared for a large flood event and about a number of very useful resources available to you for flood preparation and emergency help. Finally, the chapter will help you to assess damage to your property immediately after a flood in order to begin a recovery plan.

How is living along a stream different?

People choose to live near streams for a variety of reasons: agriculture and ranching uses, recreational uses like fishing or wading, having natural scenery in their backyard or feeling a closer connection to nature. While living along a stream provides these unique experiences in a special setting, it also exposes the owners to some unique risks, considerations and concerns. As a streamside landowner, you will want to have a clear understanding of topics that need to be considered differently when along a stream, as opposed to properties without streams or rivers.

Living along a stream, portions of your property are probably within the **floodplain** and/or **floodway**. These areas are legally defined by FEMA and they are tied into the National Flood Insurance Program (NFIP). The NFIP offers affordable insurance for properties within NFIP-participating communities. Most, if not all of the areas within the four watersheds covered in this Handbook (Lefthand, Big Thompson, Little Thompson and Saint Vrain), are in NFIP-participating communities. In addition to these four watersheds, there are over 80 watershed coalitions in the State of Colorado. Find a full directory on the Colorado Watershed Assembly website at: ***coloradowater.charityfinders.com/Watershed%20Group%20Directory***

Because most homeowners insurance policies do not cover flood damage, flood insurance can be a valuable tool for streamside properties. You can find out more about the differences between a **floodplain** and a **floodway**, as well as how to identify them on your property, in the ***'Flood Risk Management'*** *[page 38]* section of **Chapter 2**.

NATIONAL FLOOD INSURANCE PROGRAM

Find out more about the NFIP:

Look up communities that participate in the NFIP:
www.fema.gov/national-flood-insurance-program-community-status-book

YouTube

Watch videos on how floodplains work at the LWOG YouTube Channel!
http://bit.ly/2yNaPMm

Did You Know...?

When your property line lies at the center of a stream, it can legally change as the stream moves gradually, but not in the case of a large flood event.

Visit *https://www.blm.gov/cadastral/casebook/basicwater.pdf* to learn more details!

Another item to consider is how the limits of your property relate to the stream. Historically, property boundaries are tied to landmarks or easily visible features. As a result, many properties along streams use the actual stream to define the property boundary. Although this seems straightforward, there are a couple of details that you should be aware of. First, landowners in Colorado typically own the land under the stream, but not the stream itself. This means that while you may own the **land** to the middle of the stream (or on both sides of the stream), you do not own the actual water or the fish within them. Additionally, you are not allowed to divert water off of the stream onto your property. Not only can this have negative impacts on upstream and downstream properties, but it also impacts water rights by removing water that legally belongs to someone else.

The next thing to keep in mind with your streamside property is that **waterways** are a regulated natural amenity. Certain construction activities need to be properly designed and permitted when they are within the stream or if they impact particular elements such as wetlands or floodplains. This is discussed in more detail in the ***'Permitting Requirements'*** *[page 121]* section of Chapter 3, but a general guide is that if your project will be within the stream channel or will impact wetlands, it is likely that the project will require a permit. If the project will modify the floodplain or floodway, it will also require permitting and engineering. Some of these permits can be applied for by the landowner, while others will require outside assistance. If you are unsure about if your project will require a permit, you can contact your local watershed coalition and/or the appropriate local, state or federal agency. Contact information for these agencies is provided in the above mentioned **Permitting Requirements** section.

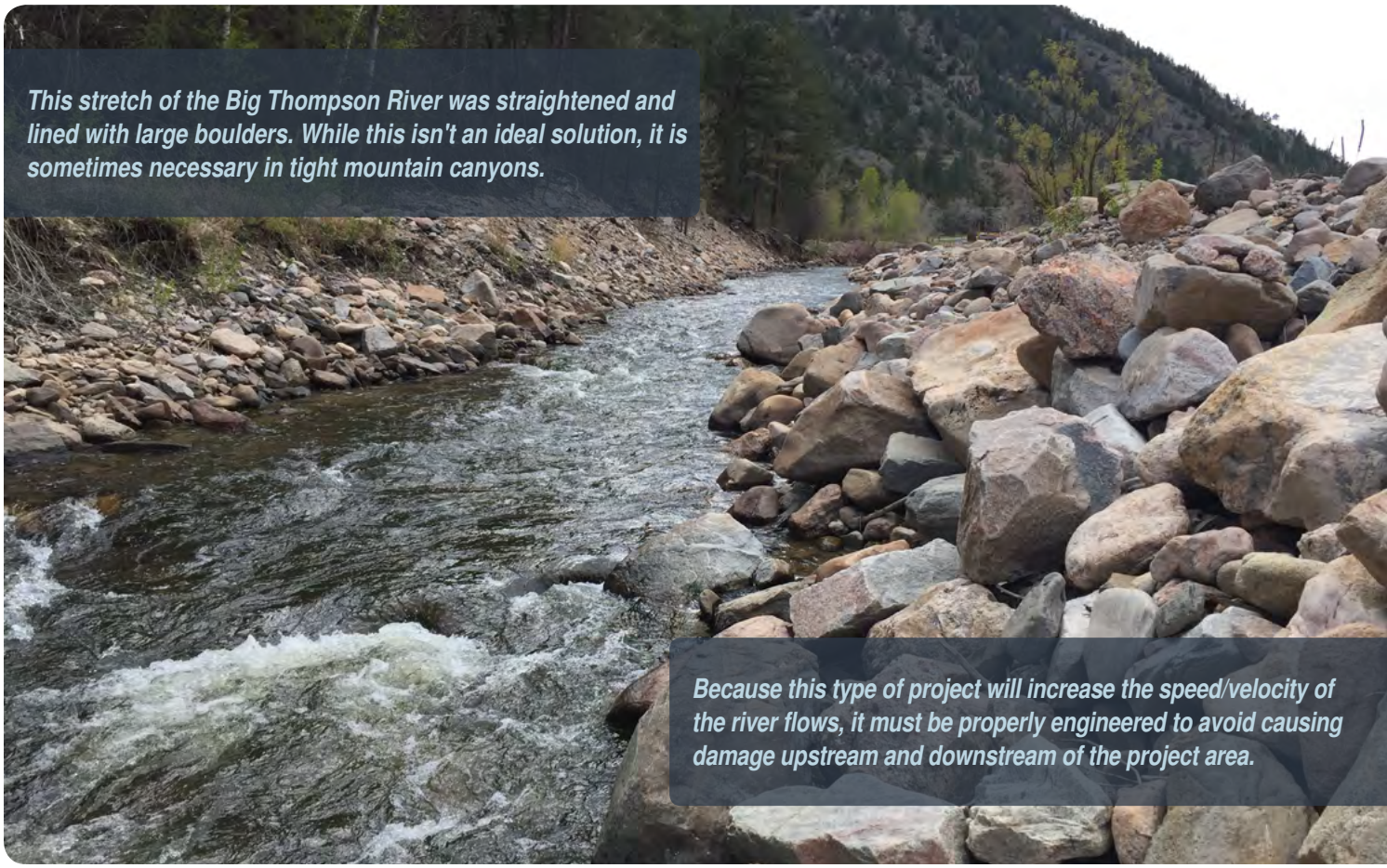
Waterway | *waw•ter•wey* | noun

A river, canal, or other body of water serving as a route or way of travel or transport.

Dictionary.com, n.d. [page 188]

Although many legal documents (such as the Clean Water Act) reference 'navigable' waterways, they also cover non-navigable tributaries that feed into navigable waterways. This means that small streams and creeks that feed into larger rivers are covered/regulated by the Clean Water Act. Therefore, certain activities within them will require permits prior to beginning work.

These regulations are put in place to not only protect the stream system, but also to protect all of the property owners that live along the stream. Small changes on one property can result in greater impacts to the neighboring properties and the overall watershed. Large changes can have even greater impacts on the entire stream system. As a landowner, it is important to recognize these larger connections when considering projects or improvements on your property. This is also important when evaluating the cause of changes on your property. Using this knowledge, you can work with adjacent and nearby landowners to develop a more sustainable stream for yourself and your community.



This stretch of the Big Thompson River was straightened and lined with large boulders. While this isn't an ideal solution, it is sometimes necessary in tight mountain canyons.

Because this type of project will increase the speed/velocity of the river flows, it must be properly engineered to avoid causing damage upstream and downstream of the project area.

Understanding a Riparian Corridor

In addition to recognizing the legal and permitting factors associated with streamside properties, it is also important to understand that riparian environments are extremely complex natural systems with many inter-connected pieces. These pieces include **unique ecosystems**, intricate **river dynamics** that affect how a stream moves and changes over time and **seasonal variations** that can completely change the stream and its surrounding areas.

Riparian | *ri•pair•ee•uh n* | adjective

Of, relating to, or situated or dwelling on the bank of a river or other body of water.

Dictionary.com, n.d. [page 188]

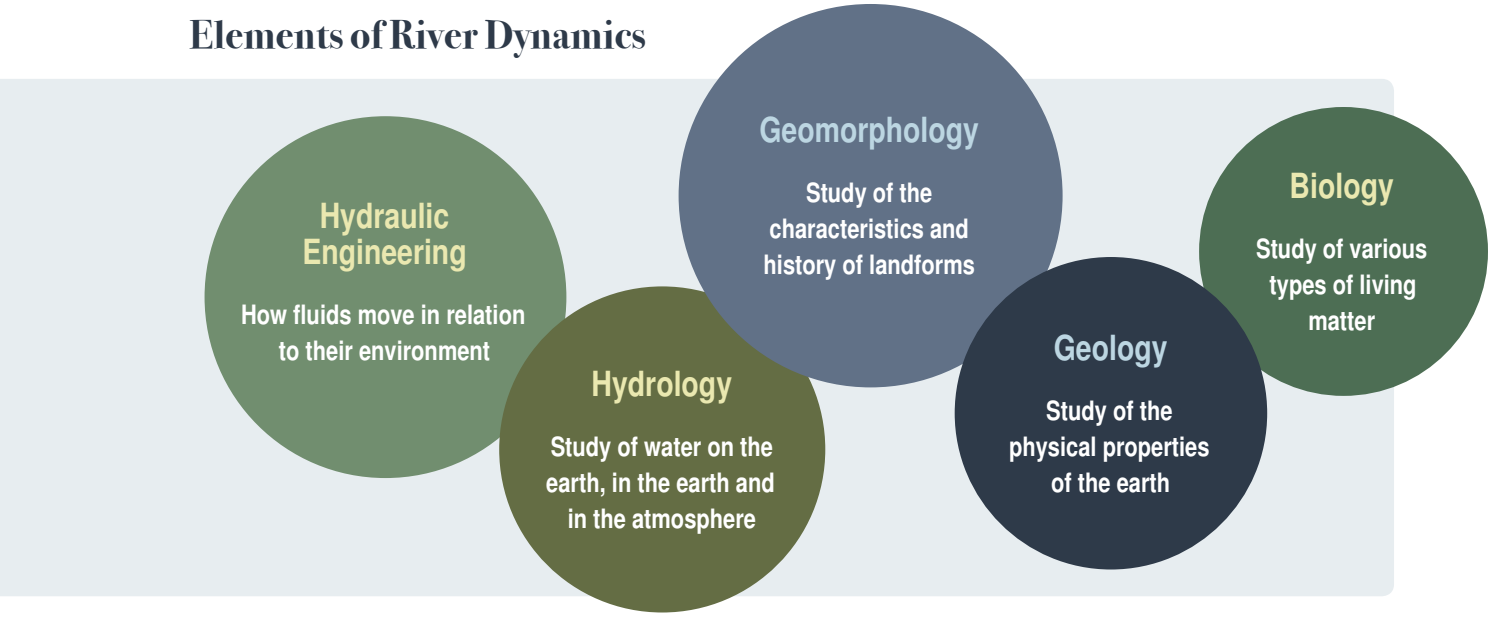
Each stream includes distinct **ecosystems** that vary based on their elevation, their distance from the stream and the nearby land types. The organisms in these ecosystems include insects, fish, rodents, mammals, birds and plants that range from mosses to trees. Microscopic organisms are also important pieces of these ecosystems. All of these organisms depend on each other, as well as the surrounding environment, to survive and grow. Changes to plant communities, such as removing plants or allowing invasive weeds to take over, will affect the types of animals that live in and migrate through those areas. This is because animals depend on particular plants for food sources, as well as resting and rearing habitat. Similarly, the introduction or removal of animal species will have a direct link to the types of plants that grow and spread in the area. Many plant species are spread by animals eating and passing the seeds, or seeds that attach to the fur of an animal and then fall off in a new area.

Ecosystem | *ee•koh•sis•tuhm* | noun

A system, or a group of interconnected elements, formed by the interaction of a community of organisms with their environment.

Dictionary.com, n.d. [page 188]

Elements of River Dynamics

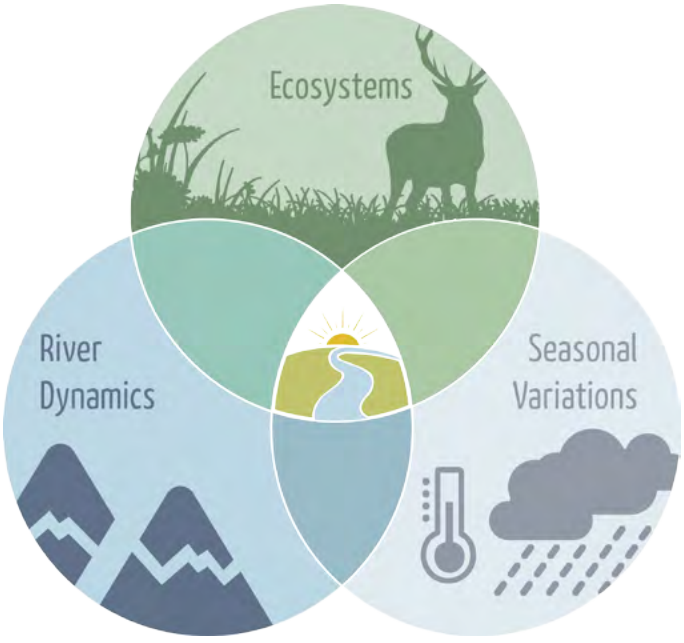


River dynamics, or how a river functions and moves, is a very complicated subject that combines multiple fields of study such as hydraulic engineering, hydrology, geology, geomorphology and various types of biology. Similar to the ecosystems, all of these fields are connected to each other and to the overall riparian corridor. A change in one field will have impacts on all of the others not only for that reach of the stream, but also in upstream and downstream areas. These changes will also have impacts on 'human boundaries' such as floodplains and floodways. For example, one landowner creating a pile of boulders and soil to direct the stream away from one of their buildings could be causing the stream to flow right into another landowner's house. This can also impact upstream landowners by changing the way the stream is moving sediment and in turn changing the rate and location of erosion caused by the stream.

In addition to ecosystems and river dynamics, streams are also influenced by **weather and seasonal changes**. Streamside landowners know that the depth and flow of the water will change greatly based on the time of year and the type of weather. These changes, whether they are large floods or regular seasonal fluctuations from snowmelt and rainfall, will of course have effects on ecosystems, river mechanics and the landowner's property.

Seasonal runoff will result in higher flows that can threaten houses and structures

All of these pieces interact and connect with each other to create what we view as the stream corridor. Part of living along a stream corridor is understanding these connections and interactions. A change in the **ecosystems** will not only affect the organisms, but will also impact the **river dynamics**. For example, the roots of many types of plants help stabilize streambanks, protecting them from erosion. If those plants are removed, the streambank is more likely to erode. This will release sediment into the stream and can result in the stream channel moving across the land. A better understanding of these inter-connected pieces, as well as recognizing how they relate to each other, can help you be a good steward for the stream, your community and the larger watershed.



What is your role within the larger stream corridor and watershed?

Watershed | *waw•ter•shed* | noun

The region or area drained by a river, stream, etc.; drainage area.

Dictionary.com, n.d. [page 188]

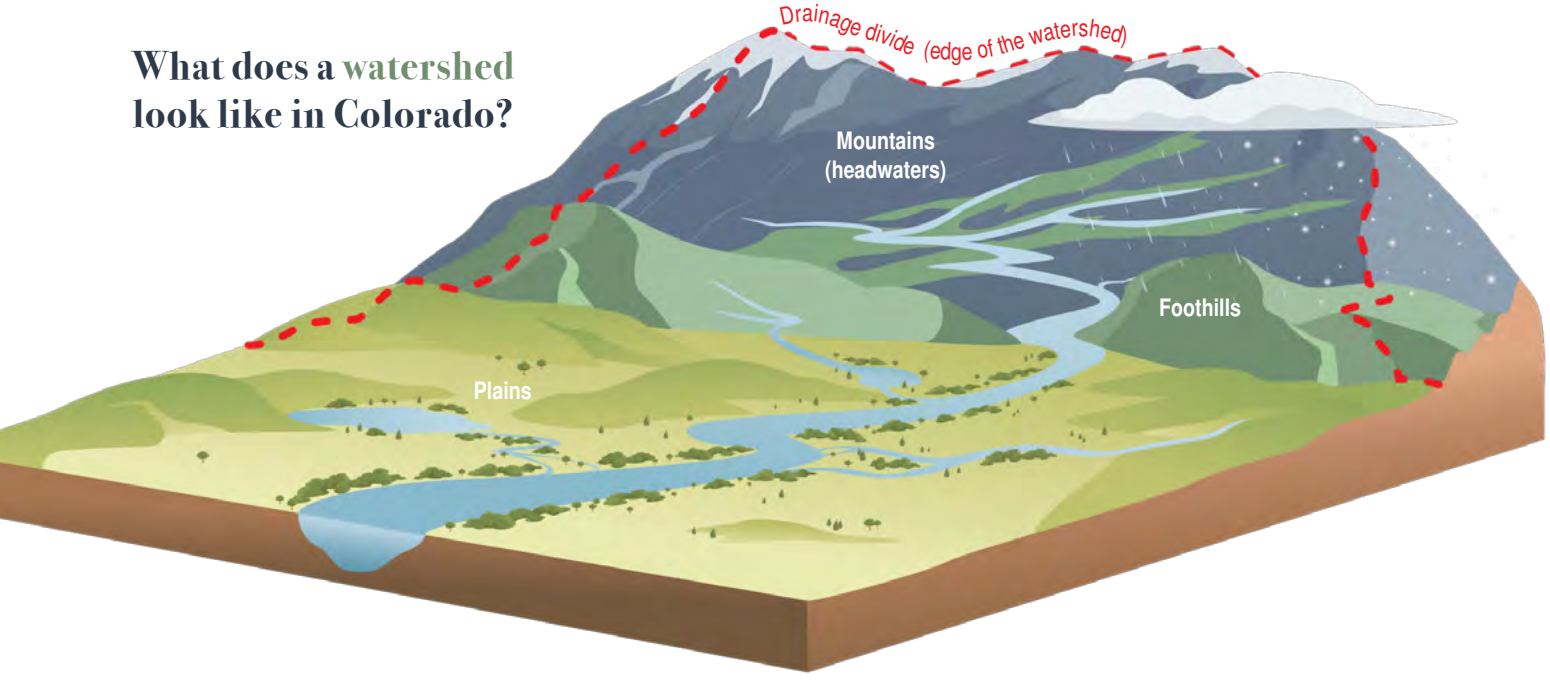
Generally speaking, a watershed is an area of land consisting of a network of streams, rivers and lakes that drains to a single point. This point can be where a river meets the ocean, or where a large river meets an even larger river. The term watershed is also interchangeable with "drainage basin" or "catchment basin/area". Watersheds are separated by drainage divides or high points along the landscape that result in water flowing towards different streams and rivers. For example, one of the most commonly recognized drainage divides is the Continental Divide. Watersheds are 'fed' water by rainfall, snowmelt and other types of runoff. This runoff then collects into streamflows that create streams and rivers within the watershed. Each watershed is defined by characteristics such as landforms (valleys vs. plains), streambed material (rock vs. sand) and steepness (slope) of the streambed. These characteristics change throughout the watershed and they influence the behavior of the stream or river.

You can identify the specific characteristics of the stream through **your property** by using the ***'Stream Classification Guide'*** *[page 68]* in **Chapter 2**.

The four adjacent watersheds being evaluated in this Handbook are along the Front Range of Colorado's Rocky Mountains. These watersheds are the Lefthand, St. Vrain, Little Thompson and Big Thompson watersheds and they share many similar characteristics. All four of these watersheds have headwaters high in the mountains. In this portion of the watersheds, the streams and rivers have carved deep valleys into the mountains. Typically, the rivers and streams in these valleys have a steep slope and the water moves quickly over the rocky terrain. These rocks are usually sharp and angular rather than rounded and bedrock is often seen at or near the ground surface.

As the water moves downstream through the foothills, the streams and valleys widen out into larger open channels along the eastern plains. These lower areas of the watershed are usually defined by streams with more gradual slopes that meander within wide floodplains. The moving water carries rocks, sand and sediment with it. The rocks become rounded and smaller from being moved by the water and are eventually deposited as sediment throughout these areas.

What does a watershed look like in Colorado?

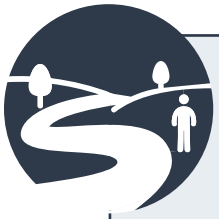


Comprehending these basics of how the watershed works, as well as identifying your place within the larger watershed, is critical to understanding the processes that shape your riverfront property. This knowledge will also help you to develop plans to properly maintain and restore the stream corridor. As an owner of a riverfront property, you have a unique opportunity to improve the health of your land and enhance the value of your property through sound stewardship practices. Being a good stream steward not only provides your property with ecological, health and economic benefits, but your upstream and downstream neighbors as well. These watershed-wide benefits also include the improvement of water quality, wildlife habitat connectivity and flood resiliency.

What simple things can you do to be a Good Steward?

A **good steward** not only has a financial investment in their property, but also a personal one. This personal investment extends beyond property lines by understanding the upstream and downstream effects of actions. In order to recognize these corridor-wide impacts, good stewardship begins with education and then develops into actions based on that knowledge. In this fashion, good stewards are informed enough to make stewardship and recovery decisions that meet their goals while avoiding negative impacts to the stream system. On the following pages, you can learn about simple ways to be a good stream steward, beginning with **education** and **knowing your watershed**, then leading to **actions** that you can take.

Education



Spend time along your riverfront property: become personally familiar with the natural processes, both in-stream and along the stream banks. Try to see the changes taking place over time at your property and learn why they are happening. The more time you spend observing the natural processes on your property, the more familiar you will become with them. This will help you when making decisions about improvements and changes.

Stay current on the latest issues related to your stream or watershed: attend local and regional coalition meetings and workshops. Your local watershed coalition is a great resource for education and up to date information. Conservation groups are also a great resource.

LEFTHAND WATERSHED oversight group
www.lwog.org

BIG THOMPSON WATERSHED COALITION
www.bigthompson.co

Little Thompson Watershed Restoration Coalition
www.ltwrc.org

SAINT VRAIN CREEK COALITION
www.saintvraincreekcoalition.org

Colorado Watershed Assembly

There are over 80 watershed coalitions in the State of Colorado.
Find a full directory on the Colorado Watershed Assembly website at:
coloradowater.charityfinders.com/Watershed%20Group%20Directory

Get involved with land management classes and stream cleanups that are offered by your local watershed coalition, non-profit organizations and local agencies throughout the year. Not only will you be making a difference, but you are likely to learn new things and meet new people within your watershed.

Know Your Watershed

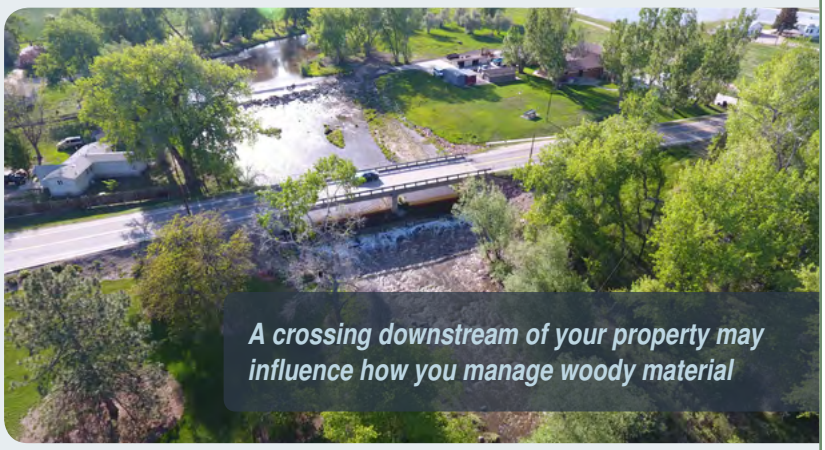
One of the easiest ways you can be a **good steward** is by simply **knowing your watershed**. This means learning about the larger area that the stream flows through and how you and your property fit into this larger picture. First steps to knowing your watershed include:

Learn about the geography, geology and water flows of your watershed. This will help you understand where the water in your stream is coming from, what types of land it flows through before arriving on your property and the types of land it will flow through after your property.

Surf Your Watershed is a great online resource provided by the Environmental Protection Agency (EPA) for learning more about your watershed!

cfpub.epa.gov/surf/locate/index.cfm

EPA

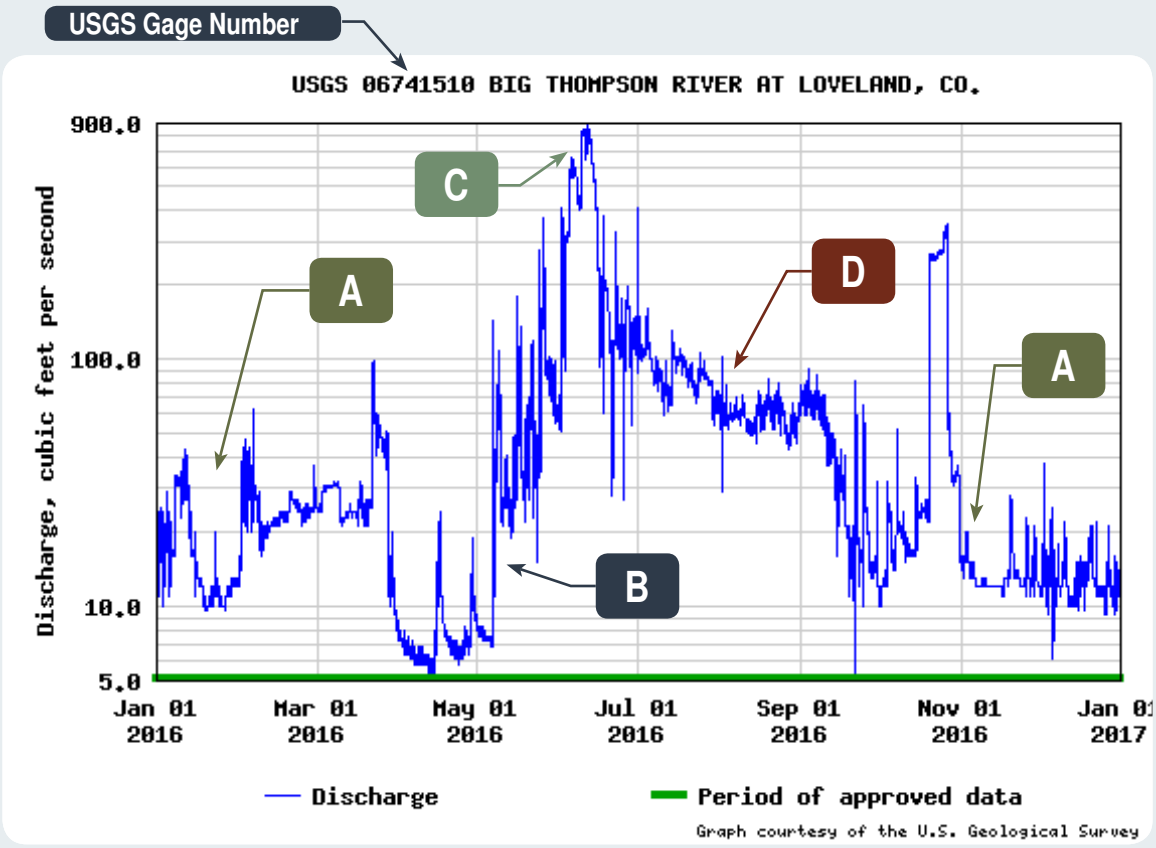


A crossing downstream of your property may influence how you manage woody material

Learn about how the stream is being used upstream and downstream of your property. For example, irrigation diversion dams upstream of you are likely to cause changes to the flows in your stream. On the other hand, if there is an irrigation ditch diversion downstream of your property, it will be helpful to know that the ditch company may dredge their ditch. As a result, this will cause changes in how the stream moves sediment on your property.

Other items to keep in mind include considering how people may be using the stream for agricultural, recreational, business and social uses. Knowing what the stream is being used for upstream and downstream of your property will help you make decisions about what types of improvements or maintenance will be most effective.

Another way to become familiar with the stream flows in your watershed is to **look at and understand the data collected at USGS gages**. The USGS has monitoring gages at multiple points along streams and rivers and the data collected is publicly available. The data is typically shown in a graph known as a **hydrograph**. You can access the hydrographs at ***https://waterdata.usgs.gov/nwis***. Below is a hydrograph for the 2016 for the Big Thompson River as it flows through Loveland. Labels A, B and C note seasonal variations and the reasons for the changes.



A Low stream flows during cold winter

B Agricultural diversions can cause low flows in spring and summer months

C Peak high flows during spring snowmelt/runoff

D Hot, dry summers result in more irrigation diversions and lower stream flows

Now that you know where to find a hydrograph and how to read one, what can you learn from a hydrograph of your stream?

- What times of the year your reach of the stream typically has the **highest** and **lowest** flows.
- What types of flows your stream experiences and **what they look like on your property**. Compare the **discharge** numbers with what you are seeing on your property.
- How the annual cycles are **generally consistent**, but flows can also vary based on short thunderstorms, or longer storm seasons. No two years will look exactly alike.

Actions

Now that you have learned more about the **educational** ways to being a good stream steward, you can put that knowledge to work through **actions**. Below are some simple strategies for putting good stewardship philosophies into practice on your property:

Protect the stream and adjacent riparian areas on your property. When possible, preserve the natural beauty of the stream by selecting actions that minimize impacts to the stream and adjacent riparian areas.

Keeping a natural buffer area between maintained turf and the stream will help to preserve the natural functions of the stream.

Monitor your stream for changes to the stream and riparian corridor. Regularly monitoring can be as easy as observing and recording where the water is reaching on your property, as well as the types and amounts of wildlife and plant species on your property. The water quality can be something scientifically tested, or it can just be visual observations of what is living and growing in the stream. All of these will help identify issues and needs along your property. Pictures are great ways to record the monitoring and having a historical record of pictures about your property will help you and others to understand how the stream is working.

The flow of a stream can change dramatically with the seasons. Keeping a record of these changes is easy but important.

Support your local coalitions that work to protect your watershed. LWOG, BTWC, LTWC and SVCC work hard to engage private landowners such as yourself to promote comprehensive approaches that improve watershed health and the communities within them.

Working with your local watershed coalition or organization is a great way to have a positive impact on the larger watershed.

Be neighborly and work together towards a common goal. As part of being a good steward is considering the larger area beyond your property limits, it makes sense to work with your neighbors to improve the overall watershed health. This can range from simply sharing advice on weed control techniques, to making a project that spans multiple properties, to creating a conservation easement that pools resources for large projects.

Participating in watershed coalition events and workshops is a great way to meet neighbors and learn what they do to be good stewards

Take on small stewardship projects before a situation worsens. As you monitor your property, continually consider if there are small projects that will help the situation. These small projects can range from invasive weed management, to culvert maintenance, to willow plantings to stabilize a streambank. More time spent monitoring your property and making small improvements generally means less time and money will need to be spent on large recovery efforts after flood events. See ***'Chapter 3: Evaluating Your Property'*** to assess your property and ***'Chapter 3: Stewardship and Recovery Strategies'*** to learn about stewardship and recovery strategies you can use.

Being diligent about removing trash in and near the stream channel will reduce the amount of debris in a flood.

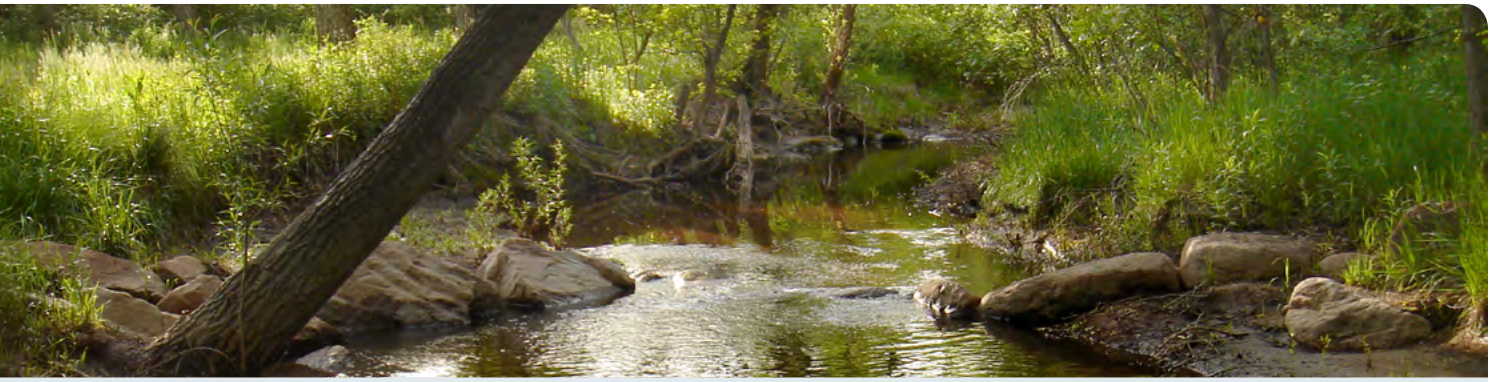
Avoid dumping lawn clippings in or near the stream. They contain mineral nutrients which decrease oxygen for fish.

Planting willow stakes above the high water level in the outer bend of this stream will stabilize the streambank while improving water quality and aquatic habitat.

Ask for help before taking on large recovery or restoration projects. Often, these projects will require engineering/design and permitting assistance both to adhere to legal requirements and to ensure your project does not have a negative impact on other properties. This includes any work in the stream channel itself and will ensure that upstream and downstream effects of the project are beneficial. You can talk to your local watershed coalition, city or county agencies, or consultants such as engineers, geomorphologists, environmental scientists or contractors. Types of outside help and how to engage them are discussed more in ***'Chapter 4: Engaging Outside Help'***. When in doubt about if your project or action will have impacts, reach out for help and advice.

Performing work in the stream channel will require permits and sometimes engineering depending on the type of work. These regulations are put in place to protect the stream system, as well as streamside landowners such as yourself.

Depending on wildlife impacts and the funding source of your project, you may be required to obtain permits before beginning work.



Give Nature a Chance

A Discussion with Rick Kauvar, Left Hand Creek Resident, Board Member & Steward

One of the main objectives of this Handbook is to show landowners what they can do to be good stream stewards. Many landowners are already doing things to care for the stewardship of their streams. Rick Kauvar, who is an LWOG board member, is a prime example what a good stream steward can be. Rick has lived along Left Hand Creek for over 30 years and has taken a hands-off approach to stream stewardship. In this way, he has striven to "Give Nature a Chance." As a result, his property had the ability to beautifully rebound from the flood of 2013. Because Rick's property has generally been left to progress 'naturally', the 2013 flood was simply a natural occurrence for it.

Left Hand Creek has a wide riparian corridor through the property.

Rick has backgrounds in environmental, population and organismic biology (more commonly known as EPOB biology) and real estate/development. He has a deep understanding of, and interest in, the biological and ecological benefits of healthy stream systems. The longer that he has lived on his property, the more this interest has grown and led him to become engaged with LWOG. In addition to being an LWOG board member, Rick is also engaged with his community. With permission, he is happy to welcome visitors to visit his property to better understand what it means to be a good steward.

Rick has left plenty of Good Wood, seen here along the streambanks.

Rick's main philosophy for stream stewardship/ streamside property management is that 'less is more.' As landowners, you can **give nature a chance** to create its own forms of resiliency in the floodplain/riparian corridor. The less man-made encroachment into the floodplain, the less damage can be done and the less recovery work will be required. Streams and rivers naturally flood and have their own ways of stabilizing banks, re-aligning channels and moving sediment. If landowners are able to give a stream enough space to perform these actions naturally, there will be far less recovery work that they need to do after large floods.

He also understands that dead wood serves valuable roles in the ecosystems and that woody material should not be automatically cleared away. Rather, a lot of woody material can and should be left in place as a carbon/nutrient source

and a great habitat for animals. While dead woody material doesn't generally fit into a manicured landscape, he believes that floodplain and riparian areas should serve as a riparian buffer between the stream and manicured landscape areas like lawns. While Rick maintains a more typical manicured lawn outside the floodplain near his house, he uses the floodplain area as a buffer for the creek.

Letting nature work on its own will also decrease how much ongoing stewardship a landowner will need to do. However, one exception to this is invasive weeds. Rick says that this is "*the one big thing that I have to continually maintain on my property*." Invasive weed management is a key to good stream stewardship and is discussed in more detail in the ***'Vegetation'*** *[page 8]* section of **Chapter 2**.

In combination with letting nature take its own course, Rick makes an effort to stay familiar with his property. Knowing your property includes being familiar with the vegetation, wildlife and the actual stream that runs through it. As discussed in the ***'Know Your Watershed'*** *[page 20]* section in **Chapter 1**, you can use hydrographs and your own observations to become familiar with typical seasonal high and low flows. In Rick's case, this allows him to know what areas will be typically flooded during normal flows, while also providing setbacks for larger events. Along with this, he has accepted that another flood will happen and he must be prepared for it to happen. Another aspect of knowing your property is understanding the geology and geography of your site. This is necessary not only to understand where water may go, but also to know which vegetation will do best on your property.

Walking their property has helped Rick and his family to understand the processes of the creek.

During the 2013 flood, Rick saw flood waves move through his property, but his house was not affected and the property surrounding the creek was minimally affected or damaged. Today, it is difficult to recognize that a major flood recently swept through the area. For recovery, Rick has hardly taken any recovery actions. Overall, Rick has only spent about $250 to repair his property from the 2013 flood.

We can learn several things from Rick's approach to being a good steward:

- You can enjoy your property **without** doing a lot of work or spending a lot of money.
- **Passive management** can often be the best management.
- Structures and encroachment in the floodplain put properties **at higher risk** during flood events.
- **Untouched floodplains** generally provide a better ecosystem.
- **Woody material** provides many benefits and should not be automatically removed.
- Nature will take its own path, including **flooding and recovery.**
- **Floods will happen.**
- Invasive weed management **does** require ongoing work and is important.

Large Event Preparedness

Owning a riverfront property has numerous benefits but also presents the risk of flooding. Though larger flood events are not an annual occurrence, they do occur and will continue to occur. If you live along a stream or river, you must accept the fact that large flood events **will** impact you and your property. Advance planning for flooding is critical for your safety and to minimize damages to your property, as well as the properties immediately upstream and downstream of you.

This advance planning can take many forms and each landowner will need to determine what they will do to prepare for flood events. This can range from making meeting place plans with family members, to stocking up on fresh water and food, to identifying secondary access points to and from their property. Whatever planning you decide to do, you must be prepared to put your plans into action in the case of a flood. It is also important to review your preparedness plan with family members frequently so that everyone knows what to do in an emergency.

Remember: floods are unpredictable and dangerous, but you can make sure that you and your family are prepared for when they happen!

Two of the largest flooding events in the Big Thompson watershed occurred in 1976 and 2013 (shown here). Both resulted in major losses of property, infrastructure and life. Part of living along a waterway is preparing your family for emergencies such as floods.

Photo Credit: Justin Smith *[page 188]*

As a property owner, you have a number of city and county resources that you can rely on for the most up to date disaster preparedness information and to access local resources in the event of a flood. Many Northern Colorado counties and cities offer comprehensive resources for disaster preparedness and recovery through their Office of Emergency Management (OEM). The links below offer the most up to date information on emergency management information for the region, as well as preparedness guides from the OEM's:

www.boulderoem.com

Boulder OEM Emergency Preparedness Guide:

http://oemwordpress.azurewebsites.net/wp-content/uploads/2014/10/Preparedness-Guide-2014.pdf

EMERGENCY MANAGEMENT

www.weldgov.com/departments/office_of_emergency_management

Weld County OEM Community Preparedness:

www.weldgov.com/departments/office_of_emergency_management/community_preparedness

Larimer County Emergency Management

www.larimer.org/emergency

http://www.cityofloveland.org/departments/fire-rescue/emergency-management

http://www.poudre-fire.org/emergency-preparedness

Fort Collins/Poudre Fire Authority Flood Preparedness:

http://www.poudre-fire.org/emergency-preparedness/preparations-risks/flood

Prepare. Plan. Stay Informed.

https://www.ready.gov/

Ready.gov Flood Information:

https://www.ready.gov/floods

Along with reviewing these websites and documents, you can create written plans for what and your family will do before, during and after a flood. The American Red Cross is an excellent resource for this type of flood preparedness, providing detailed guidance on how to prepare these plans.

American Red Cross www.redcross.org/get-help/how-to-prepare-for-emergencies/types-of-emergencies/flood

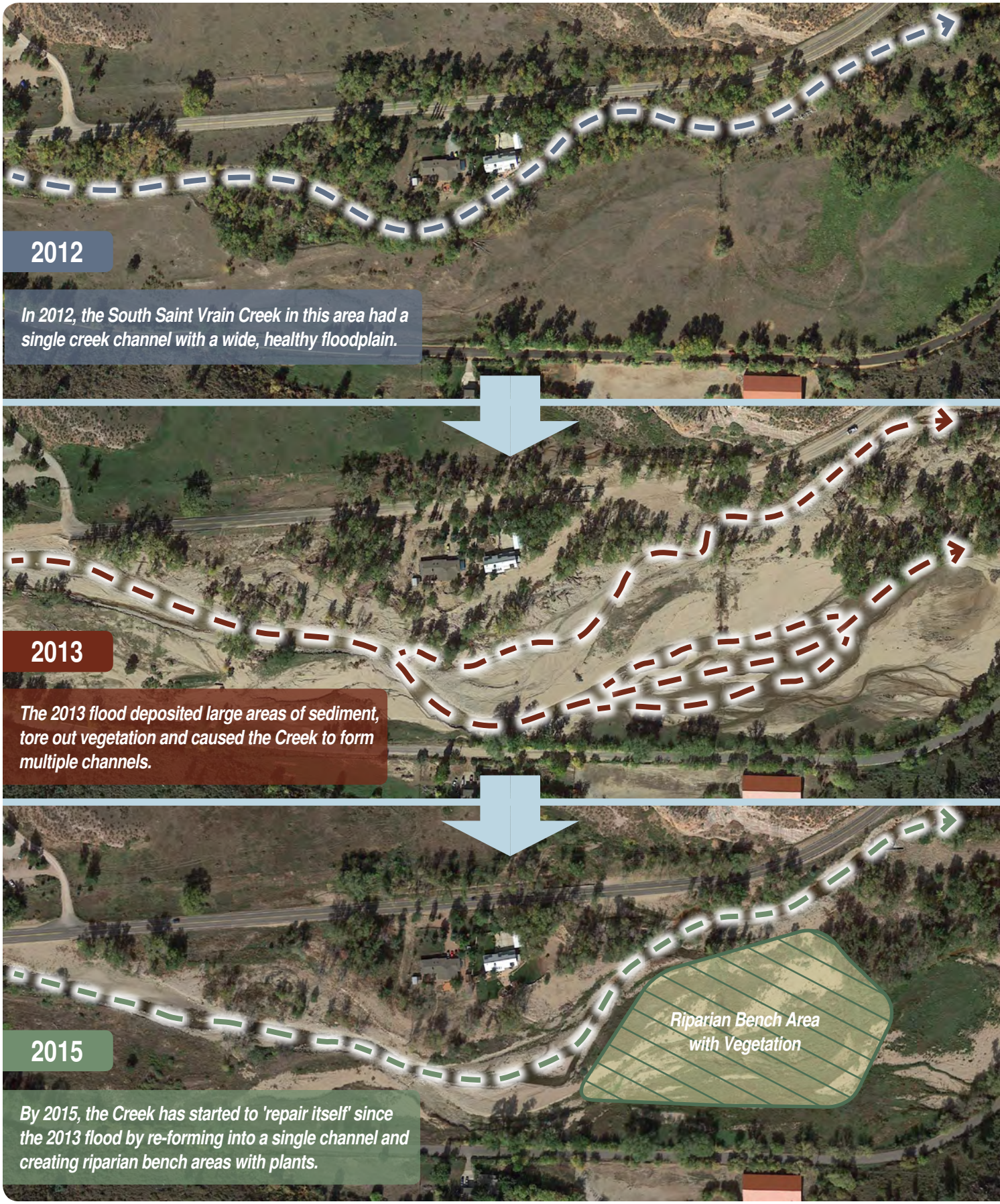
Heavy flood damages, like those shown here in Loveland, can spur emotional responses rather than logical solutions that consider long-term sustainability.

Post-Flood Evaluation

In the aftermath of a flood sometimes it's hard to identify exactly why the damage occurred in the first place and people can have **emotional** reactions that may not be in the best interest of the stream system and may even cause **additional damage**. Even worse, these reactionary 'projects' can have adverse affects on upstream and downstream neighbors.

For example, a number of emergency recovery projects were developed in response to the region's extensive 2013 flooding. Restoring damaged infrastructure was the first priority for these reconstruction efforts. Emergency funding for these projects often required a very quick construction schedule, limiting the opportunities to take a comprehensive approach to restoring the streams and rivers. In response, a number of projects armored and channelized the river to reconstruct damaged infrastructure. While this was done to protect infrastructure, it **degrades** the health of the stream. It was later found that the channelization done as part of many of these reconstruction efforts further damaged or degraded the stream function and aquatic habitat. This was also done by many private landowners in an effort to 'stabilize' their property. Unfortunately, many of these projects were not the best long-term decisions for the properties or the stream corridors.

To prevent this from happening in the future, as well as to help you avoid making **reactionary decisions** after a flood, it is important to take a step back and try to **assess** your situation with a long-term view. This includes evaluating both the damages of a flood and the restoration opportunities you may have. Furthermore, as many of you have found in the years since the 2013 flood, sometimes **doing nothing** can be the best option for an area. Since the 2013 flood, many of the areas that were damaged are starting to **repair themselves naturally**, without human intervention.


2012
In 2012, the South Saint Vrain Creek in this area had a single creek channel with a wide, healthy floodplain.
2013
The 2013 flood deposited large areas of sediment, tore out vegetation and caused the Creek to form multiple channels.
2015
By 2015, the Creek has started to 'repair itself' since the 2013 flood by re-forming into a single channel and creating riparian bench areas with plants.
Riparian Bench Area with Vegetation

The following is a list of post-flood questions to ask yourself in the months immediately following the event, along with subsequent recommendations to consider before reconstructing your property after a flood:

1. Did the flood cause significant bank erosion?	If the eroding banks do not threaten buildings or infrastructure (roads, bridges, etc.), avoid armoring the banks with riprap or stone. Instead, consider stabilizing the banks with vegetation or re-grading. You do not want to 'box' the stream into a tight channel.
2. Did the floods leave significant amounts of sediment on your property?	Consider using sediment deposits for plantings. Be careful not to move the sediment into the stream if you are doing work. Talk to an outside consultant (watershed coordinator, landscape architect, engineer, river constructor) before moving or removing sediment.
3. Did the floods leave woody material in and along the stream corridor?	Leave woody material in place if it is outside of the main flow of the stream. If you are not sure if you should remove it, contact your local watershed coalition for assistance evaluating it. If you think the woody material poses an immediate threat to property or persons, contact your local Office of Emergency Management (contact links provided on *[page 29]*). When possible, stockpile large woody material so it can be re-used for bank stabilization projects.
4. Did the stream move to a new location as a result of the floods?	If the new stream location does not threaten buildings or infrastructure (roads, bridges, etc.), leave the stream in its new place. Streams naturally move throughout their floodplains over time.

As a final rule, always consider upstream and downstream affects of your actions. If you are unsure if your actions will impact your neighbors, ask for outside help. Contact your local watershed coalition, city or county agencies, qualified engineers/river designers or environmental consultants.

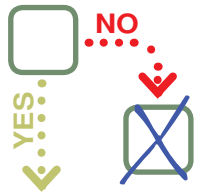
CHAPTER

2

Evaluating Your Property

In *'Chapter 1: Living Along a Stream'*, you learned about how your property fits into the larger watershed and why it is important to consider these larger regional connections. In this chapter, you will learn ways to visually evaluate the conditions on your property using the **Landowner Assessment Questionnaires** and the **Stream Classification Guide**. Your notes from evaluating your property can be recorded on the **Landowner Assessment Worksheet**.

The *'Landowner Assessment Questionnaires'* *[page 34]* are split into **7** separate categories. Each category has text that explains what you should be looking for on your property and why these items are important, followed by the actual **Questionnaire**. While you don't need to fill out all **7** at the same time, you will develop a more complete picture of the conditions on your property by the time you complete all of the **Questionnaires** and recording your notes and answers on the **Landowner Assessment Worksheet**. These notes and answers will direct you the most applicable types of **Stewardship and Recovery Strategies** for your property. You can then find the details of the strategies in *'Chapter 3: Stewardship and Recovery Strategies'*.



The *'Stream Classification Guide'* *[page 68]* will lead you through a series of steps to determine the Entrenchment, Slope and Primary Streambed Material for your property. These factors will help you to determine what type of stream you have on your property. How you will install or design some of the **Stewardship and Recovery Strategies** will vary based on what type of stream you have.

As you complete the **Assessment Questionnaires** and the **Classification Guide**, you can record notes about your property on the *'Landowner Assessment Worksheet'* *[page 72]*. In order to keep an up-to-date record of your property, you can update this **Worksheet** every year, every few years or after large events. It can also be helpful to evaluate your property at different times of year because you will see different conditions based on the water level, plant growth and other seasonal factors. At the back of the Handbook, you will find additional copies of the **Landowner Assessment Worksheet** so that you can evaluate your property multiple times.

Landowner Assessment Questionnaires

The **Landowner Assessment Questionnaires** on the following pages provide a guide to evaluating the existing conditions on your property in order to identify **Stewardship and Recovery Objectives**. In **Chapter 3**, you will determine specific **Stewardship and Recovery Strategies** to achieve these **Objectives**. Because streams and riparian corridors are complex systems with many moving parts, the **Questionnaires** are split into **7** distinct categories. Each category plays a role in the riparian corridor and it is important to complete all of the **Questionnaires** to make a comprehensive plan for your property. As you complete each **Questionnaire**, fill in your answers and additional notes on the ***'Landowner Assessment Worksheet'*** *[page 72]*.

Questionnaire Categories

- **Bank Stability** *[page 35]*
- **Flood Risk Management** *[page 38]*
- **Large Woody Material** *[page 41]*
- **Vegetation** *[page 45]*
- **Non-Aquatic Species** *[page 57]*
- **Aquatic Species** *[page 63]*
- **Desired Land & Stream Uses** *[page 66]*

How to Use the Questionnaires

Text in **Color Boxes** are questions about your property.

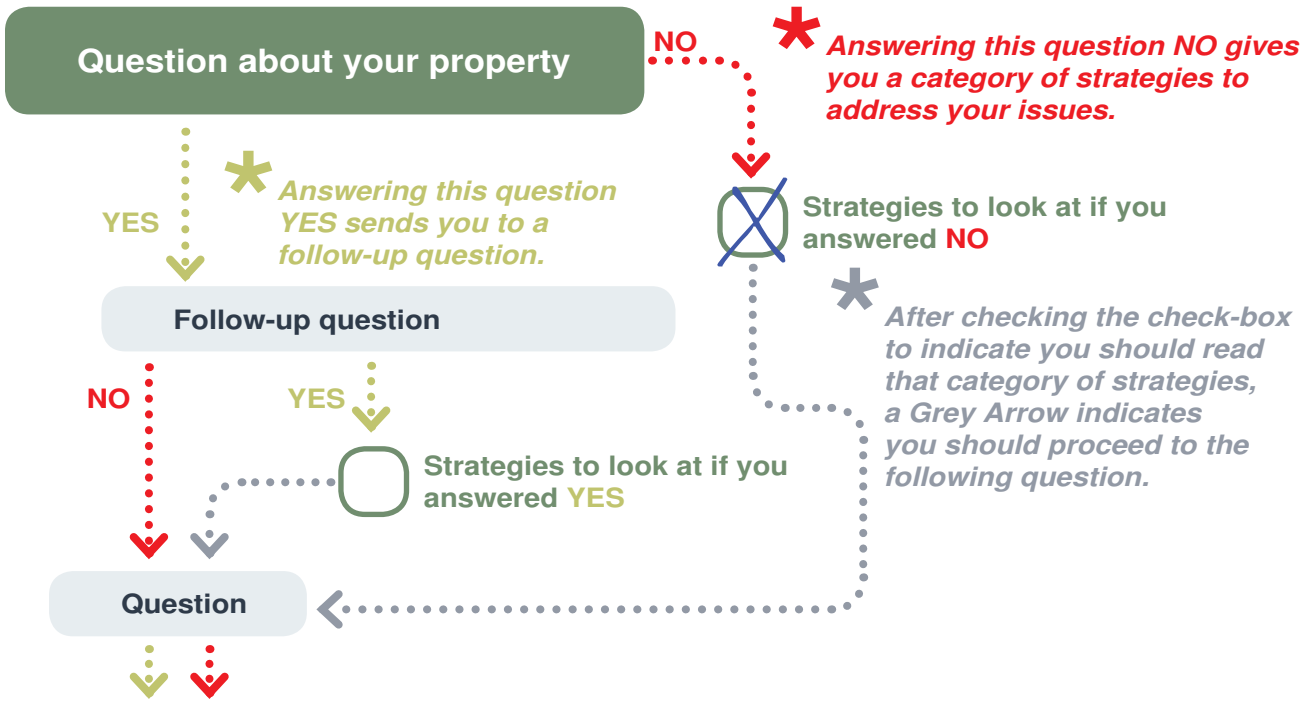
☐ **Bank Revegetation**

Text next to check-boxes are goals. If your answers lead you to these, check the box and proceed with the arrows.

Green arrows direct you if your answer to the question is YES

Red arrows direct you if your answer to the question is NO

Gray arrows direct you after you have selected a strategy



LEFTHAND WATERSHED oversight group

Bank Stability

Streambanks, or 'banks', are the sloped areas alongside streams, creeks and rivers that connect the stream to its floodplain. Banks contain the flow of the stream on either side of the channel and often dictate its behavior. Shaped by the complex processes of **river dynamics** (discussed more in ***'Chapter 1: Living Along a Stream'***), banks can vary from bedrock or large boulders barren of vegetation to finer soils lush with trees, shrubs and grasses. Banks will also vary in their height and slope, as well as their distance from the river.

Bank Stability

Bank Stability refers to the ability of a streambank, including its soils and vegetation, to resist erosion from water flows and gravity.

A Gradual streambank being created by sediment being deposited by the stream.

B Faster water is eroding the streambank in this area, creating an unstable bank.

C **Floodplain**; this area is above the streambank but water may still run over it during higher flows. When a stream is well-connected to its floodplain, seasonal high flows will run through the floodplain area. This is normal and healthy for a stream corridor.

Streams will naturally change their course by **shifting** and **meandering**. These changes are the result of the stream working to maintain a balance, or equilibrium, between the movement of water and the movement of sediment. As this happens, both the stream and the streambanks will change. For example, a slow moving section of stream may **deposit sediment** along a streambank. On the other hand, a faster moving section of stream may **intensify the erosion** of the adjacent streambanks and carry more sediment downstream.

Typically, a streambank will erode when the soils and vegetation cannot stand up to the flows of water from the stream. In other words, if the water is moving faster than what the vegetation can support, erosion will take place. For example, a dense stand of trees with roots in stable soils can generally resist greater flows than a gravelly area with little or no plants. In addition to the type of soils and vegetation that are visible on the surface, a streambank's stability will also depend on factors such as the frequency and force of stream flows, nearby land uses, health of the plants and the types of soil layers underneath the surface.

While it may be difficult for you to identify all of these factors, there are many indicators of bank instability that you can watch for. These include exposed soils, the bottom of the streambank falling into the stream and eroding vertical walls along the stream. In addition, the vegetation and how it might be growing/positioned could be an indicator. For example, a tree leaning across a river with its roots exposed could be a sign that the bank is not stable.

Vertical walls are a giveaway that a streambank is unstable. The white deposits on the soil indicate that the erosion may be depositing very salty soils into the stream. Some wildlife, such as bank swallows, will use steep or vertical cutbanks for shelter.

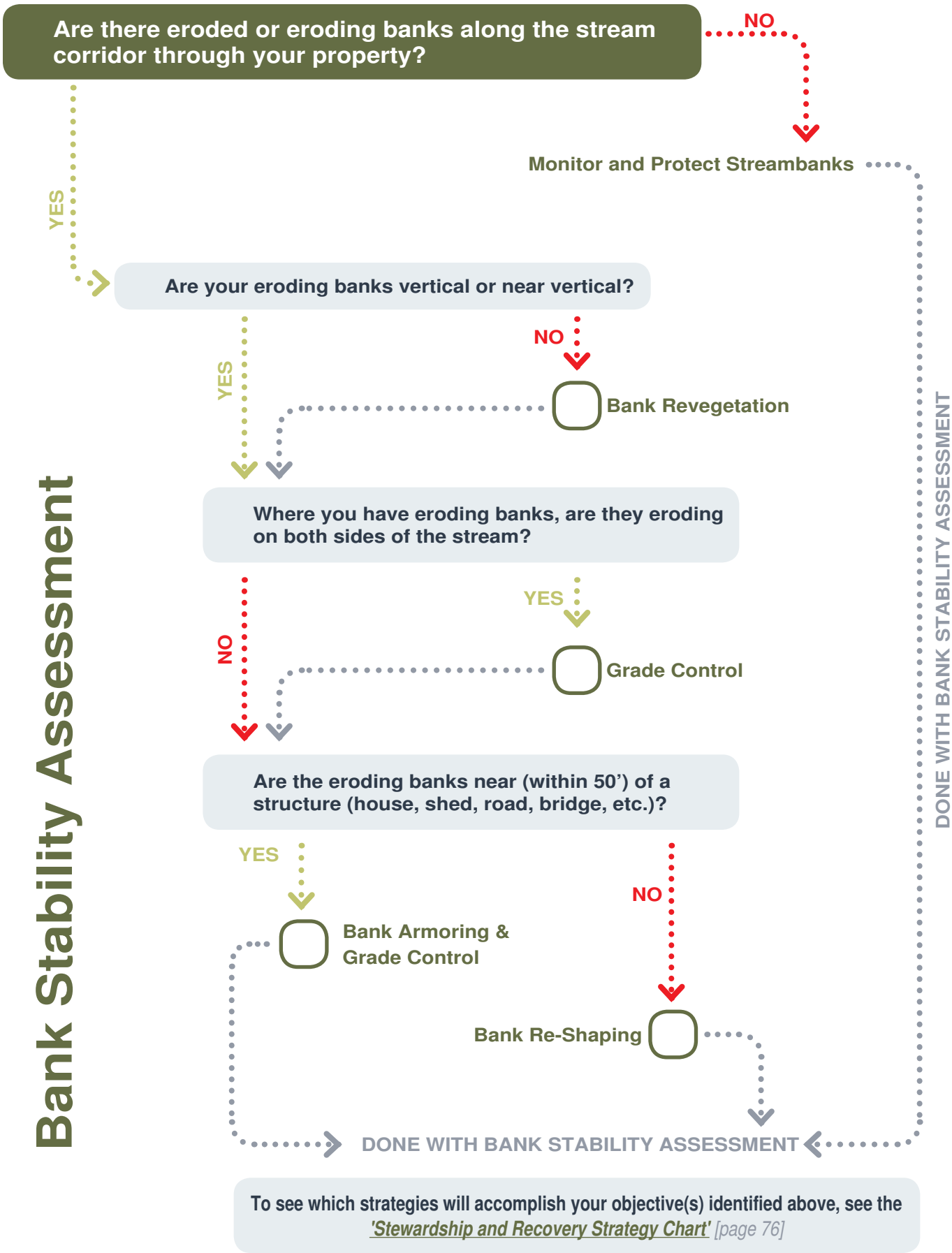
Because this isn't threatening a structure, the landowner may consider leaving the bank alone, especially if bank swallows are using the bank. Another option would include re-grading to create a more gradual slope down to the channel and adding vegetation to create a stable riparian bench.

To evaluate a streambank, you should consider what 'degree' of stability the bank is offering. Often times, banks have the strength to withstand the forces produced by **annual high flows**, but are unstable under the forces of **larger flood flows**. It is important to understand that even though a bank can appear stable under average daily flow conditions, it may not be able to withstand a 100-year flood event. For this reason, it is always recommended that structures be built away from the streambanks wherever possible.

The ultimate goal behind improving bank conditions is to encourage the stability and resiliency of a stream. However, the **appropriate approach** to improving bank conditions is highly dependent on each site's conditions. If there is a structure nearby, such as a house or road, it may be most appropriate to **armor** unstable banks with large rock. On the other hand, if an unstable streambank is not threatening a structure, simply **revegetating** the banks may be the best option for achieving this goal. The revegetation will still allow for greater resiliency and stability, but it will also allow the stream to migrate over time. This is much more in line with what the stream would naturally do.

Because many of the **bank stability strategies** will require working in the stream, floodplain and wetland areas, you may be required to work with outside help such as engineers, environmental consultants or river constructors to design, permit and install the project. This will ensure that your project is successful for you and for your upstream and downstream neighbors.

Bank Stability Assessment



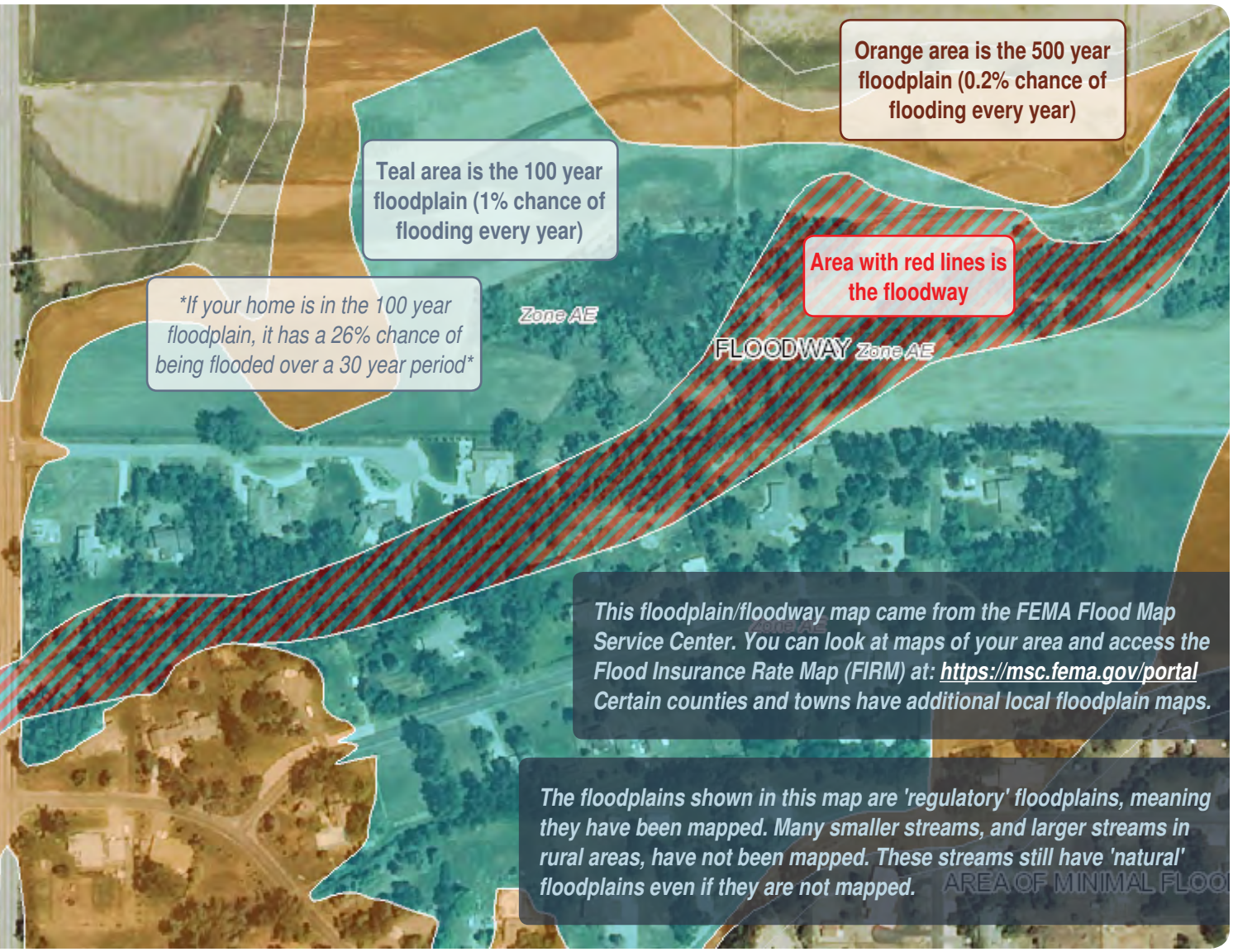
To see which strategies will accomplish your objective(s) identified above, see the *'Stewardship and Recovery Strategy Chart'* [page 76]

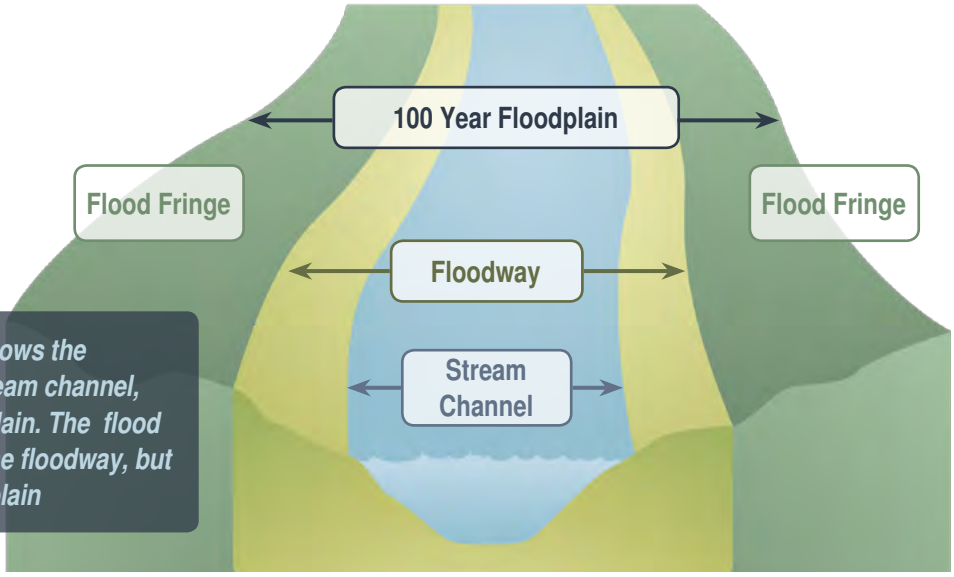
Flood Risk Management

Inherently, living along a stream or river presents landowners with the risk of flooding. Because stream flows typically fluctuate seasonally with higher flows during the spring runoff season and lower flows in the winter months, it is possible to anticipate when you are more likely to see a flood. However, floods are naturally occurring events that cannot always be predicted. Not only is it important to accept that **floods will happen**, but also to understand the effects that a large flood could have on your property. By doing this, you can take precautions to minimize the damage to your property and ensure your own safety as well as the safety of your upstream and downstream neighbors.

In terms of **flood risk management**, there are many topics that must be evaluated for your property. Two of the main concepts to consider when evaluating flood risk on your property are the **floodplain** and the **floodway**. The **floodplain** of a stream system refers to the overall area that becomes inundated or flooded during a given event, most commonly a **100 year event**. A **100 year event** does not mean that the water will only reach those areas once every 100 years. Instead, it means that there is a **1% chance every year** that you will experience a flood that reaches the edge of the 100 year floodplain.

During a flood event, there is a narrower area of land through which the flood waters will flow efficiently. This area is called the **floodway**. Areas of standing water within the floodplain are not typically considered part of the floodway. The floodway was delineated to ensure development or building does not take place within the area of greatest volume and velocity of flow.





This cross-section graphic shows the relationships between the stream channel, floodway and 100 year floodplain. The flood fringe is the area outside of the floodway, but still within the 100 year floodplain

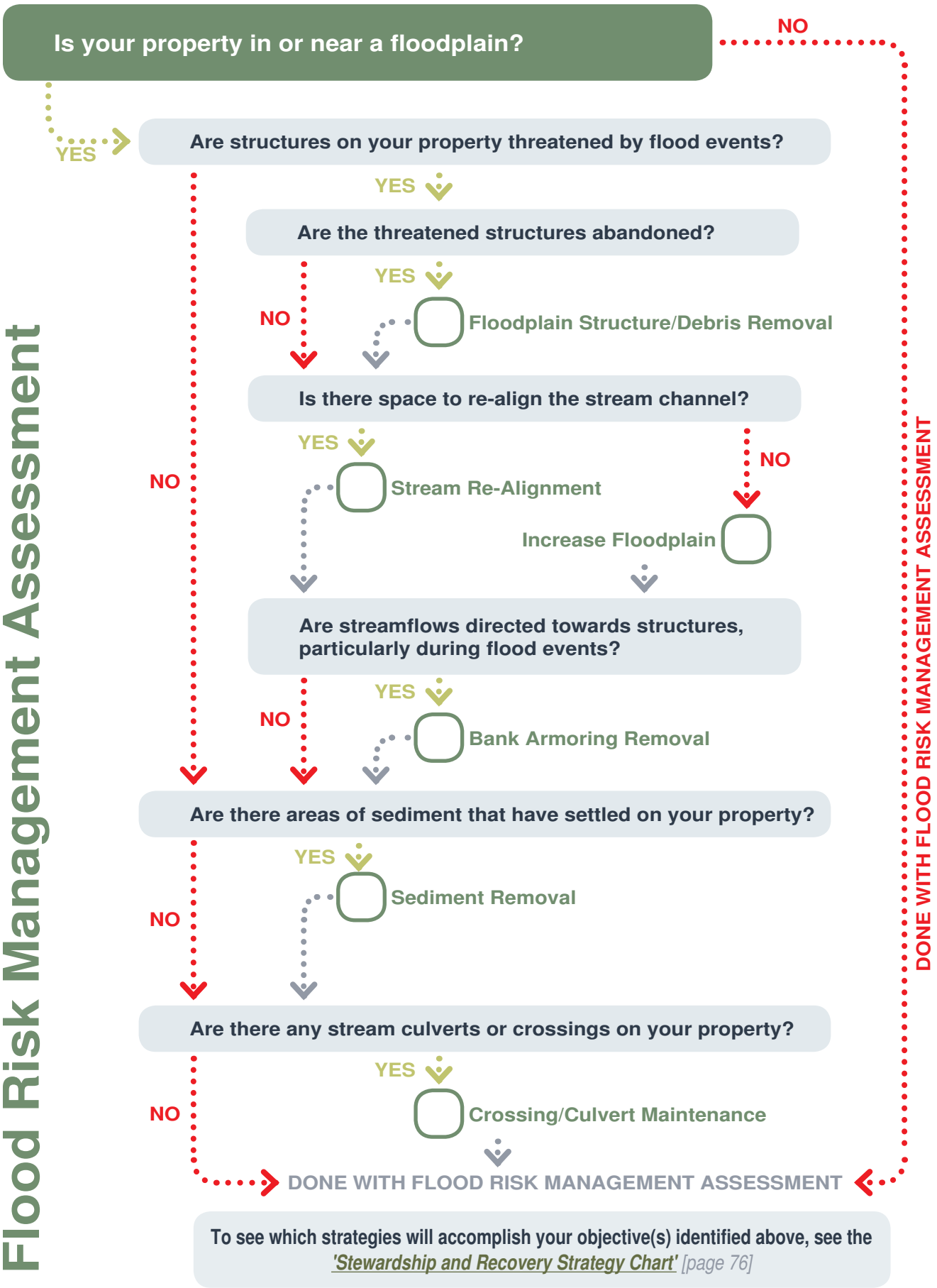
The first way to limit your flood risk is to keep structures such as buildings and roads out of the floodway and floodplain. Every structure that is in the floodplain is likely to be heavily damaged by floods. If you are able to keep structures out of the floodplain, your property will be far less prone to costly flood damages. Ideally, all structures should be outside of the floodplain; however, this may not always be feasible given the constraints of the site. While you may already have structures in the floodplain, you can consider if those structures are able to be relocated to a safer location or removed if they are not used. At a minimum, structures in the floodway should be secure enough to minimize the risk of becoming dislodged and turning into debris for downstream neighbors.

One type of 'structure' that is typically in a floodplain is a stream crossing. Stream crossings such as bridges and culverts play a critical role in determining the extents and the impacts of a flood. As an example, a crossing that does not have enough area to allow floodwater and sediment to move downstream will impact upstream properties. As water and sediment begin to back up behind the structure, the properties upstream of it can become flooded. Similarly, bridges and culverts that become clogged by debris from upstream will not be able to move as much of the flood flow downstream. This causes a significant upstream impact. As the flood and debris progresses and the clogged stream crossings cannot hold back any more water, they will fail and send a wall of water down the channel. In order to not minimize these flood risks, stream crossings must be carefully designed and continually maintained.

Some of the **flood risk management strategies** will require working in the stream and/or modifying the floodplain/floodway. Therefore, you may be required to work with outside help such as engineers, environmental consultants or river constructors to design, permit and install the project. This will ensure that your project is successful for you and for your upstream and downstream neighbors.

Major flood risk management projects, such as boulder armoring, require professional help for engineering, permitting and installation.

Flood Risk Management Assessment

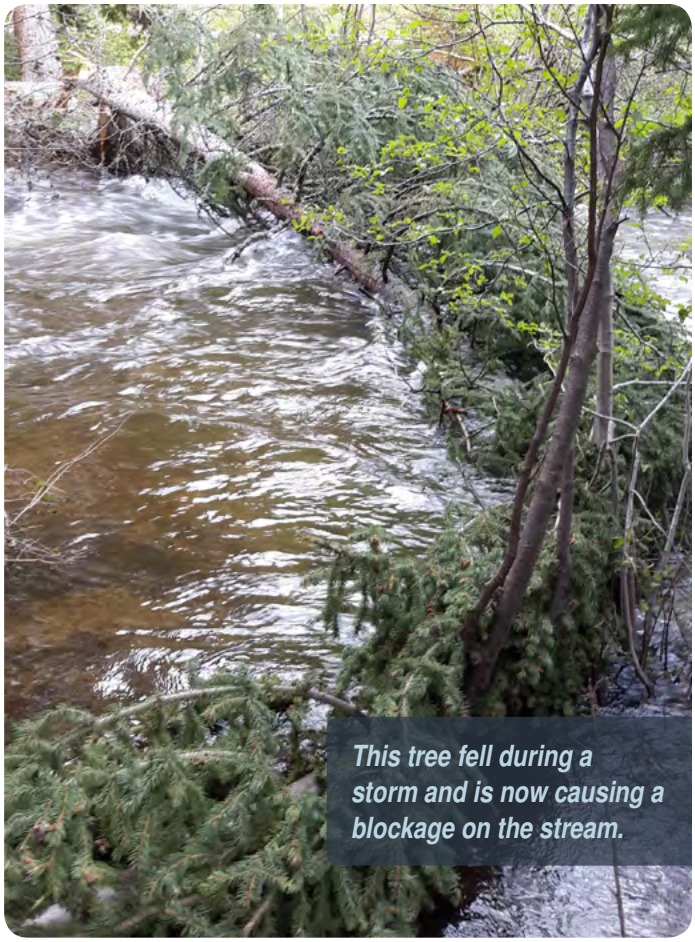


To see which strategies will accomplish your objective(s) identified above, see the *'Stewardship and Recovery Strategy Chart'* [page 76]

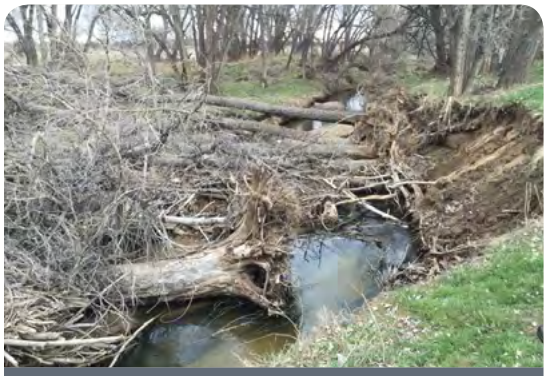
Large Woody Material

Large woody material (LWM) generally refers to dead trees, branches, limbs and logs. These may have been left on your streambanks by flood flows, or they may be the result of trees dying on your property. Large woody material can also come from high up on valley walls through mud or debris slides during or after heavy rains. Regardless of how the large woody material arrived on your property, the assessment and strategies to manage it are the same. While one goal of large woody material management is to reduce flood risks, you can also use large woody material to provide wildlife, vegetation and other environmental benefits to your property.

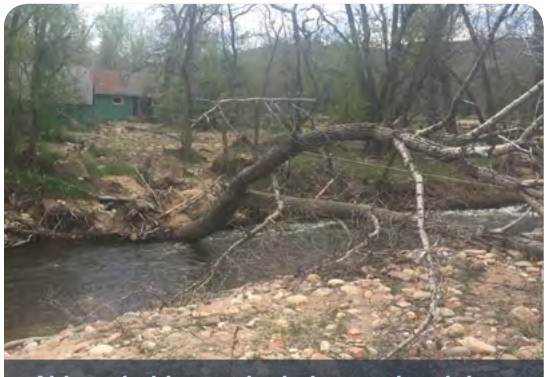
When evaluating large woody material on your property, you will need to decide if it poses a risk during floods or high flows. In general, large woody material provides many benefits to stream corridors and you only want to remove or relocate this material if you are sure it poses a risk. If you are unsure about if a piece of woody material poses a risk, please contact your local watershed coalition or a qualified stream restoration professional.



This tree fell during a storm and is now causing a blockage on the stream.



Large woody material blocking the entire channel; should be removed

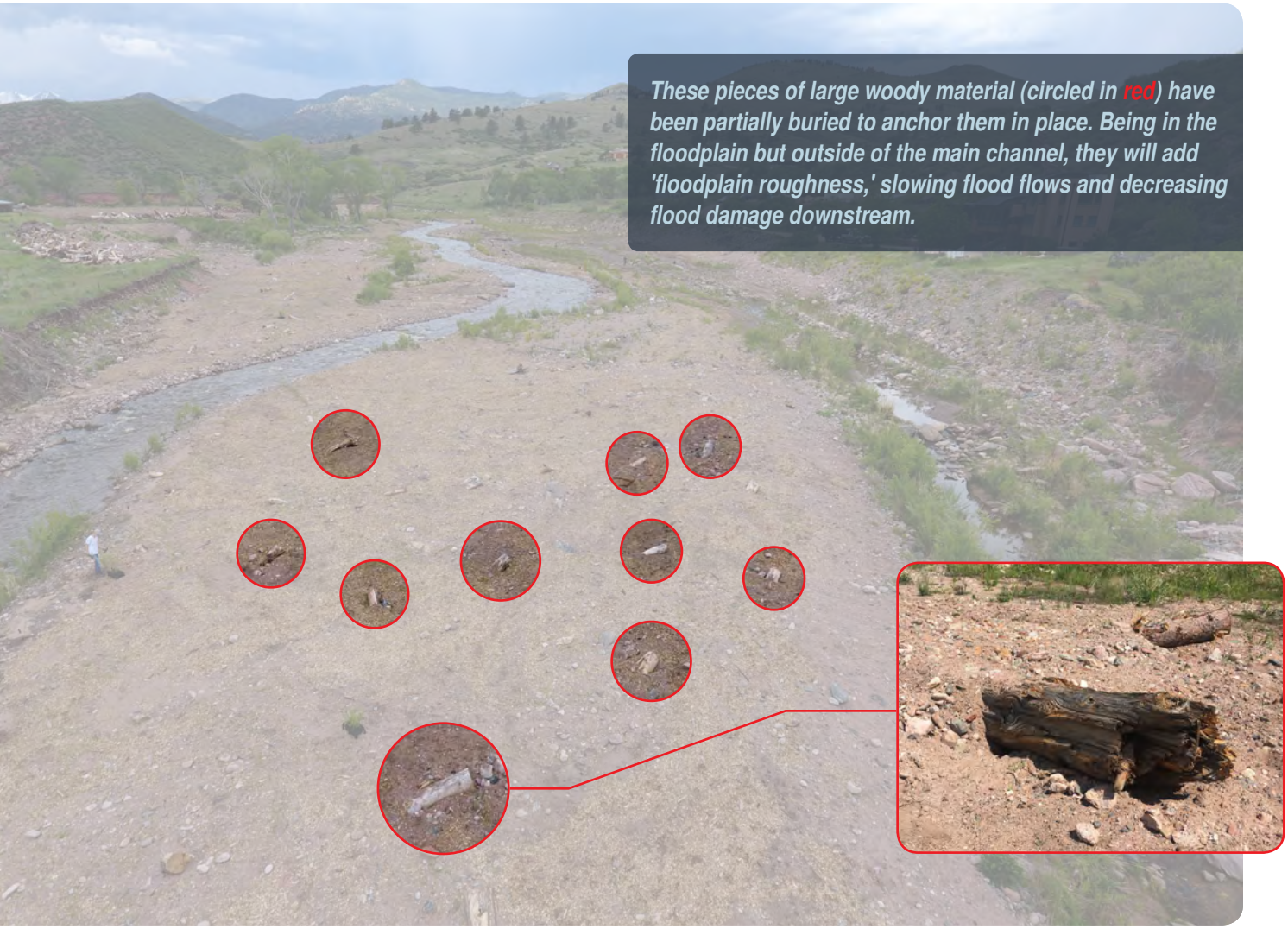


Although this may look threatening, it is not obstructing flows; should be watched

This large woody material is not likely to become debris and should be left in place.

Bottom three photographs courtesy of : Boulder County OEM

Where it does **not** pose a flood risk, large woody material is commonly referred to as '**Good Wood.**' Having large woody material along streams and streambanks is a natural occurrence and **Good Wood** provides a variety of environmental and stream function benefits to your property. Floods naturally deposit **Good Wood** that can often be either left in place or re-located on-site.



These pieces of large woody material (circled in red) have been partially buried to anchor them in place. Being in the floodplain but outside of the main channel, they will add 'floodplain roughness,' slowing flood flows and decreasing flood damage downstream.

Good Wood includes wood that is in the **floodplain**, along **streambanks** and within the **channel**. Having large woody material in the floodplain adds 'floodplain roughness.' Floodplain roughness refers to how quickly flood waters will flow over an area. By adding pieces of large woody material to the floodplain, flood waters can be slowed down. This is actually a goal of many stewardship and restoration projects because flood waters can be slowed down and wood can help capture smaller debris and sediment and help build up functional floodplain material. By slowing the water down, the large woody material is also creating more storage space for the flood waters. This does not mean that flood waters will stay in the area for long periods of time. Instead, this means that the flood waters will slow down and spread out in the floodplain, then slowly flow back into the stream as the flood recedes. This is in line with the natural progression of a flood event.

YouTube

Watch videos on what makes "Good Wood" at the LWOG YouTube Channel!

http://bit.ly/2yNaPMm

Good Wood will also often become wildlife habitat for birds, small mammals, insects and amphibians. It is an excellent source of carbon, the building block of life. As the wood decomposes, it adds organic matter (carbon) and nutrients back into the soils. **Good Wood** can also have benefits on how the stream moves and stores sediment, as well as habitat for aquatic organisms. Frequently the best strategy for managing **Good Wood** is to secure it (if necessary) and leave it in place. Depending on location, it may need to be anchored in place so it is not carried away by flood waters.

Properly anchored in place, this large woody material is providing habitat for fish, insects, amphibians and small mammals.

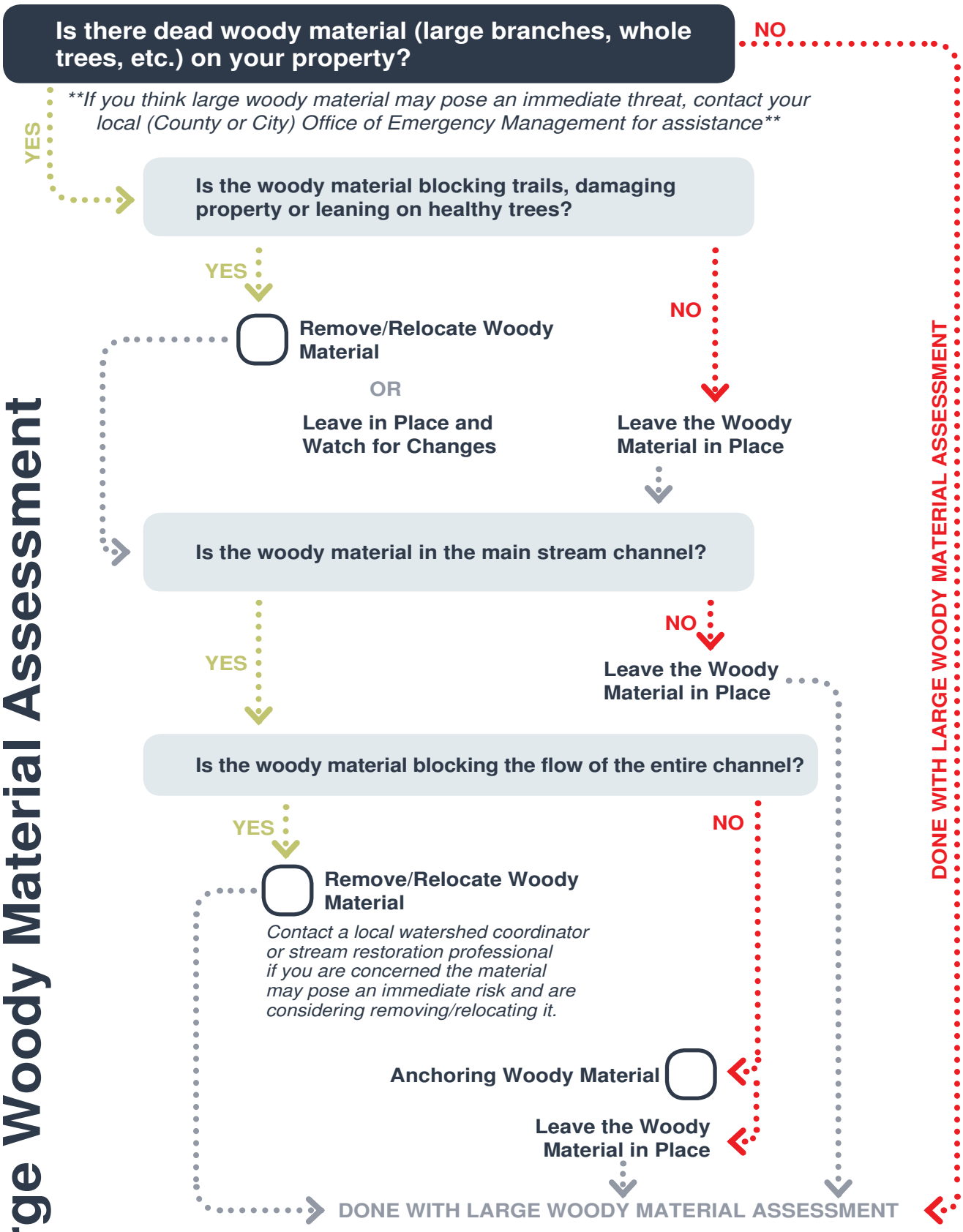
Using the **Questionnaire** on the following page, you will evaluate large woody material on your property. Evaluating large woody material can be difficult and it is easy to second guess yourself. When in doubt, contact your local watershed coalition or a qualified stream restoration professional for assistance evaluating the woody material. If you think the woody material may pose an immediate and imminent threat to roads, bridges or properties, contact your local (County or City) Office of Emergency Management. Contact information for these organizations can be found in the ***'Large Event Preparedness'*** *[page 28]* section of **Chapter 1**.

Because fallen or dead trees can become dislodged from an eroding bank or the floodplain during a large storm event, it is a good idea to re-evaluate your property soon after major floods or storms.

For a more in-depth and technical guide to evaluating and managing large woody material in stream corridors, please see:

sites.warnercnr.colostate.edu/fluvial-geomorphology/wp-content/uploads/sites/53/2016/05/Wohl-et-al-JAWRA-WOOD.pdf

Large Woody Material Assessment

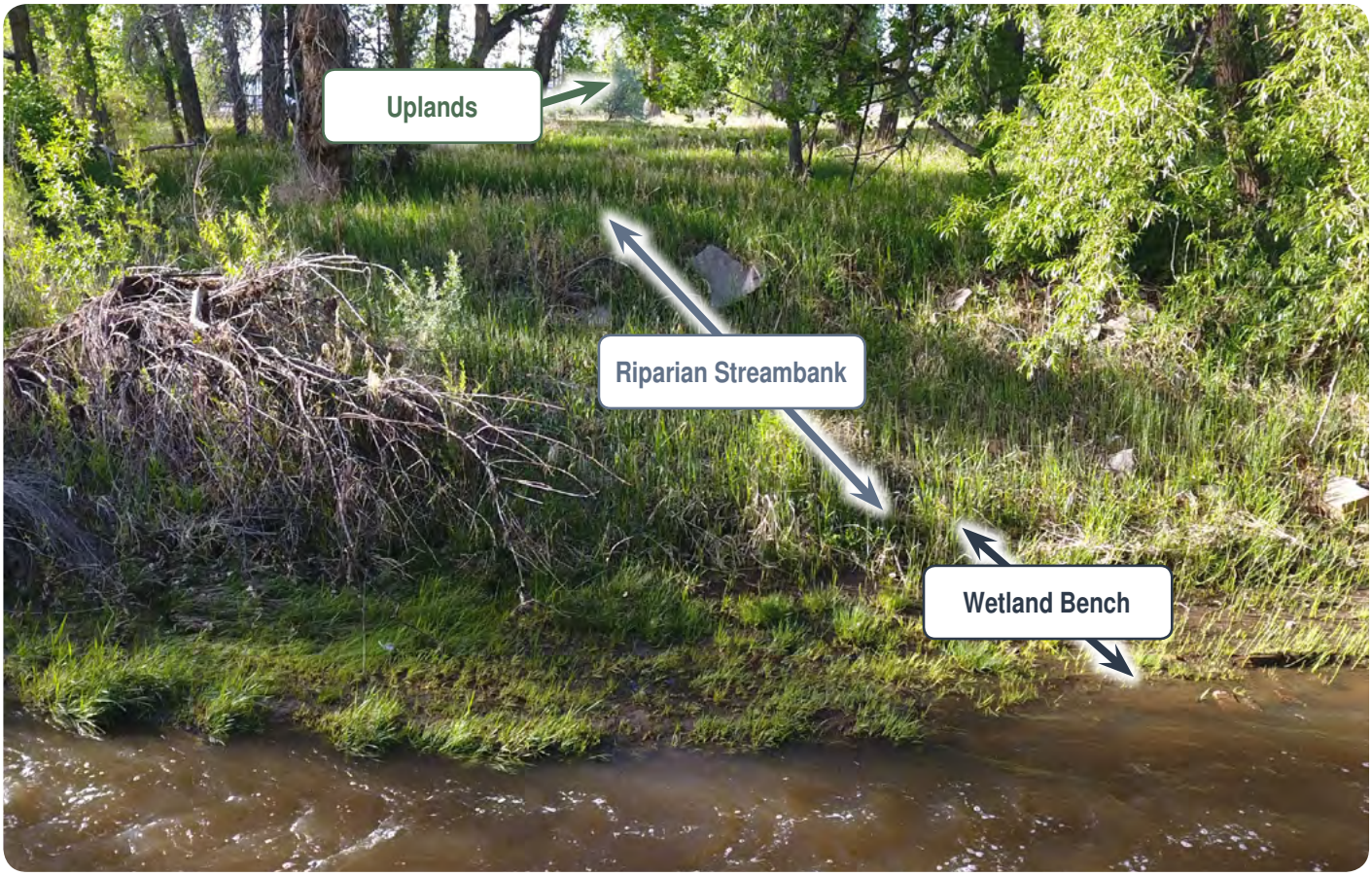


To see which strategies will accomplish your objective(s) identified above, see the *'Stewardship and Recovery Strategy Chart'* [page 76]

Vegetation

Plant communities and the vegetation within them play many important roles along the stream and within your property. Not only can plants provide shade and pleasant scenery for you, but they can also provide wildlife habitat and food, streambank stabilization, boundaries for wildlife or properties and many other ecological benefits. On the other hand, some plants can be undesirable and even invasive. In this section, you will learn what you can look for on your property, as well as what types of **stewardship and recovery strategies** you can consider.

Along riparian corridors, vegetation can generally be grouped into three overall categories: **wetland**, **riparian** and **upland** vegetation. These categories transition from right along the stream/water (**wetlands**), to areas a little higher up and along the streambanks (**riparian**), to areas above the streambanks and further away from the active stream channel (**uplands**). Although you will find overlap between these areas, you should be able to recognize where the vegetation changes based on its distance from the stream. In this case, distance means both horizontal distance from the edge of the stream, as well as vertical distance from the surface of the stream.



All of these unique plant communities provide homes for a wide variety of animals. Providing a diversity of habitats on your land supports an intertwined collection of insects, reptiles, birds and mammals. For example, eagles and other raptors use large cottonwoods and other trees for nesting and as perching platforms to rest and survey for prey. Even dead trees are used by these birds because the lack of leaves allows for a clear view of the surrounding countryside. Songbirds nest in a wide variety of large to small trees and feed on chokecherries and other berry producing shrubs. Bears will also eat the berries in the fall when they are fattening up for winter hibernation. Deer and elk browse on shrubs such as mountain mahogany. Willow shrubs hanging over streams provide shade and shelter for fish and beavers. Wildflower strewn grassy meadows provide food and shelter for everything from bees to hummingbirds to rabbits. When assessing the vegetation on your property, it is important to consider the wildlife that calls it home. More specific details about wildlife habitat are discussed in the ***'Non-Aquatic Species'*** *[page 57]* **Questionnaire** section.

Wetlands

As discussed above, **wetlands** are a specific vegetation community that occur between water and dry lands. Generally, wetlands occur on the lower banks of streams where high stream flows and groundwater saturate the soils long enough to support plants adapted to wet conditions. Wetlands can also occur where groundwater seeps from hillsides, as well as in depressions or low spots that hold water. There are many benefits that wetlands provide, including:

Flood Reduction

Wetlands in floodplains store floodwaters temporarily and release the waters in a controlled manner. This minimizes flood damage downstream.

Water Quality

Wetlands filter out pollutants as the water flows through them. This can include nitrogen and phosphorous from a number of upland sources like fertilizer. Reducing the amount of these in the streams will prevent unhealthy blooms of algae, as well as oxygen-deprived 'dead zones' where fish and other aquatic life cannot live.

Wildlife Habitat

Although wetlands make up less than 2% of Colorado's land area, they provide habitat and benefits to more than 75% of the wildlife in the state. Wetlands provide feeding, resting and rearing habitat. They also create important corridors for wildlife to move within. For aquatic wildlife, overhanging willow shrubs and other plants provide shade on the water. This decreases the water temperature and offers important areas of shelter in the stream.

Streambank Protection

Wetland plants can often have extensive root systems. These roots hold the soil together and stabilize the streambank. Strong wetland root systems will reduce the amount of erosion along the streambank.

In addition to bringing these benefits to the ecosystem and your property, wetlands are highly sensitive areas. As a result, wetlands are protected by various federal, state and local agencies. At a federal level, the Army Corps of Engineers (the Corps) regulates work or projects that will impact wetlands. State and county agencies also play regulatory roles for wetlands.

Although this area probably doesn't have water covering it year-round, it would likely be classified as a wetland.

In order to know if you will be impacting wetlands, you need to know how to identify them. Some wetlands will be easily identifiable when they have plants such as cattails growing in standing water. However, wetlands also include less obvious areas, such as grassy meadows that only have soil saturated for about a month in the spring. The edge of wetlands can also be difficult to identify. For example, sandbar willows growing along the edge of a stream may be wetlands, but sandbar willows growing on the top of a slope may be uplands. Generally, wetlands are defined by **water**, **type of soils** and **types of plants** present. You can find out more about what legally defines a wetland in the ***'What is a wetland?'*** *[page 126]* section of **Chapter 3**.

If you have an area that you are planning on doing construction and you are unsure if it is a **wetland**, call the Corps Denver Regulatory Office or a wetland specialist to get more information **before** starting the work. The permitting section of the Corps website provides more detailed information on permitting requirements for wetlands.

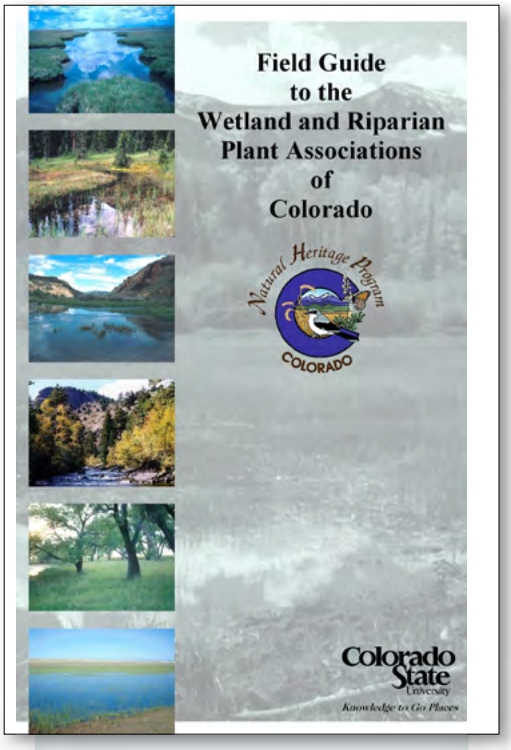
US Army Corps of Engineers®

www.nwo.usace.army.mil/Missions/Regulatory-Program/Colorado

9307 South Wadsworth Blvd
Littleton, CO 80128
(303) 979-4120

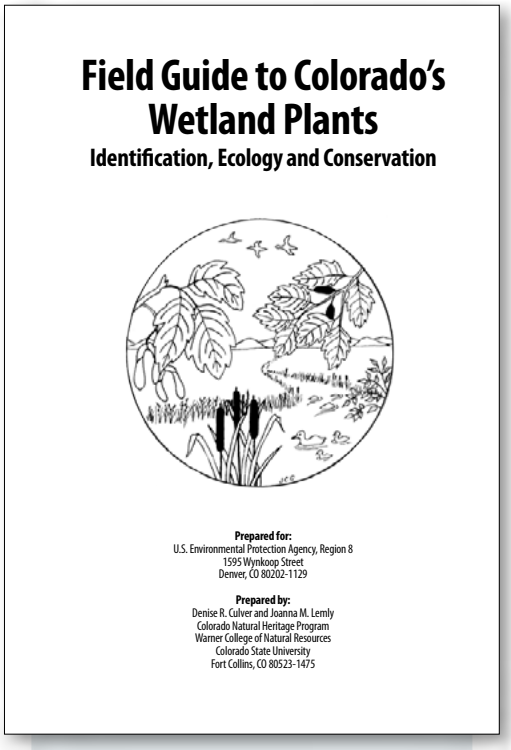
Wetlands are very special ecosystems and many professionals dedicate their entire career to studying them. If you are interested in learning more about wetlands in Colorado, there are many great resources available. A few of them are listed below:

Field Guide to the Wetland and Riparian Plant Associations of Colorado:



www.cnhp.colostate.edu/download/documents/2003/wetland_field_guide_2003.pdf

Field Guide to Colorado's Wetlands Plants - Identification, Ecology, and Conservation



www.cnhp.colostate.edu/cwic/documents/WetlandPlantsOfColorado_P1.pdf

Colorado Wetlands Mobile App *(by Colorado State University)*
itunes.apple.com/us/app/colorado-wetlands-mobile-app/id1077511822?mt=8
play.google.com/store/apps/details?id=edu.colostate.cnhp.cwic&hl=en

Weed Identification and Management

Weeds are invasive non-native plants that displace native vegetation and can be detrimental to your property's land uses (such as grazing, crops or open space). The Colorado Department of Agriculture (CDA) uses the specific term "**noxious weed**" for weeds deemed as threats to native ecosystems and agricultural lands. The CDA noxious weed program, as well as County weed control programs, are discussed in more detail in the ***'Noxious Weeds – State and County Regulations'*** *[page 123]* section of **Chapter 3**.

Before determining how to manage invasive weeds, the first step is being able to identify them on your property. The CDA provides a number of helpful resources for identifying noxious weeds. Their website provides a full list of the noxious weed species, as well as pictures, Fact Sheets and a mobile app for identification. They also have a list of contacts for all of the County Weed Programs within Colorado. Your County Weed Program manager is also a great resource for additional information about identifying noxious weeds on your property.

www.colorado.gov/pacific/agconservation/noxiousweeds

Colorado Noxious Weeds Mobile App *(by State of Colorado)*
itunes.apple.com/us/app/colorado-noxious-weeds/id833042035?mt=8
play.google.com/store/apps/details?id=com.coloradostate.coweedid&hl=en

The following pages have Fact Sheets for three noxious weed species that you are likely to encounter in the Lefthand, Big Thompson, Little Thompson and St. Vrain watersheds. You may notice that each of the Fact Sheets include management recommendations, separated into Cultural, Biological, Mechanical and Chemical categories. These categories, as well as how to choose the most applicable one for you, is discussed on the ***'Invasive Weed Management'*** strategy sheet *[page 93]*.

Canada Thistle - This is a non-native perennial plant that spreads by an aggressive creeping horizontal root system, as well as seeds. Several small purple flowers grow on top of the spiny plant. Canada thistle can blanket large swathes of streambanks and pastures with dense prickly patches. These patches can significantly reduce crops, livestock pasture land and native vegetation.

Scotch Thistle - In contrast to Canada thistle, Scotch thistle is a large biennial plant that only grows from seeds. Scotch thistle can grow extremely large, up to 12 feet tall, with spines all over the stems and leaves. Because this thistle forms large dense thickets of tall plants, they significantly decrease the quality of pasture lands and croplands, and replace native grasses and wildflowers.

Russian Olive - This is a thorny tree (or shrub) with gray-green leaves and olive-like fruit. Russian olives reproduce by seeds or roots, and birds readily spread the seeds. Although once thought beneficial as a windbreak, this species forms dense clumps in riparian areas, displacing native trees and shrubs. Although used by some birds, riparian areas dominated by Russian olives have less bird species diversity than the same areas dominated by native trees and shrubs.

Other noxious weeds that are common along the northern Colorado front range include (click for **Fact Sheets**):

- ***Common Teasel***
- ***Flowering rush***
- ***Diffuse knapweed***
- ***Eurasian watermilfoil***
- ***Russian knapweed***
- ***Salt cedar/Tamarisk***

Canada Thistle Identification and Management

List B

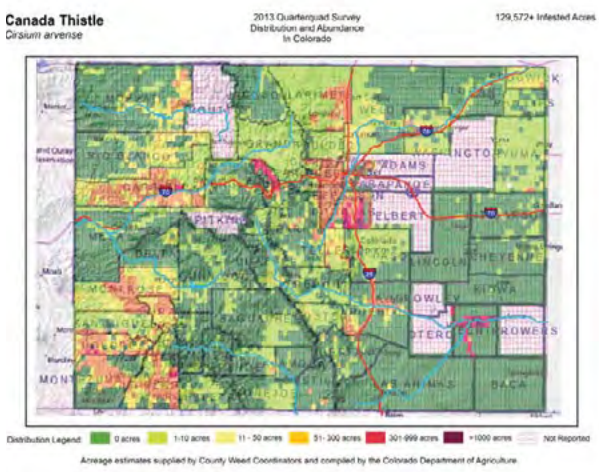
Canada thistle (*Cirsium arvense*) is a non-native, deep-rooted perennial that spreads by seeds and aggressive creeping, horizontal roots called rhizomes. Canada thistle can grow 2 to 4 feet in height. The leaves are oblong, spiny, bright green, and slightly hairy on the undersurface. Unlike other noxious biennial thistles which have a solitary flower at the end of each stem, Canada thistle flowers occur in small clusters of 1 to 5 flowers. They are about 1 cm in diameter, tubular shaped, and vary from white to purple in color.

Canada thistle emerges from its root system from late April through May. It flowers in late spring and throughout the summer. It produces about 1,000 to 1,500 seeds per plant that can be wind dispersed. Seeds survive in the soil for up to 20 years. Additionally, Canada thistle reproduces vegetatively through its root system, and quickly form dense stands. Each fragmented piece of root, 0.25 inch or larger, is capable of forming new plants. The key to controlling Canada thistle is to eliminate seed production and to reduce the plant's nutrient reserves in its root system through persistent, long-term management.

Canada thistle is one of the most troublesome noxious weeds in the U.S. It can infest diverse land types, ranging from roadsides, ditch banks, riparian zones, meadows, pastures, irrigated cropland, to the most productive dryland cropland. Large infestations significantly reduce crop and cattle forage production and native plant species. It is a host plant to several agricultural pests and diseases. Canada thistle prefers moist soils, but it can be found in a variety of soil types. It has been found at elevations up to 12,000 feet.

Effective Canada thistle control requires a combination of methods. Prevention is the most important strategy. Maintain healthy pastures and rangelands, and continually monitor your property for new infestations. Established plants need to be continually stressed. Management options become limited once plants begin to produce seeds. Details on the back of this sheet can help to create a management plan compatible with your site ecology.

2013 Quarter Quad Survey



Canada thistle is designated as a "List B" species as described in the Colorado Noxious Weed Act. It is required to be either eliminated, contained, or suppressed depending on the local infestations. For more information visit www.colorado.gov/ag/weeds and click on the Noxious Weed Program link or call the State Weed Coordinator at the Colorado Department of Agriculture, Conservation Services Division, (303) 869-9030.

Key ID Points

1. Cluster of 1-5 white to purple flowers on a stem.
2. Floral bracts are spineless.
3. Small flowers that are 1 cm in diameter.
4. Perennial, rhizomatous plant with spiny, oblong, green leaves.

Canada thistle

Cirsium arvense

Fact Sheet courtesy of Colorado Department of Agriculture [page 188]

List B

Canada thistle

Cirsium arvense

Integrated Weed Management Recommendations

Integrated weed management is imperative for effective Canada thistle control. This weed needs to be continually stressed, forcing it to exhaust root nutrient stores, and eventually die. Mowing or grazing can be followed up with herbicide application. Avoid hand-pulling and tilling which can stimulate the growth of new plants.

CULTURAL
Prevention is the best control strategy. Maintain healthy pastures , riparian areas, and rangelands. Prevent bare ground caused by overgrazing, and continually monitor your property for new infestations. Establishment of select grasses can be an effective control.

BIOLOGICAL
Cattle, goats, and sheep will graze on Canada thistle when plants are young and succulent in the spring. Follow up grazing with a fall herbicide application. Insects are available, and provide limited control. Currently, collection and distribution methods for Canada thistle rust (*Puccinia punctiformis*) are being refined. For more information on Canada thistle biocontrol, contact the Colorado Department of Agriculture - Palisade Insectary at (970) 464-7916.

MECHANICAL
Due to Canada thistle's extensive root system, hand-pulling and tilling create root fragments and stimulate the growth of new plants. Mowing can be effective if done every 10 to 21 days throughout the growing season. Combining mowing with herbicides will further enhance Canada thistle control.

CHEMICAL
The table below includes recommendations for herbicides that can be applied to rangeland and some pastures. Treatments may be necessary for an additional 1 to 3 years because of root nutrient stores. Always read, understand, and follow the label directions.

HERBICIDE	RATE	APPLICATION TIMING
Aminopyralid (Milestone)	5-7 oz/acre or 1 teaspoon/gal water	Apply in spring until flowering and/or to fall regrowth. Add 0.25% v/v non-ionic surfactant (equivalent to 0.32oz/ gal water or 1 qt/100 gal water). Can also add chlorsulfuron (Telar) at 1 oz/acre to the mix.
Aminoclopyrachlor + chlorsulfuron (Perspective)	5.5 oz product/acre + 0.25% v/v non-ionic surfactant	Apply in spring from rosette to flower bud stage and/or fall regrowth. Important: Applications greater than 5.5 oz product/acre exceeds the threshold for selectivity. DO NOT treat in the root zone of desirable trees and shrubs. Not permitted for use in the San Luis Valley.
Clopyralid + triclopyr (Prescott; others)	3 pints product/acre or 1.25 oz/gal water	Apply in spring until flowering and/or fall regrowth. Add 0.25% v/v non-ionic surfactant.

Colorado Department of Agriculture - Conservation Services
305 Interlocken Parkway
Broomfield, CO 80021
(303) 869-9030
www.colorado.gov/ag/weeds

Fact Sheet courtesy of Colorado Department of Agriculture [page 188]

Scotch Thistle Identification and Management

List B

Scotch thistle includes two species, *Onopordum acanthium* L. and *O. tauricum* Willd. Both are non-native biennial forbs. During the first year of growth, both species appear as a rosette in spring or fall. During the second year in mid to late spring the stems bolt, the plants flower, set seed, and the plants die. Both Scotch thistle species can grow up to 12 feet tall and basal rosettes can be up to 2 feet in diameter. Stems are numerous and branched. Characteristically, the entire length of stems from both species have broad wings with spiny tips. *O. acanthium* leaves have an overall gray color from dense woolly hairs. *O. tauricum* leaves are glandular and not as hairy as *O. acanthium*. For both, leaves are spiny. Both species have a distinct mid-rib. Flower heads are terminal, violet to reddish in color, 1 to 3 inches in diameter, and arranged in a raceme. One plant can produce up to 100 flower heads. The spine-tipped bracts curve away from the flowering head. The flower receptacle is fleshy and has pits to hold seeds. The plants flower from mid-June to September. Scotch thistle seeds have the ability to mature in flower buds and heads that have been removed from the stalk. Both species can produce up to 14,000 seeds per plant. Seeds remain viable for up to 30 years but germinate readily with moisture in spring and fall.

Scotch thistle invades rangeland, overgrazed pastures, roadsides, and irrigation ditches. Both species prefer moist soil, such as areas adjacent to creeks and rivers. Roadsides appear to be especially vulnerable to invasion likely due to the water runoff from the shoulders. Maintaining healthy pastures and native plants, minimizing soil disturbance, changing land use practices to prevent overuse, and using seed-free equipment are critical measures to preventing infestations. As with most biennials, once established, limiting seed production is critical to effective control. Due to the robust, spiny nature of Scotch thistle, this plant can act as a living barbed wire fence, making areas impassible for wildlife, livestock, and people and unpalatable to cattle.

To control seed production, plants with buds or flowers should be collected, bagged and immediately disposed of or destroyed. Chemical control is most effective when plants are in rosette stage, spring or early fall. Mechanical controls can be used to eliminate small patches or plants in a later growth stage.

Scotch thistle is designated as a "List B" species in the Colorado Noxious Weed Act. It is required to be eradicated; some populations may be contained or suppressed depending on state regulations. For state regulations described for each county, refer to the most recent Rule, or visit www.colorado.gov/ag/coweedcontacts for details.

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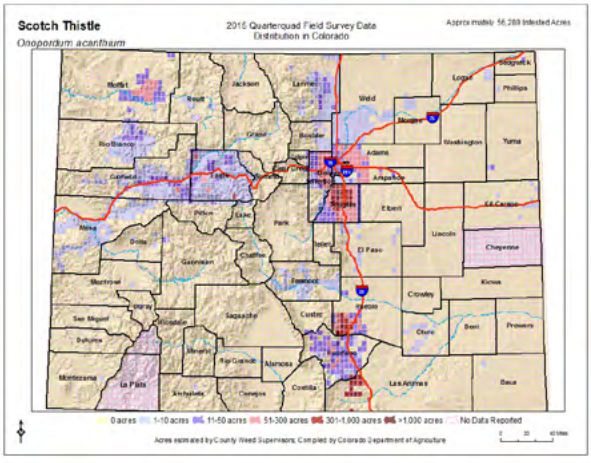
© Bonnie Million, NPS

© Bonnie Million, NPS

Key ID Points

1. Pitted fleshy flower receptacle.
2. Prominent mid-rib.
3. Wide lobed leaves with distinct mid-rib.
4. Wide spiny wings extend the length of the stem.

2015 Quarter Quad Survey



Scotch thistle

Onopordum acanthium L. and *O. tauricum* Willd.

Fact Sheet courtesy of Colorado Department of Agriculture [page 188]

List B

Integrated Weed Management Recommendations

Scotch thistle

Onopordum acanthium L. and *O. tauricum* Willd.

Effective integrated management means using a variety of eradication methods along with restoration, prevention of seed production and dispersal, and monitoring. Maintain robust healthy native landscapes. Restore degraded sites. Avoid soil disturbance. As with most biennials, prevent seed production in the first and second year of growth. Prevent seed from dispersing, such as on contaminated equipment. Rest sites until they are effectively restored. Change land use practices. Use methods appropriate for the site.

CULTURAL CONTROL METHODS

Effectiveness begins with maintaining or restoring a competitive native forb and forb assemblage. Continue restoration efforts until native plants are robust and abundant. Use locally adapted native seeds whenever possible to improve competitiveness. Include cool season and warm season, as well as perennial and annual grasses in revegetation efforts. Soil may need to be restored by adding soil amendments, soil microbes, mycorrhizal fungi and nitrogen fixing plants such as legumes. Manage land uses so they do not create bare mineral soil or compact soil. Annual crop cultivation appears to be an effective control measure.

© Jacqui Turner, The Timaru Herald

BIOLOGICAL CONTROL METHODS

Domestic livestock are likely to avoid this plant due the large number of spines all over the plant. Goats and sheep may eat flower heads if plants are small. Since most livestock and herbivores avoid the leaves and stems, Scotch thistle can become an "increaser" in over-grazed systems. Properly managed grazing systems can increase desireable plant vigor and indirectly reduce Scotch thistle. There are no known biological control agents effective against scotch thistle or authorized in Colorado. For more information about biological control agents, visit the Colorado Department of Agriculture's Palisade Insectary website at www.colorado.gov/ag/biocontrol.

© Bugwood

MECHANICAL CONTROL METHODS

Methods, such as tilling, hoeing and digging, are best for infestations smaller than 0.5 acres; weigh this against other plants present, ecology and site condition. Sever roots below the soil surface during the first year before the plant stores energy and in the second year before seed production. Mowing, chopping and deadheading stimulates more flower production; these methods require consecutive years of season-long treatments. Flower heads must be collected, bagged, and disposed of or destroyed; seeds will mature and germinate if left on the ground. Fire gives Scotch thistle a competitive advantage. Large fleshy stems and leaves would not be consumed in a low severity fire and seeds would remain unaffected. High severity fires would likely damage native plants, which favors Scotch thistle if seeds are not killed and this is not recommended.

CHEMICAL

NOTE: The following are recommendations for herbicides that can be applied to pastures and rangeland. Rates are approximate and based on equipment with an output of 30 gal/acre. Follow the label for exact rates. Always read, understand, and follow the label directions. The herbicide label is the LAW!

HERBICIDE	RATE	APPLICATION TIMING
Aminopyralid* (Milestone)	7 oz. product/acre + 0.25-0.5% v/v non-ionic surfactant	Apply in spring rosette to early bolting growth stages or in fall to rosettes. *Product not permitted for use in the San Luis Valley.
Chlorsulfuron** (Telar)	1-2.6 oz. product/acre (0.75 oz. active ingredient/acre)+ 0.25% v/v non-ionic surfactant	Spring from bolting to flower bud stages. **This herbicide has residual soil activity that will affect all broadleaf seedlings germinating after application has occurred.
Metsulfuron + Chlorsulfuron (Cimarron X-tra)	2 oz. product/acre + 0.25-0.5% v/v non-ionic surfactant	Apply during rosette to flower bud stages.
Clopyralid (Transline)	0.67-1.33 pints product/acre + 0.25% v/v non-ionic surfactant	Apply to rosettes in spring or fall.
Aminocyclopyrachlor + chlorsulfuron (Perspective)* *Product not permitted for use in the San Luis Valley.	4.75-8 oz. product/acre + 0.25% v/v non-ionic surfactant	Apply from the seedling to the bolting stage. IMPORTANT: Applications greater than 5.5 oz. product/acre exceeds the threshold for selectivity. DO NOT treat in the root zone of desirable trees and shrubs. Not for use on grazed or feed forage.

Colorado Department of Agriculture - Conservation Services
305 Interlocken Parkway
Broomfield, CO 80021
(303) 869-9030
www.colorado.gov/ag/weeds

Rev. 11/16

Fact Sheet courtesy of Colorado Department of Agriculture [page 188]

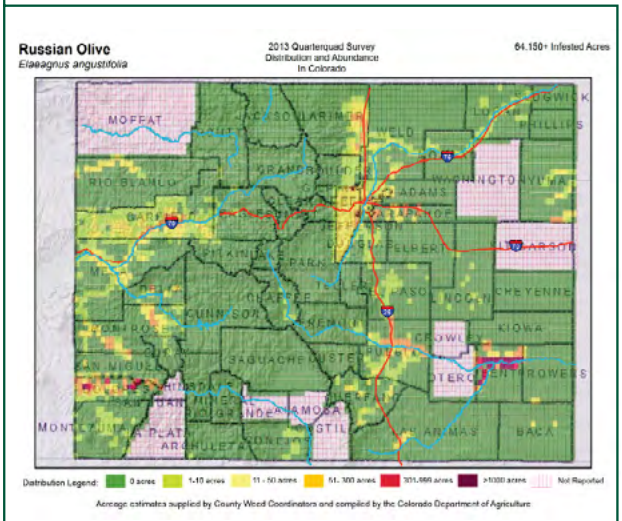
Russian Olive Identification and Management

List B

Russian olive *(Elaeagnus angustifoilia)* is a perennial tree or shrub that is native in Europe and Asia. The plant has olive-shaped fruits, silver color at first then becoming yellow-red when mature. Russian olive can reproduce by seed or root suckers. Seeds are readily spread by birds and can remain viable for up to 3 years. Spring moisture and slightly alkaline soil tend to favor seedling growth. The plant's extensive root system sprouts root suckers frequently. The tree can reach up to 30 feet in height with branches that have 1 to 2 inch thorns. Leaves are 2 to 3 inches long, alternate, narrow, and have simple blades with smooth edges. The leaf's lower surface is silvery white, while the upper surface is light green in color. Flowers are 4 small sepals in light yellow clusters, fragrant, and appear May through June. Fruits mature from September to November. Russian olive twigs are flexible, reddish, and have surfaces coated with gray and scaly pubescence, becoming smooth.

Once thought to be a beneficial windbreak tree, it since has been deemed detrimental to the environment. Russian olive can grow in a variety of soil and moisture conditions, but prefers open, moist, riparian zones. It is shade tolerant and can be found along streams, floodplains, fields and open areas up to approximately 8,000 feet in elevation. Russian-olive can outcompete native plants, interfere with natural plant succession and nutrient cycling, and tax water reserves. Because Russian olive is capable of fixing nitrogen in its roots, it can grow on bare, mineral substrates and dominate riparian vegetation. Although Russian olive provides a plentiful source of edible fruits for birds, ecologists have found that bird species richness is actually higher in riparian areas dominated by native vegetation.

The key to effective control of Russian olive is preventing establishment of the trees or shrubs. If plants are already present, control options include cut-stump treatments and mechanical mowing. These treatments depend on size and location of the plant. Details on the back of this sheet can help you create a management plan compatible with your site ecology.



Russian olive is designated as a "List B" species in the Colorado Noxious Weed Act. It is required to be either eradicated, contained, or suppressed depending on the local infestations. For more information visit www.colorado.gov/ag/weeds and click on the Noxious Weed Management Program. Or call the State Weed Coordinator at the Colorado Department of Agriculture, Conservation Services Division, 303-239-4100.


© Patrick Breen, OSU


© Patrick Breen, OSU

Key ID Points

1. Leaves are silvery white.
2. Branches have 1 to 2 inch thorns.
3. Yellow-red fruits on mature plants.
4. Mature trees have shedding, reddish-brown bark.

Russian olive

Elaeagnus angustifolia

Fact Sheet courtesy of Colorado Department of Agriculture [page 188]

List B

Russian olive

Elaeagnus angustifolia

Integrated Weed Management Recommendations

Integrated weed management offers the most effective combination of control efforts through the "cut stump" treatment. Trees are cut down with a hatchet or chainsaw, then immediately treated with an approved herbicide on the surface of the cut stump. The most effective timing is late summer/early fall for herbicide transfer into the roots.

© John Randall, TNC

© James Miller, USFS

© Chris Ness, Adams County

© Scott Peterson, USDA

CULTURAL

Replace Russian olives with native trees. Prevent establishment of new trees by removing seedlings and saplings before they mature. Contact your local Natural Resources Conservation Service for recommendations of other possible trees or shrubs.

BIOLOGICAL

Tubercularia canker is an unapproved biocontrol. However, it overwinters on infected stems and spreads via rain-splash, animals, or pruning implements to open wounds in the bark. Infected tissue becomes discolored or sunken. Entire stems may be girdled and killed, and the disease can deform or kill stressed plants over time.

MECHANICAL

Saplings can be pulled with a weed-wrench or cut with brush-cutters. Trees can be girdled or cut with chainsaws. However, stump sprouting commonly occurs after cutting down the tree; and stump excavation without removing all parts of the roots can result in root sprouting. Treating cut-stumps with an herbicide can eliminate sprouting. Stump burning is practical when conditions support a long, hot fire and most effective in summer or early fall. Saplings are most sensitive to mechanical treatment.

CHEMICAL

The table below includes recommendations for herbicides that can be applied to range and pasturelands. Always read, understand, and follow the label directions. The herbicide label is the LAW!

HERBICIDE	RATE	APPLICATION TIMING
Triclopyr (Garlon 4, Remedy)	Undiluted (100% solution)	Apply to the cambial layer of the tree immediately after the cut-stump treatment.
Imazapyr + Water (Habitat + Water or Arsenal + Water)	Diluted by mixing 8 to 12 fl. oz / 1 gallon of water	Apply to the cambial layer of the tree immediately after the cut-stump treatment.
Imazapyr (Habitat or Arsenal)	4 to 6 pt./acre	Broadcast spray/spraying individual trees; low or high volume spray.

Colorado Department of Agriculture - Conservation Services
305 Interlocken Parkway
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303-869-9030
www.colorado.gov/ag/weeds

Fact Sheet courtesy of Colorado Department of Agriculture *[page 188]*

In addition to noxious weeds, there are also less invasive weeds and plants that certain landowners simply may not like. The non-native crack willow tree (*Salix fragilis*) is not on the noxious weed list, but it is often considered a weed by many landowners. This species of willow tree grows along streams and is considered detrimental because it grows fast, forms wide patches that displace native cottonwoods and peachleaf willows. It often also creates large areas of shade that prevent native shrubs and grasses from growing. The tree earned its name of 'crack willow' because it is has weaker wood and branch angles that result in large branches and trunks breaking (or cracking) in storms. While these trees have their downfalls, a landowner may not want to remove them because this would create a treeless area. This bare area could then take decades to regrow into a healthy riparian woodland. If you do not want crack willows to be growing on your property, a better approach is to remove them when they are younger, smaller plants and replace them with desirable vegetation.

Threatened, Endangered and Rare Plants

Besides identifying invasive plants, it is also helpful to be able to identify threatened, endangered and rare plants on your property. Two plants protected under the Endangered Species Act potentially occur within the Lefthand, Big Thompson, Little Thompson and St. Vrain watersheds.

Colorado Butterfly Plant - This is an inconspicuous multi-branched plant with scattered white to pink flowers that grows 20 to 30 inches tall. It blooms from May to August and grows along active meandering stream channels below 6,400 feet in elevation.

Ute Ladies'-Tresses Orchid - This small orchid has numerous white flowers spiraling along the stem (similar to braided hair). Ute ladies'-tresses orchid is a small plant, usually less than 2 feet tall, that is hard to identify except when blooming (usually in August). It grows along streams and open meadow wetlands below about 7,000 feet in elevation.

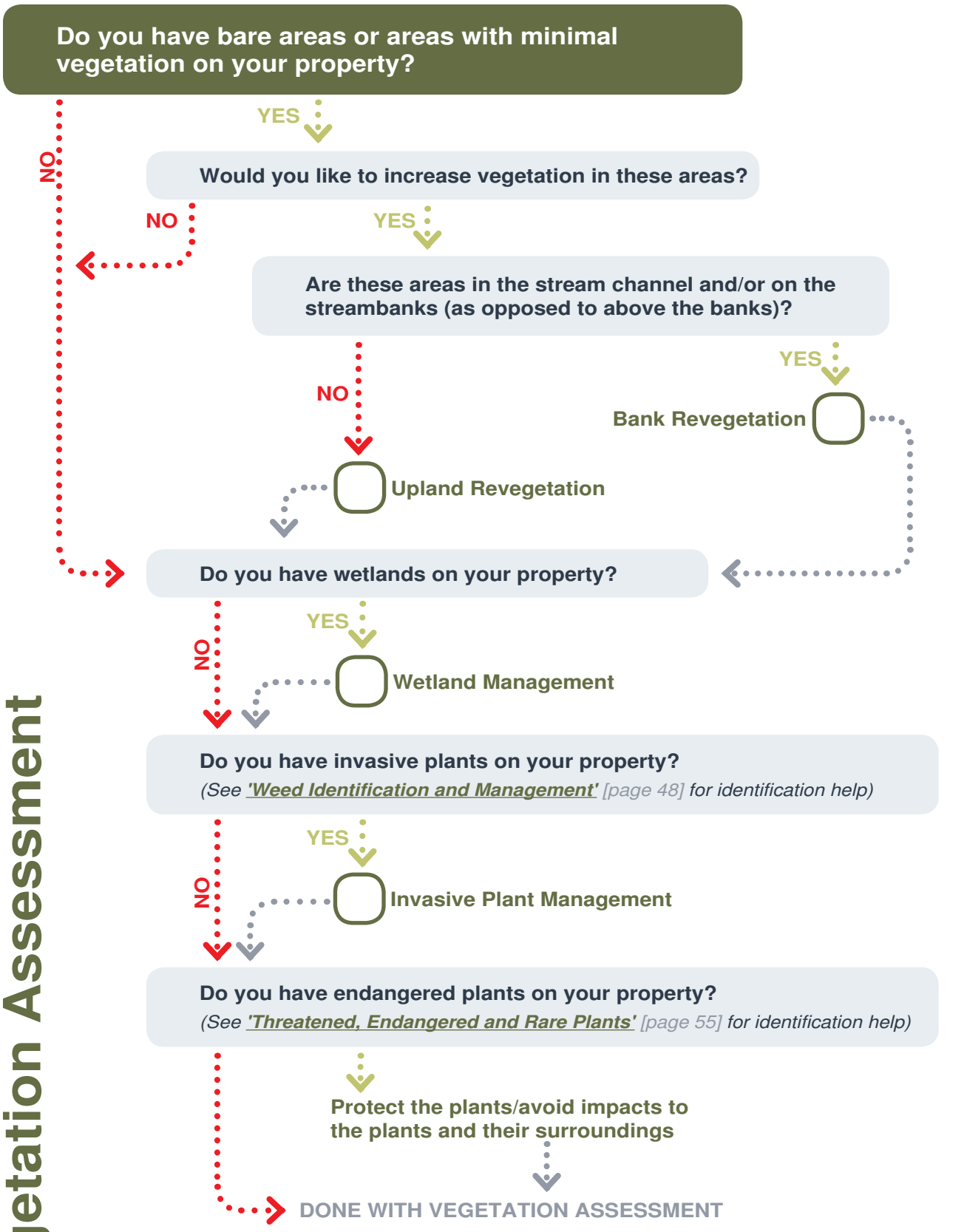
While threatened and endangered plants are federally listed, there are also a number of rare plants that could occur on your property. These plants are rare because they are restricted to certain areas or site conditions (such as soil types), or they are threatened by the loss of habitat. One example is the Bell's twinpod (shown below), a small rosette plant with clusters of yellow flowers that bloom in the spring. This small plant is only found in a narrow band at the toe of the Front Range on loose shale slopes and has been observed along the Little Thompson River. Another uncommon species that may occur in wet meadows along streams below 6,000 feet in elevation is Showy prairie gentian.

If you would like more information on rare plants in the Northern Colorado area, look at the rare plant list (by County) on the Colorado Natural Heritage Program website:

www.cnhp.colostate.edu/download/projects/rareplants/list_location.aspx?GeoScaleID=3

The **Questionnaire** on the following page will assist you in determining what types of stewardship and recovery strategies relating to vegetation are the most applicable for your property.

Vegetation Assessment



To see which strategies will accomplish your objective(s) identified above, see the *'Stewardship and Recovery Strategy Chart'* [page 76]

Non-Aquatic Species

Most Colorado wildlife species use streams and riparian ecosystems at some time during their lives. Even species such as mule deer, who range widely throughout the landscape, depend on riparian areas for fawning and shelter during the winter. Other wildlife that use riparian areas include small mammals such as cottontail rabbits and mice that feed on the abundant vegetation growing along streams. In turn, these small mammals, as well as snakes and fish, are prey for foxes, raccoons and other carnivores. Additionally, the trees growing around streams are prime nesting habitat for hawks and other raptors, and numerous other bird species. Many of the same species that are in riparian corridors also use the upland areas for hunting, foraging and shelter.

The species of wildlife present on your property will have influences on the vegetation and the function of the river, not to mention the experiences you will have. One of the main ways that plants spread are by wildlife and as we have learned in this Handbook, vegetation is closely tied to many functions in a riparian corridor. When an animal eats berries or other plant 'fruits,' the plant is using the animal to transport its seeds to a new location. When the animal passes the seeds, they are deposited with feces that are rich in nutrients for the plant to start growing. Seeds are also carried by wildlife when they stick to an animal's fur or hair. Eventually they fall off and can sprout in their new location. Animals will also influence your property when they move materials around to create homes. This could include logs, dirt, dead woody material or leaves and plant material. These changes will obviously have effects on the rest of your property.

When assessing non-aquatic habitat on your property, you will want to consider what types of animals are desirable and compatible with your property and land use, including livestock that you or neighbors keep. You will want to manage grazing and rangeland effectively, as well as reduce the potential for wildlife/livestock conflicts. For example, if you keep chickens or other small livestock, you probably won't want to promote fox habitat right next to the chicken coops/range area. Of course, you can promote fox/predator habitat on your property as long as you have an adequate way of protecting your livestock such as a buffer or fence. You will also want to consider what types of wildlife naturally live in your area.

High Quality Wildlife Habitat

Once you have decided what types of wildlife are desired on your property, there are several factors that contribute to a high quality wildlife habitat. Generally, high quality wildlife habitat consists of sufficient resources to provide food, water and shelter (for nesting and resting spaces) for a variety of animal species. For non-aquatic species, this includes:

Connectivity

High quality wildlife habitat is not confined to a single property. Most non-aquatic wildlife species thrive when their habitat is a large connected network of corridors and patches. Within these areas, animals will hunt, breed and take shelter.

Complexity of Vegetation

Individual wildlife species are part of a larger ecosystem with other species and plant communities. By having multiple layers of a variety of trees, shrubs and grasslands, an ecosystem will be 'more complete.' The ecosystem will be able to support more types of wildlife, as well as more types of wildlife activities.

Cover/Shelter

While this may seem obvious, areas of cover and shelter are crucial to the survival and health of wildlife species. Lack of cover causes deaths due to exposure during severe weather and increased vulnerability to predators. Vegetation, woody material and underground dens are the most common types of cover in Northern Colorado.

Common Wildlife

Assessing the non-aquatic species on your property includes being able to identify the types of wildlife currently living on or traveling through your land. In addition to seeing signs of wildlife such as scat, bones, or vegetation impacts, you can also be on the lookout for the actual animals themselves. For many of you, this is one of the reasons you choose to live along a waterway. The following pages contain some of the more common wildlife species for the Lefthand, Big Thompson, Little Thompson and St. Vrain watershed areas.

Raptors (hawks, eagles and owls) - Raptors use large cottonwoods and other trees for nesting and as perching platforms to rest and survey for prey in the surrounding grasslands, fields, and wetlands. Often, dead trees are used by these birds because the lack of leaves allows for a clear view of the surrounding countryside.

Songbirds - Many songbirds nest in a wide variety of large to small trees and feed on chokecherries and other berry producing shrubs. Other songbirds nest on the ground or, in the case of red-winged blackbirds, in cattails (see photo at right). Brush piles left by landowners may be used by songbirds for perching sites, especially if the piles are located near feeding or nest sites.

Waterfowl - Bodies of water and associated wetlands are critical for waterfowl. They use the wetlands for feeding and shelter for nesting. Many waterfowl also feed in the surrounding fields and, in the case of geese, bluegrass lawns.

Photo courtesy of: Audubon Society *[page 188]*

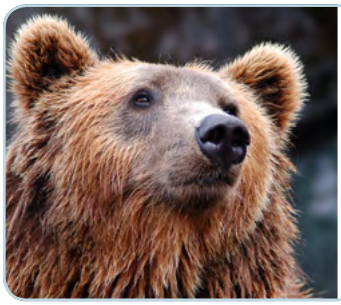
Deer and elk - These mammals forage on a wide variety of vegetation from shrubs and trees such as mountain mahogany and aspen, flowers such as dandelions and cow parsnip, and grasses. Heavily grazed trees and shrubs will have a distinctive browse line at the point where these ungulates can reach, below which there are little or no twigs and leaves. Deer also notoriously feed on shrubs and flowers planted in gardens and lawns.

Thickets of shrubs and trees are important sources of shelter for deer and elk. White-tailed deer stick close to riparian woodlands and water sources most of the time making them hard to see. Mule deer range out into grasslands and shrub lands, but use thick woodlands to shelter their fawns and to take cover during extreme weather. Elk also shelter in woodlands and forests.

Pollinators - Wildflowers and flowering shrubs are food for bees, butterflies, hummingbirds and other pollinators. In return, these pollinators distribute pollen to other plants, a critical step in producing new seeds. Find out more information about Colorado pollinators at:

bouldercolorado.gov/ipm/protecting-pollinators

Small mammals - Rabbits, mice and other small mammals use brush piles for shelter, especially if located near water. They feed on the seeds and leaves of the vegetation growing in meadows and shrub lands as well.



Bears - Bears are omnivores that will eat most anything – from berry laden shrubs, to insects, to small mammals to sugar water in hummingbird feeders. Especially in the fall when they are fattening up for winter hibernation, bears will search out high energy food such as chokecherries and other berry-producing shrubs. Bears are also known for foraging through garbage at homes and campsites.

Mountain lions - These predators tend to avoid human dwellings, but they do hunt for deer, rabbits and other small mammals. This means that they may enter or pass through your property while pursuing their prey. Mountain lions can also hunt and kill domestic animals ranging from smaller livestock to household pets

Photo courtesy of: Colorado Parks and Wildlife *[page 188]*

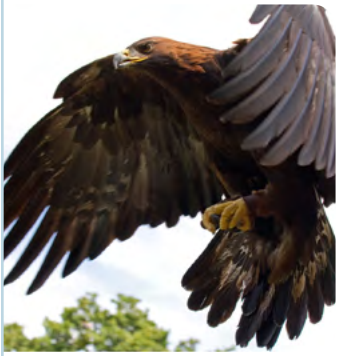
Threatened, Endangered and Species of Concern

From the common garter snake to bald eagles, there are many rare non-aquatic species that are vulnerable to extinction in the Lefthand, Big Thompson, Little Thompson and St. Vrain watersheds. Any activity that may impact threatened and endangered species will require a permit process to protect the animals. Colorado Parks and Wildlife (CPW) keeps a list and description of all federally and state listed threatened and endangered species on their website. If you are unsure about if your project will impact a threatened or endangered species, contact Colorado Parks and Wildlife or U.S. Fish and Wildlife. The following pages contain brief descriptions of some of the threatened, endangered and species of concern you may encounter in Northern Colorado.

Federally Listed Species

www.fws.gov/offices/Directory/ListOffices.cfm?statecode=8

Preble's meadow jumping mouse (Preble's) - This small mouse, federally listed as threatened, is known to occur along the streams within the Lefthand, Big Thompson, Little Thompson and St. Vrain areas below 7,500 feet in elevation. Typically found near water, Preble's prefers dense vegetation. In these areas, they can find shelter from predators.



Bald and Golden Eagles - Although bald eagles are no longer listed on the Endangered Species Act list, both bald and golden eagles are protected under the Bald and Golden Eagle Protection Act. Bald eagles are becoming more common in Northern Colorado roosting and nesting in large trees along rivers and lakes. Golden eagles usually nest on cliffs but occasionally nest in trees. Both birds hunt in a wide variety of habitats.

Photo courtesy of: Tony Hisgett *[page 189]*

Arapahoe Snowfly - This clumsily flying insect has been found only along a few streams in the foothills from Douglas to Larimer Counties, along a narrow band from 5,600 to 6,900 feet in elevation. It is currently **not** listed under the Endangered Species Act, but it is a candidate species and may be listed in the future.

State Listed Species

cpw.state.co.us/learn/Pages/SOC-ThreatenedEndangeredList.aspx

Burrowing Owl - This small owl often nests in abandoned prairie dog holes. Burrowing owls are listed by the state of Colorado as threatened. Because of threats to their habitat and population, they are also protected under the Migratory Bird Treaty Act.

Photo courtesy of: Audubon Society *[page 188]*

Northern Leopard Frog - Found in wet meadows, marshes and long banks of ponds, streams and irrigation ditches, this small frog used to be much more common in Colorado. It is now rare or completely eliminated from many areas, particularly the mountains. As a result, it is listed by Colorado as a Species of Special Concern.

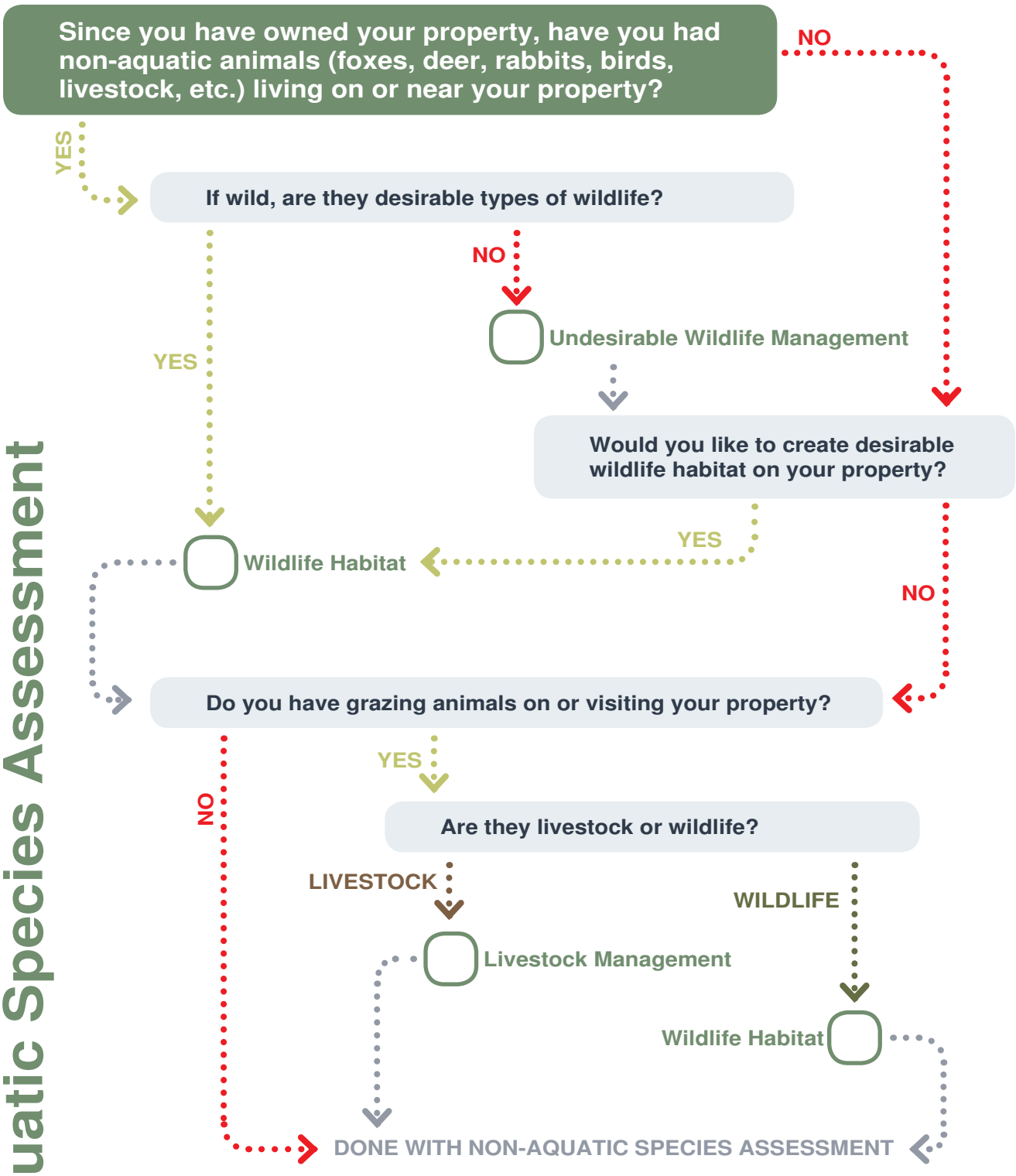
Photo courtesy of: BuBZ *[page 189]*

Common Garter Snake - The common garter snake is no longer common and is listed by Colorado as a Species of Special Concern. Recent research has shown that the decline in garter snake populations may be tied to a decline in amphibians, which is a primary food source for the snakes. This is a great example of how small changes can have far-reaching impacts to a riparian corridor.

This small snake with pale stripes occurs below 6,000 feet in elevation along tributaries to the South Platte River. Left Hand Creek, Big Thompson River, Little Thompson River and St. Vrain Creek are all tributaries to the South Platte River. The common garter snake's habitat is generally restricted to wetland areas and along streams.

The **Questionnaire** on the following page will assist you in determining what types of stewardship and recovery strategies relating to non-aquatic habitat are the most applicable for your property.

Non-Aquatic Species Assessment



To see which strategies will accomplish your objective(s) identified above, see the *'Stewardship and Recovery Strategy Chart'* [page 76]

Aquatic Species

In addition to non-aquatic species, riparian corridor are obviously home to many aquatic species as well. Unique to stream corridors and other bodies of water, aquatic species can thrive under the right conditions. Land use, water quality, stream features and biology are just some of the factors that influence a healthy fish community. Recognizing what makes a healthy fish community can help you protect and preserve it. Below, you will learn about what contributes to a high quality aquatic species habitat, as well as what to look for on your property. You will also learn about some of the more common aquatic species that live in the Lefthand, Big Thompson, Little Thompson and St. Vrain watersheds.

High Quality Aquatic Habitat

High quality aquatic habitat is comprised of a number of factors. An important item to consider is that aquatic habitat refers to much more than just fish. Aquatic habitats also support insects and non-aquatic animals as well. In fact, many insect species begin their life cycles in the water. The primary factors of high quality aquatic habitat are:

Connectivity

While non-aquatic organisms rely on a network of patches and corridors for habitat, aquatic habitat connectivity is more straight-forward. Fish and insects need to be able to move upstream and downstream in order to thrive. If there are barriers to this movement, the organisms will be confined to a limited area for breeding, feeding and shelter. As a result, this will also limit their population.

Complexity of Habitat

A key to aquatic habitat quality is the complexity of the stream itself. Higher quality stream habitats will have a variety of bank edge conditions, bed material and in-stream features like boulders, riffles and pools. This variety will provide areas for fish and insects to feed, hide from predators and breed.

Cover/Shelter

Cover in aquatic habitat can take multiple forms. Willow plants growing along the streambanks can often provide cover for fish to hide from predators. The willows also shade the water, which cools the temperature during hot summer days. Dead woody material also provides valuable cover and shelter for wildlife. Boulders and deep pools in the river can also provide cover/ shelter for fish. Insects will use rocks of many sizes as shelter.

Water Quality and Water Quantity

For many aquatic organisms such as fish, the stream water is their entire habitat. It is a confined area that can be heavily impacted by the surrounding activities. Because of this, fish and other aquatic organisms can be very vulnerable to detrimental activities next to or along streams. Pollutants such as fertilizers, oils or pesticides can quickly kill off large fish populations. Similarly, a blockage in a stream can cause low flows downstream. While seasonal fluctuations are normal, an irregular/drastic low flow can cause the water temperature to rise and algae to grow very quickly. This can then cause a dramatic reduction in the amount of oxygen in the water. All of these changes impact the aquatic habitat and can cause large fish die-offs.

Common Aquatic Species

The following pages contain information about some of the more prevalent aquatic species in the Lefthand, Big Thompson, Little Thompson and St. Vrain watersheds. Fish species can vary greatly depending on elevation, stream temperature and general environment. Many aquatic biology books and resources will group Colorado fish species into **mountain region species** and **plains region species**. Colorado Parks and Wildlife has online identification guides for fish species, as well as aquatic insects. Both can be very useful for anglers and landowners (links at right).

cpw.state.co.us/learn/Pages/FishID.aspx

cpw.state.co.us/aboutus/Pages/RW-ContentsEntomology.aspx

Mountain Region Species

Often found in high mountain lakes and streams, trout are a favorite among anglers in Colorado. There are many prevalent species of trout in Colorado, including Brook, Brown, Cutthroat, and Rainbow Trout. Cutthroat Trout are the only species native to Colorado, with a number of subspecies found throughout the state. While most trout thrive in the cold water of mountain streams and lakes, Brown Trout can also be found in larger rivers flowing onto the plains.

Photos courtesy of: Ben Swigle, CPW

Plains Region Species

Plains fish, usually in a warmer ecosystem, comprise of a variety of fish, including bass, carp, bluegill and smaller species such as chubs, suckers, dace and darters. The Longnose Sucker can sometimes be seen in mountainous streams as it prefers colder waters. The Longnose Dace, chub species and the darter are smaller fish found exclusively along the plains. Most of these are not considered game fish (fish that anglers try to catch), although some such as bass and bluegill are. All of them thrive in areas with shaded streambanks and woody debris.

Illustration courtesy of: Ellen Edmonson [page 189]

Aquatic Species Assessment

Do you want to have fish living in the stream within your property?

NO → DONE WITH AQUATIC SPECIES ASSESSMENT

YES → **Since you have owned your property, have you had fish living in your reach of the stream?**

NO → DONE WITH AQUATIC SPECIES ASSESSMENT

YES → **Are they still living there?**

NO → DONE WITH AQUATIC SPECIES ASSESSMENT

YES → **Has the fish population declined over the past years?**

NO → DONE WITH AQUATIC SPECIES ASSESSMENT

YES → **Are there areas on your property preventing aquatic organisms, like fish, from moving upstream?**

YES → Fish Passage

NO → **Does your streambank have vegetation that shades the water?**

NO → Bank Revegetation

YES → **Does your stream have areas of refuge for fish (boulders, vegetation, slower water, etc.)?**

NO → Fish Habitat

YES → **Does your stream vary in size and type of bed material, slope/speed of the water and how much it curves?**

NO → Channel Complexity

YES → **Do you see bugs hatching/flying on or near your stream?**

NO → Bank Revegetation
Insect Habitat

YES → DONE WITH AQUATIC SPECIES ASSESSMENT

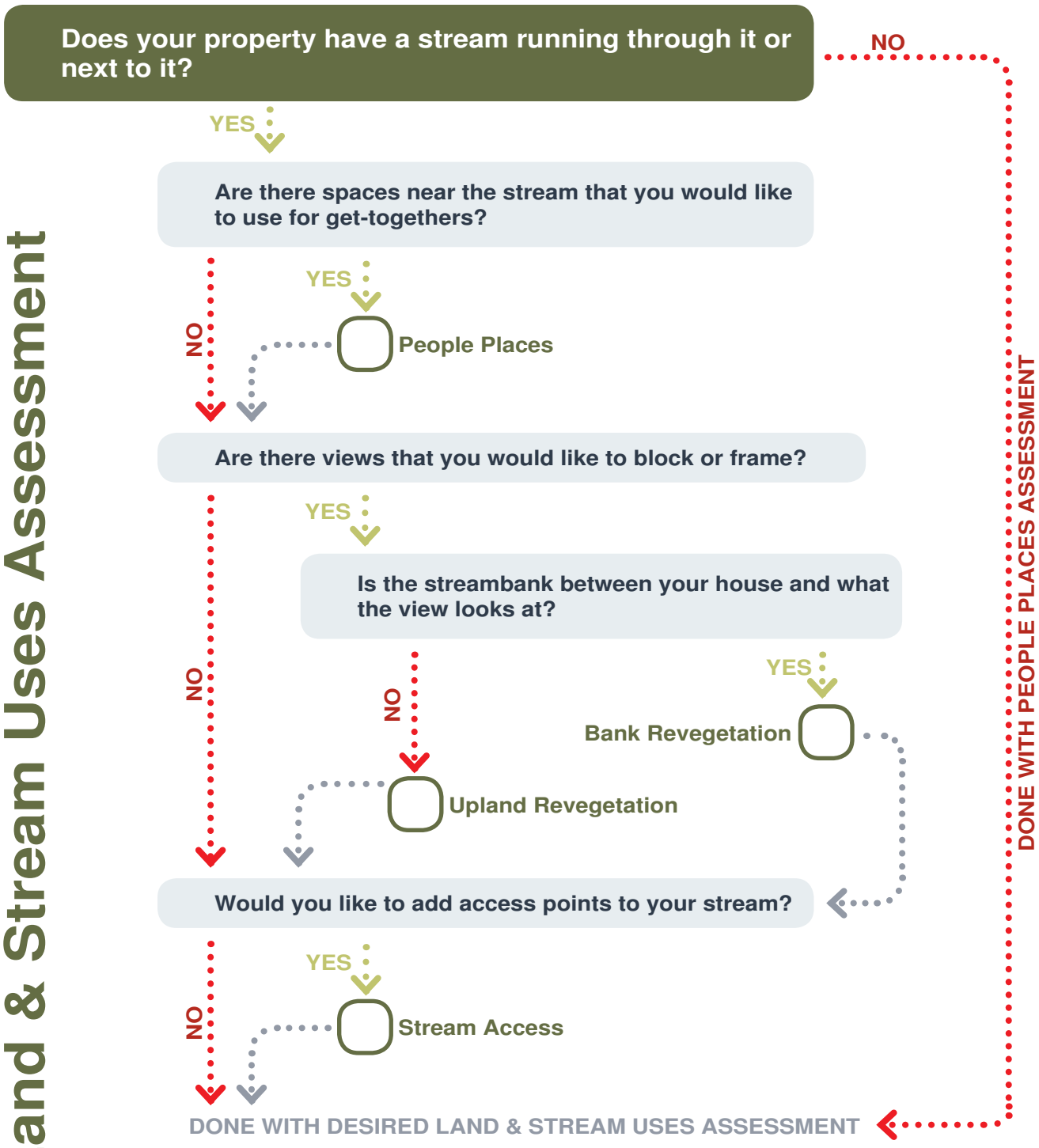
To see which strategies will accomplish your objective(s) identified above, see the *'Stewardship and Recovery Strategy Chart'* [page 76]

Desired Land & Stream Uses

Similar to any other property owner, you probably want to use your land for a variety of uses including exploring nature, relaxing, walking, playing with pets or kids, picnics or get-togethers with family and friends. For areas that are next to streams, there are some additional considerations that should be taken into account. Regardless of how you choose to use your property, streams can be dangerous and unpredictable. Therefore, safety is a top concern when planning how to use your streamside property. You also want to make sure that improvements to your property don't accidentally cause negative impacts to other areas of your property, or neighbors upstream or downstream of you. For example, you don't want to install a deck or shade structure only to have it be washed away in a flood and cause damage to someone else's property. The final concern when planning how to use your property is wildlife and ecosystems. As we have discussed many times in this Handbook, stream corridors are complex networks of ecosystems that include birds, fish, insects, animals and a wide variety of plants. Properly planning people places to minimize any detrimental effects to these systems, as well as minimizing human-wildlife conflicts, will lead to a healthier stream corridor and a better experience for you and your family.

When deciding how to use your property and the improvements you may make, it is important to take all of these considerations into account. The strategy sheets that the **Questionnaire** on the following page will lead you to are a bit different than many of the other strategy sheets. These sheets will teach you about specific details to consider **when planning or designing** your people spaces, rather than giving detailed information about what the **final product may look like**. For example, everyone knows what a patio looks like, but knowing where to place a patio in relation to a stream is not always so simple.

Desired Land & Stream Uses Assessment



To see which strategies will accomplish your objective(s) identified above, see the *'Stewardship and Recovery Strategy Chart'* [page 76]

Stream Classification Guide

Identifying the type of stream on your property is an important step to understanding how and why the stream behaves the way it does. Within the stream stewardship and recovery profession, there are **technical stream classification systems** that have been widely accepted. Two of the most recognized classification systems are River Styles Framework and Rosgen's Stream Classification System. You can learn more about both of these systems, how they are used for restoration work and how your stream fits into them in the ***'Technical Stream Classification Systems'*** *[page 152]* section in **Chapter 5**. For this Handbook, we have provided a simplified classification system based on the same principles as these systems. The factors you will be evaluating and classifying on the following pages are your stream's **Entrenchment**, **Stream Slope** and **Primary Bed Material**. Please record your answers on the ***'Landowner Assessment Worksheet'*** *[page 72]* at the beginning of this chapter so that you have your stream's information easily available when determining the details of your stewardship and recovery projects.

1 Classifying Your Stream Entrenchment

Determine your stream entrenchment type by following the steps and classification types.

Entrenchment is a way of judging how well the stream is connected to its floodplain. In a **not entrenched** stream system such as the picture at right, the stream will flow into the floodplain multiple times a year, meaning the stream is well connected to its floodplain. This allows the water to spread out and slow down, typically causing less damage than higher speed flows. In an **entrenched** stream system (shown below), the water is confined and will move much quicker. While every stream system will have varying types of entrenchment, identifying the entrenchment type of your reach of stream will allow you to better understand the high flow risks on your property and how to address them. It will also give you more information and insight if you decide to work with outside help to alter your stream's entrenchment type.

"Not Entrenched" stream example

How to determine your stream entrenchment:

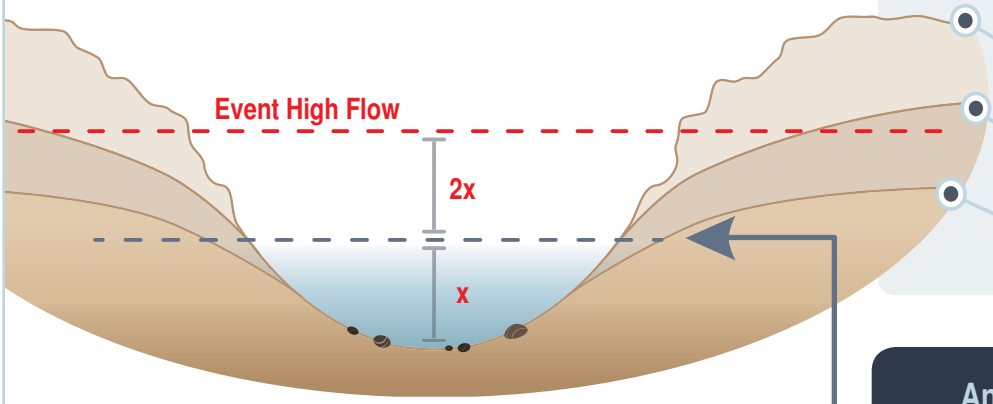
"Entrenched" stream example

Step 1 Standing near the water, look at the banks and changes in plants to determine the **annual high water level**.

Step 2 Double the height of the **annual high water level** to estimate **event high flow.**

Step 3 Is the **event high flow** within the banks? Choose your stream's **entrenchment type:**

3 Types of Entrenchment:



**This graphic shows the differences of each type of possible entrenchment overlaid to demonstrate the physical differences between each type of entrenchment.*

Annual High Water Level

The level a stream will rise to from seasonal flows annually, not from a large flood. This is often called the Ordinary High Water Mark (OHWM or OHW).

Entrenchment Types Defined:

If 2x of your annual high water level stays in the channel, it is **entrenched**.

If it barely reaches the top of the channel, it is **moderately entrenched**.

If it spills over and out of the channel, it is **not entrenched**.

What is your entrenchment? _____

2 Classifying Your Stream Slope

Determine your stream slope by following the steps and equation below.

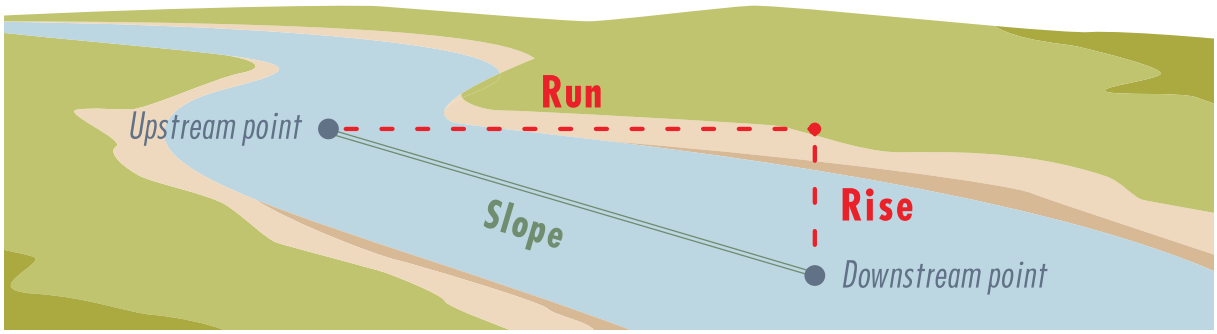
The slope of a stream measures the vertical distance that a stream drops over a given horizontal length. The slope is usually shown as a percentage. A stream's slope influences a number of items such as how quickly the water is moving through the stream, how much sediment the stream will carry and how the streambed may erode. Understanding your stream's slope will help you to understand how and why the stream is behaving the way it does and determine specific details for stewardship and recovery strategies.

Classifying stream slope example

How to determine your stream slope:

Step 1 Determine a length of area you want to work with (at least 100 ft. long), mark the upstream & downstream points. Measure the distance while keeping a string level. **This is the Run.**

Step 2 Place a stake with string. Pull string to downstream mark. Level & measure the distance from ground. **This is your Rise.**



Step 3 Calculate your slope using the equation:

$$\frac{\text{Rise}}{\text{Run}} \times 100 = \text{Slope \%}$$

Step 4 Use your **Slope %** to classify your stream as **Steep, Moderate,** or **Gentle.**

Steep	Moderate	Gentle
>4%	1-4%	<1%

What is your stream slope? _____

3 Classifying Your Primary Streambed Material

Determine your stream's primary bed material type from the below.

Understanding the primary bed material of your stream will help you to determine specific details for some of the stewardship and recovery strategies. For example, certain strategies will make different recommendations based on whether your streambed is primarily **sand** or primarily **cobble**. When determining your stream's primary bed material, you will likely encounter more than one of the categories described below. Select that material/size that makes up the majority of your streambed. If your streambed is mostly **cobble** but has some **boulders** mixed in, select **cobble** as your stream's primary bed material.

Boulder streambed material example

Determine your stream's primary bed material:

Boulders are larger than a basketball.

>10" across

Cobble is between the size of a basketball and a baseball.

2.5" - 10" across

Gravel is smaller than a baseball, but can be picked up individually.

2mm - 2.5" across

Sand is made up of fine sediment that is difficult to pick up individual pieces of.

<2mm across

What is your primary streambed material? _____

Landowner Assessment Worksheet

As you complete each of the preceding **Questionnaires**, please use the **Landowner Assessment Worksheet** on the following page to record notes about your property, your stream and the recommended categories of strategies. Once this is complete, you will have a record of what you have observed on your property and a plan of what strategy types are most applicable for your project. In order to keep an up-to-date record of your property, you can update this **Worksheet** every year, every few years or after large events. It can also be helpful to evaluate your property at different times of the year because you will see different conditions based on the water level, plant growth and other seasonal factors. At the back of the Handbook, you will find additional copies of the **Landowner Assessment Worksheet** so that you can evaluate your property multiple times.

Landowner Assessment Worksheet (page 1)

Landowner Name: _____ **Property Address:** _____

Stream Name/Watershed: _____ **Date:** _____

Description of Property/Interest Reach: _____

_____

_____

Noticeable Changes since Last Assessment: _____

_____

Flow Conditions and Season: _____

Entrenchment:

- ☐ Entrenched
- ☐ Moderately Entrenched
- ☐ Not Entrenched

Stream Slope:

- ☐ Steep Slope (>4%)
- ☐ Moderate Slope (1-4%)
- ☐ Gentle Slope (<1%)

Primary Streambed Material:

- ☐ Boulders (>10")
- ☐ Cobble (2.5-10")
- ☐ Gravel (2mm-2.5")
- ☐ Sand (<2mm)

Map/Sketch of Property/Site:

Map/Sketch Notes:

_____

_____

Landowner Assessment Worksheet (page 2)

Below, check any of the objective boxes that you checked while completing the Questionnaires earlier in this Chapter:

Stewardship & Recovery Objectives

- ☐ Bank Revegetation
- ☐ Grade Control
- ☐ Bank Armoring
- ☐ Bank Re-Shaping
- ☐ Floodplain Structure/Debris Removal
- ☐ Stream Re-Alignment
- ☐ Increase Floodplain
- ☐ Sediment Removal
- ☐ Crossing/Culvert Maintenance
- ☐ Remove/Relocate Woody Material
- ☐ Anchoring Woody Material
- ☐ Upland Revegetation
- ☐ Wetland Management
- ☐ Invasive Plant Management
- ☐ Undesirable Wildlife Management
- ☐ Wildlife Habitat
- ☐ Livestock Management
- ☐ Fish Passage
- ☐ Fish Habitat
- ☐ Channel Complexity
- ☐ Insect Habitat
- ☐ People Places
- ☐ Stream Access

Strategy Notes/Highest Priorities: _____

CHAPTER

3

Stewardship and Recovery Strategies

Once you have completed the ***'Landowner Assessment Questionnaires'*** *[page 34]*, the ***'Stream Classification Guide'*** *[page 68]* and recorded your answers/notes on the ***'Landowner Assessment Worksheet'*** *[page 72]* in **Chapter 2**, you should have a general idea of the types of stewardship and recovery strategies that are applicable to your property. In this chapter, you will learn the details of specific strategies ranging from stream re-alignment to invasive weed management. The ***'Stewardship and Recovery Strategy Chart'*** *[page 76]* lists all of the strategies contained in this chapter, as well as checkmarks indicating what objectives they can accomplish. Using your notes on the L**andowner Assessment Worksheet**, you can easily see which strategies will help you accomplish your goals. You can then review each of those strategy sheets and decide which strategies may be a good fit for you and your property.

Landowner Assessment Questionnaires &

Stream Classification Guide

→

Landowner Assessment Worksheet

→

Applicable Stewardship & Recovery Strategies

While many of these strategies can be done without professional engineering or permits, many of them will require these. For any project, if you are unsure if a permit or engineering will be required, contact your local watershed coalition and/or the agency in charge of administering that permit. There is a summary chart of the potential permits, as well as detailed discussions of each one, in the ***'Permitting Requirements'*** *[page 121]* section at the end of this chapter.

Following recommendations for when to contact a professional engineer, environmental consultant, landscape architect and/or river constructor will make sure that your project has the final outcome that you desire. It will also check that the project does not impact the stream corridor or upstream and downstream properties in a negative way. Permits and regulations have been put in place to protect you as well as other property owners and the stream system.

Stewardship and Recovery Strategy Chart

Objectives that you checked on the **Landowner Assessment Worksheet** match the objectives listed along the top of this chart. Use the chart below to identify which strategies will meet the objectives you identified on the Worksheet, then read about those strategies to determine which one(s) will be best for you and your property.

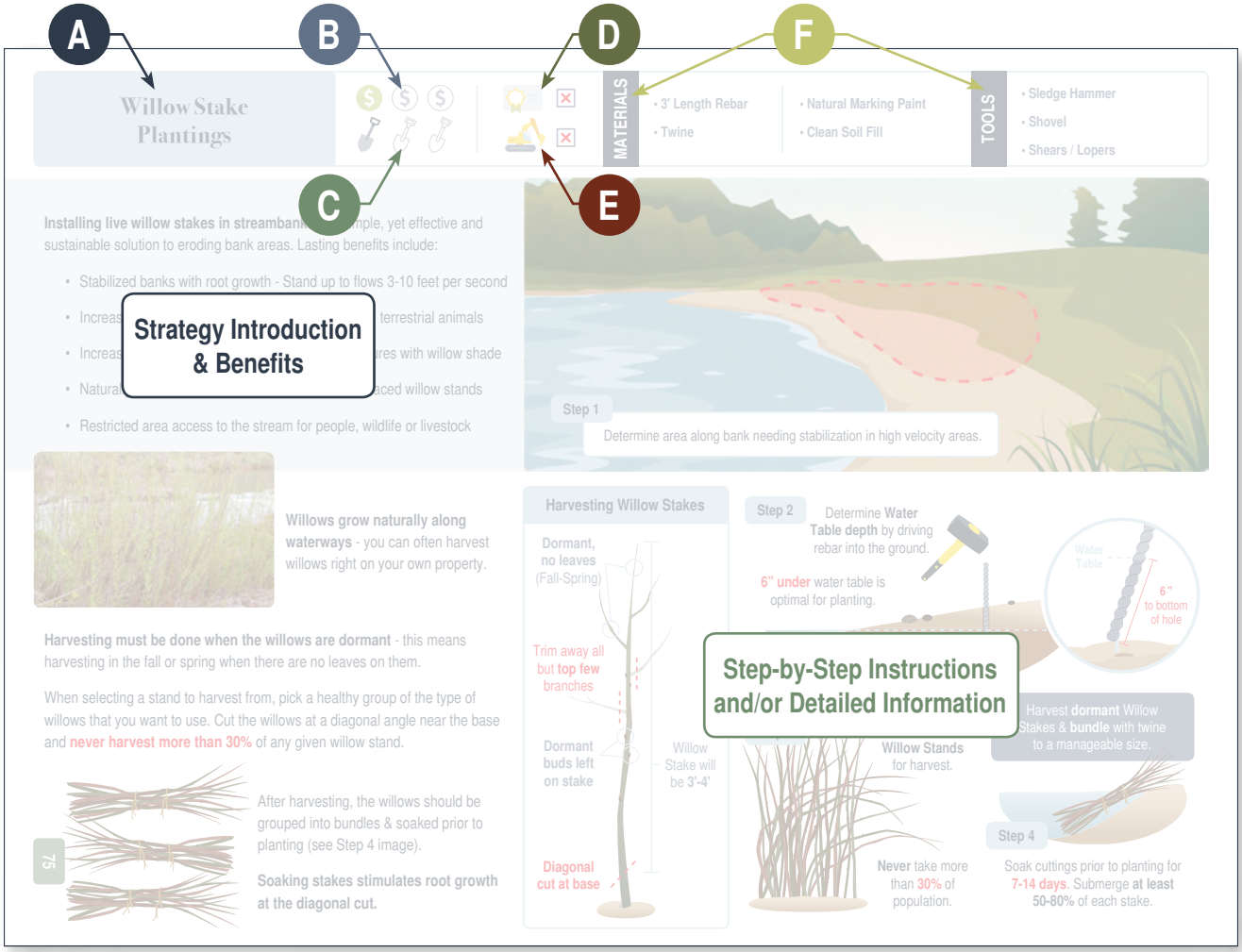
Strategies	Page	Bank Revegetation	Grade Control	Bank Armoring	Bank Re-Shaping	Floodplain Structure/Debris Removal	Stream Re-Alignment	Increase Floodplain	Sediment Removal	Crossing/Culvert Maintenance	Remove/Relocate Woody Material	Anchoring Woody Material	Upland Revegetation
		Objectives											
Bank Stabilization	page 79			✓									
Beaver Dam Analogues	page 81		✓										
Boulder Clusters	page 82												
Coir Logs with Tubelings	page 83	✓			✓								
Constructed Riffle	page 85		✓										
Crossing/Culvert Enhancements	page 86									✓			
Crossing & Culvert Maintenance	page 87							✓	✓	✓			
Drop Structures	page 88		✓										
Fish Passage	page 89		✓										
Floodplain Structure Removal	page 90				✓								
Geotextiles	page 91	✓		✓	✓								
Increasing Floodplain Conveyance	page 92				✓		✓	✓					
Invasive Weed Management	page 93												✓
Livestock Management	page 95												
Log Rollers	page 96			✓							✓	✓	
LUNKERS Boxes	page 97			✓	✓								
Overflow Channel Management	page 98	✓					✓	✓					
People Places Along Your Stream	page 99												✓
Riparian Plantings	page 101	✓			✓								
Root Wads	page 103			✓							✓	✓	
Sediment Removal	page 104				✓		✓	✓					
Stream / Channel Re-Alignment	page 105				✓	✓	✓						
Terraced/Natural Channel Design	page 106	✓		✓	✓		✓	✓					
Undesirable Wildlife Management	page 107												✓
Upland Plantings	page 109												✓
Vegetated Soil Lift	page 111	✓		✓	✓								
Wetland Creation/Expansion	page 113	✓			✓		✓	✓					
Wildlife Habitat Management	page 115	✓									✓	✓	✓
Wildlife Tree/Snag (Dead Wood)	page 117										✓	✓	
Willow Stake Plantings	page 119	✓											

Objectives

Wetland Management	Invasive Plant Management	Undesirable Wildlife Management	Wildlife Habitat	Livestock Management	Fish Passage	Fish Habitat	Channel Complexity	Insect Habitat	People Places	Stream Access	Page	Strategies
											page 79	Bank Stabilization
✓		✓	✓								page 81	Beaver Dam Analogues
						✓	✓	✓			page 82	Boulder Clusters
							✓	✓			page 83	Coir Logs with Tubelings
					✓	✓	✓				page 85	Constructed Riffle
					✓	✓					page 86	Crossing/Culvert Enhancements
					✓	✓					page 87	Crossing & Culvert Maintenance
					✓	✓	✓				page 88	Drop Structures
					✓	✓					page 89	Fish Passage
									✓		page 90	Floodplain Structure Removal
✓											page 91	Geotextiles
✓											page 92	Increasing Floodplain Conveyance
✓	✓		✓	✓				✓	✓	✓	page 93	Invasive Weed Management
			✓	✓					✓	✓	page 95	Livestock Management
					✓	✓	✓				page 96	Log Rollers
						✓	✓				page 97	LUNKERS Boxes
			✓					✓			page 98	Overflow Channel Management
	✓	✓	✓	✓				✓	✓	✓	page 99	People Places Along Your Stream
✓	✓		✓			✓	✓	✓		✓	page 101	Riparian Plantings
						✓	✓				page 103	Root Wads
											page 104	Sediment Removal
											page 105	Stream / Channel Re-Alignment
			✓				✓	✓			page 106	Terraced/Natural Channel Design
		✓	✓					✓	✓	✓	page 107	Undesirable Wildlife Management
	✓	✓	✓	✓				✓	✓		page 109	Upland Plantings
							✓				page 111	Vegetated Soil Lift
✓			✓			✓		✓			page 113	Wetland Creation/Expansion
✓	✓		✓			✓		✓	✓	✓	page 115	Wildlife Habitat Management
			✓					✓			page 117	Wildlife Tree/Snag (Dead Wood)
✓			✓			✓	✓	✓		✓	page 119	Willow Stake Plantings

How to Use the Strategy Sheets

Each of the strategy sheets is arranged in a consistent format to make it quick and easy to compare strategies, or find out basic information about them. Below is an example of one of the strategy sheets with notes showing you where to find the information that will be on every sheet. Although details will vary for each strategy and each project, these 'quick facts' will give you a general idea of what a project will entail. Some sheets are a front and back, and others are just a single page.



A **Strategy Title**

Green background indicates outside help (engineering, planning and/or permitting) will be needed regardless of project details.

B **Cost Range** $ $ $

Approximate range of installation cost compared with other strategies.

C **Difficulty of Install**

Approximate difficulty to install compared with other strategies.

D **Permitting Required**

- ✓ Permits required
- * Permits may be required
- ✗ Permits not required in most cases

E **Heavy Equipment Required**

- ✓ Equipment required
- * Equipment may be required
- ✗ Equipment not required

F **Materials and Tools**

Recommended materials and tools for installation.

Bank Stabilization

OUTSIDE HELP

- Landscape Architect
- Environmental Consultant
- River Constructor
- Engineer

Potential permits required: CWA 404, Threatened & Endangered Species, NHPA, Floodplain

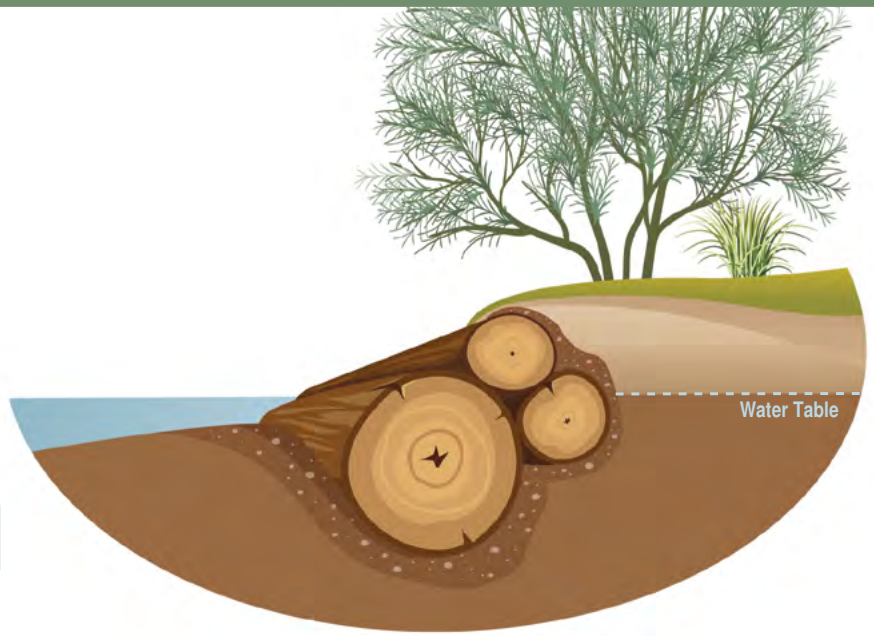
Bank stabilization is needed when streambanks are eroding and threatening infrastructure or buildings. The methods discussed on this sheet are generally recommended when there is not space to re-shape the streambank into a terraced natural channel design. Benefits of bank stabilization include:

- Reduces bank erosion
- Protects steep slopes
- Protects infrastructure

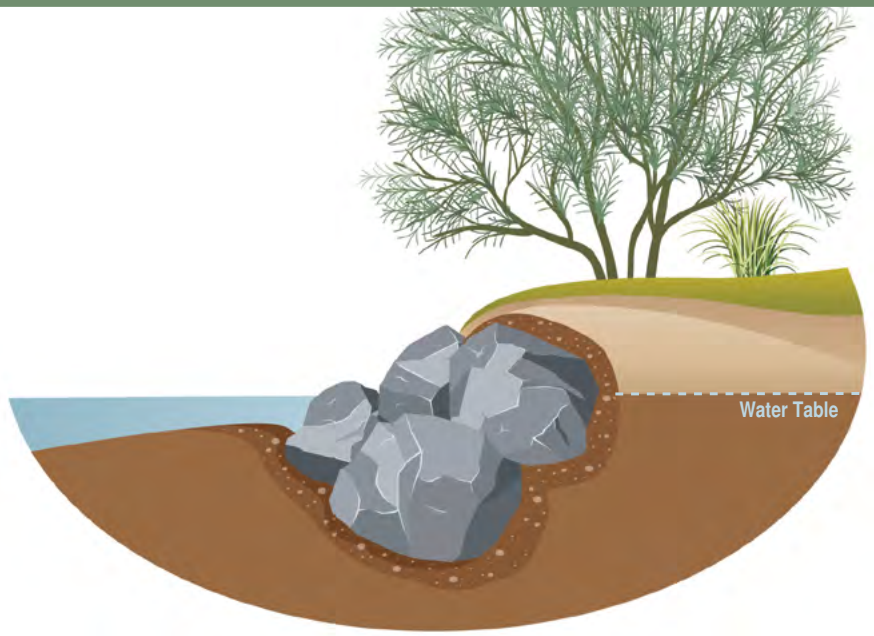
Bank stabilization can take many forms, including riprap/stone armoring, boulder toes and log toes. Boulder and log toes refer to the material used to stabilize the 'toe,' or bottom edge of the streambank.

All of these methods often require a significant amount of earthwork in the stream channel. **The project must be engineered to withstand the anticipated flows of the stream.** This includes selecting appropriate rock or log sizes, along with the method of stabilizing them into the stream bank. Environmental consultants and/or landscape architects can help to design riparian plantings behind or in the bank stabilization areas.

Bank Stabilization with Log Toes



Bank Stabilization with Boulder Toes



Bank Stabilization (pg 2)

OUTSIDE HELP

- Landscape Architect
- Environmental Consultant
- River Constructor
- Engineer

✔ **Potential permits required:** CWA 404, Threatened & Endangered Species, NHPA, Floodplain

Boulder toe bank stabilization

Riprap stabilization on left; vegetative stabilization (bioengineering) on right.

Example of major bank erosion along Fish Creek as a result of the 2013 flood.

Before speaking to outside resources, it will help if you have a general idea of the type of bank stabilization you are interested in. This means thinking through if you want exposed logs, boulders, willow plantings or a combination. The consultants should be able to discuss the pros and cons of each option with you in order to make a sound decision. The method chosen could be very different based upon location along the stream, as well as other criteria.

COLORADO EWP Colorado Emergency Watershed Protection (EWP) Program

Sponsored by the Colorado Water Conservation Board (CWCB)
Administered by the Natural Resources Conservation Service (NRCS)

The Living Streambanks Manual provides great information on a number of bank stabilization methods that use plants and natural materials to provide stabilization. Many of the techniques in the manual will require engineering and/or permitting.

coloradoewp.com/files/document/pdf/Biostabilization_Manual_072416.pdf

Beaver Dam Analogues

OUTSIDE HELP

- Landscape Architect
- Environmental Consultant
- River Constructor
- Engineer

Potential permits required: CWA 404, Threatened & Endangered Species, NHPA, Floodplain

Beaver Dam Analogues (BDAs) are man-made structures that can be built on secondary channels to encourage beaver populations in the area. Benefits of installing these analogues include:

- Controls sediment movement
- Creates wildlife habitat
- Controls secondary flows and erosion

Photo courtesy of : E-Science News [page 188]

Although they can sometimes cause conflicts, beavers are an important species in many riparian ecosystems. When decided if/where a BDA would be appropriate on your property, it is important to recognize that beavers naturally chew down trees. By encouraging beaver populations, you will be encouraging the removal of some trees in the area. In a well-balanced ecosystem, beavers chew down trees at a rate that still allows tree & plant communities to establish.

Beaver dam analogues should never be constructed on the main stream channel because they will block water flows. However, BDA's can be built on secondary channels to encourage nearby beavers to inhabit them and begin building a new home. These are also sometimes referred to as "Beaver Starter Kits". BDA's will change the natural flow in the secondary channel they are built on. As a result, they need to be properly engineered, permitted and constructed by professionals. Improper construction of a BDA can result in water backing up upstream of the BDA. Failure of the structure may cause negative downstream impacts as well.

Beaver dam analogues are fairly new to the stream restoration community and it will be helpful if you can work with outside consultants who have experience designing and building BDAs. Because BDAs are fairly new, someone who has gone through the permitting process for these structures on other projects will also be able to guide you through the permitting process more easily.

If beavers begin working on the BDA you should expect water to begin backing up behind the structure, creating a pool and new wetland habitat. Your discussions with the outside consultants should include making sure you have sufficient area that can be inundated. It is also important that you do not have structures in the area where pooling and wetlands will occur. BDAs have the potential to cause dramatic changes to your land and they are typically used on very large properties. Make sure to talk with environmental consultants and engineers about the effects a beaver dam could have on your property.

U.S. Fish and Wildlife has created a great resource for beaver habitat restoration & considerations:

www.fws.gov/oregonfwo/promo.cfm?id=177175812

Boulder Clusters

OUTSIDE HELP

- Landscape Architect
- Environmental Consultant
- River Constructor
- Engineer

Potential permits required: CWA 404, Threatened & Endangered Species, Floodplain

Boulders clusters are groups of boulders placed in the stream channel to create pools for fish to take refuge. Boulder clusters also provide surfaces for insects to attach their eggs to. They provide:

- Aquatic habitat
- Insect habitat

Photo courtesy of: Geosyntec [page 188]

Boulder clusters naturally occur in stream systems and they provide valuable benefits to the corridor. By breaking up the flow of the stream, deeper pools are formed downstream of the boulders. These pools are used by fish for shelter and rest. The surface of the boulders also provide a surface on which insects can lay their eggs.

Because a boulder cluster project involves placing material in the stream, there will be permitting associated with the project. Often, a properly qualified river constructor will be able to guide you through the permitting process without having to go through expensive engineering processes.

If the project is larger or has more potential to cause negative effects, you may need to hire an engineer to make sure the project will be beneficial for the stream corridor, neighbors and yourself.

Boulder clusters are intended to promote aquatic habitat. Before contacting outside help, it is important to understand what type of aquatic species you have in your stream. It will also help to observe if there are boulders in the channel upstream or downstream of you. If you are in a sandy plains stream, it is not very likely that there are boulder clusters in your area. Likewise, installing boulder clusters in your stream will not be effective for aquatic habitat and it could have negative effects on the stream system.

Placement of boulder clusters will require heavy equipment and some excavation. The river constructor should be able to discuss the project schedule and what the final product will look like with you.

Typically, boulder clusters are not used in sandy streambeds because they have a greater chance to become dislodged in stream systems with bed material that is much smaller than the boulder itself.

Coir Logs with Tubelings

MATERIALS
- Coir Logs
- Tubeling plants (native)
- Hardwood Stakes

OPTIONAL:
- Willow Stakes

TOOLS
- Sledge Hammer
- Shovel

Potential permits required: CWA 404, Threatened & Endangered Species, NHPA, Floodplain

Coir logs are a type of **erosion control** product that consist of tightly wound coconut fibers and/or soil wrapped into cylindrical bundles. They can be very effective at preventing erosion and they can be planted with tubelings to create a **stable vegetated streambank**. Lasting benefits include:

- Stabilized banks with root growth - Can stand up to lower velocity flows
- Erosion control/restricts sediment into the stream
- Creation and/or increase of healthy riparian plant communities
- Increased habitat & food source for birds, insects & terrestrial animals

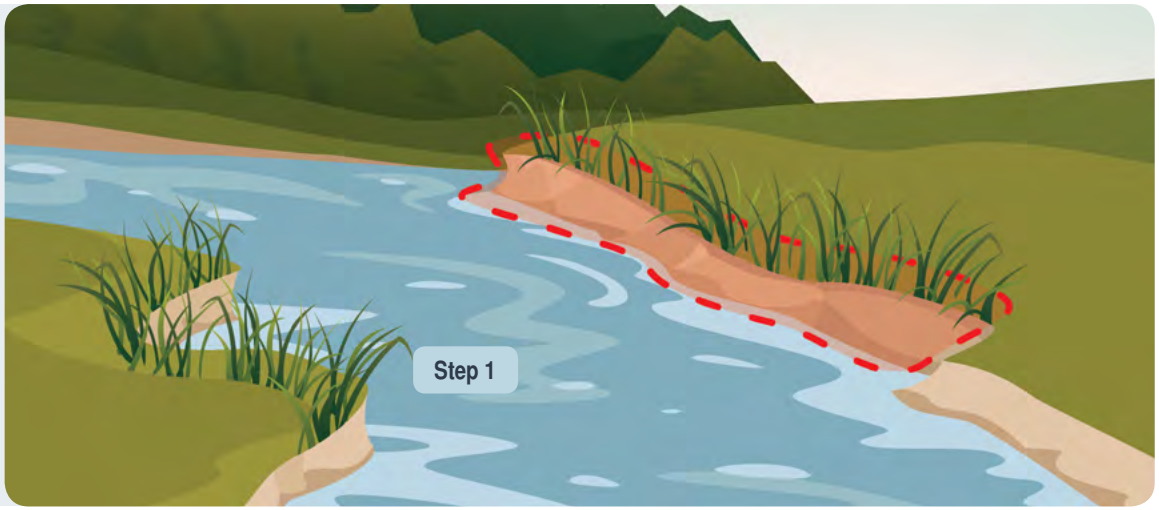


Photo Courtesy of: Maccaferri [page 188]

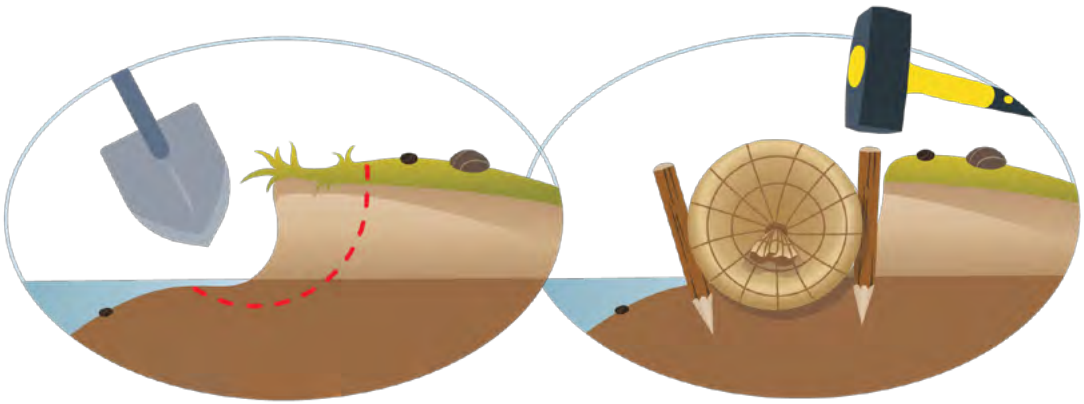
Many types of plants can be purchased as tubelings. **A tubeling is a young seedling plant grown in long plastic tube**, or 'plug,' containers. This allows the plants to be grown very quickly and in large quantities. For best results, you will want to **select plants native to your area.**

Because you are likely to be working below the annual high water level, you may need to apply for a **CWA 404 permit.** Your local **Army Corps of Engineers office** should be able to assist you with determining which permit you need and how to apply for it.

Step 2 Based on location, obtain necessary permit(s) with outside help.

Step 3 **Dig a small trench** parallel to the stream and lay the coir log into it.

Step 4 To secure the coir log, **hammer hardwood stakes** on either side, spaced every **8-10'.**



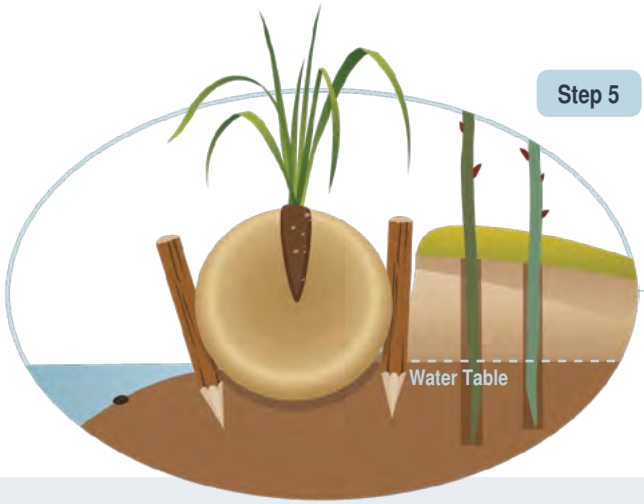
Coir Logs with Tubelings
(pg. 2)

MATERIALS
- Coir Logs
- Tubeling plants (native)
- Hardwood Stakes

OPTIONAL:
- Willow Stakes

TOOLS
- Sledge Hammer
- Shovel

Potential permits required: CWA 404, Threatened & Endangered Species, NHPA, Floodplain



Step 5

Plant the tubelings through the center of the coir logs **approximately every 3'.**

You can also plant the tubelings or willow stakes directly **behind the log.**

OPTIONAL: For additional plantings, place **willow stakes** through/around the logs making sure the stakes **reach the water table.**

Step 6

Backfill the trench around the log/stakes.

If possible, water tubelings until they begin to establish

As the tubelings become more established, the coir log will eventually break down into the soils below. **You will be left with a stable and vegetated streambank.** This streambank will not only look great, but it will also provide your property and the stream with ecological, wildlife and water quality benefits!

Photo Courtesy of: Coleman Moore Company [page 188]

Do's & Don'ts of Coir Logs with Tubelings

Do's

- Place coir logs in areas where there is some erosion on the streambanks; avoid boulder areas
- Select plants native to your area
- Apply for appropriate CWA 404 permits prior to beginning work

Don'ts

- **Don't** install coir logs to try to fix major erosion on streambanks
- **Don't** install coir logs too far away from stream- the plants will depend on the stream's water!
- **Don't** install coir logs without the hardwood stakes-they need to be secured in place

Constructed Riffle

OUTSIDE HELP

- Landscape Architect
- Environmental Consultant
- River Constructor
- Engineer

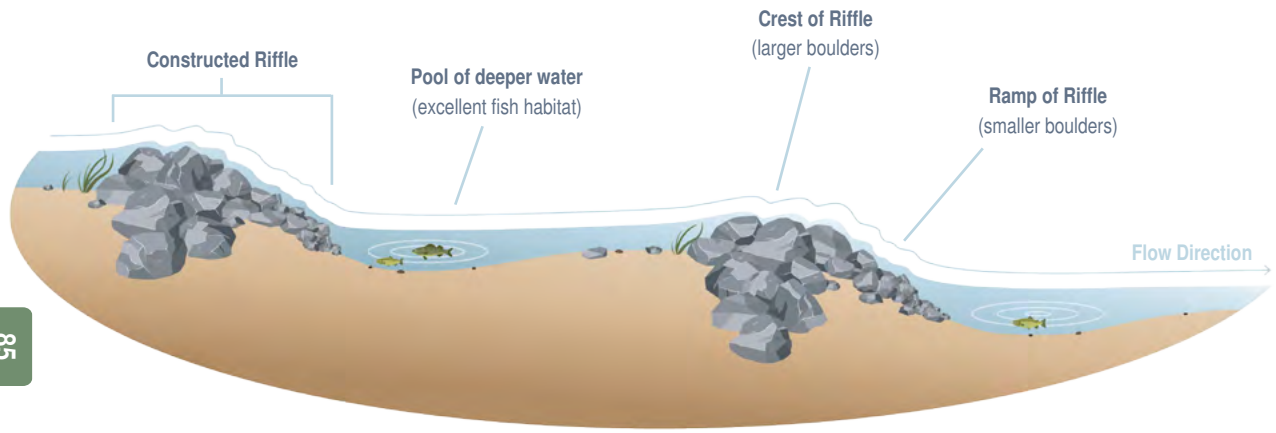
Potential permits required: CWA 404, Threatened & Endangered Species, Floodplain

A constructed riffle is a grade control and habitat structure built by placing river cobble in a stream to create changes in flows that benefit aquatic organisms. Benefits of installing constructed riffles include:

- 'Structural' way to 'drop' grade in a stream
- Fish and insect habitat
- Added oxygen to the water

Constructed riffles mimic riffles that occur naturally in stream systems. Often, riffles are part of a 'sequence' of in-stream structures. Moving downstream, a riffle will be followed by a pool, then a fairly calm section of stream, then another riffle. You will see this sequence both in constructed stream systems and natural streams.

Constructed Riffle System and Sequence



The design and construction of a constructed riffle involves engineering for structural stability and floodplain impacts. It also requires environmental and wetland considerations. All of these impacts mean that permitting will be required for constructed riffles. While these structures mimic natural features, installation into existing streams requires careful planning to ensure they don't cause unintended negative effects.

When selecting outside resources for your project, be sure to check references. It is always helpful if the consultants and constructors have experience designing and installing similar projects, especially in your area. Once selected, they should be able to discuss design options, construction costs, timeframe and what the construction process will look like. You can also discuss revegetation options for any areas disturbed by the work with the consultants.

Crossing/Culvert Enhancements

OUTSIDE HELP

- Landscape Architect
- Environmental Consultant
- River Constructor
- Engineer

Potential permits required: CWA 404, Threatened & Endangered Species, NHPA, Floodplain

If you currently have a crossing on your property, you may be interested in modifying it, removing it or combining it with other crossings. This could range from rebuilding the entire crossing structure itself or just making changes to the existing structure. These enhancements could improve the:

- Crossing capacity/conveyance
- Provide fish/aquatic organism passage
- Stabilize crossing embankments and abutments

Undersized culvert near Estes Park.

Enhancing an existing crossing can take the form of a variety of projects ranging from adding fish baffles for aquatic habitat connectivity, to adding additional culverts, to rebuilding or replacing parts of the culvert/ crossing. These improvements might involve extensive construction, in turn requiring permitting. The crossing must be adequately designed to pass daily flows, as well as stand up to large flood events.

Generally, any modification or enhancement should retain or increase the conveyance of the culvert (the flow of water through the culvert). In addition to design considerations of the culvert, you want to make sure that the project won't negatively impact upstream or downstream neighbors, or the riparian ecosystems. The required permits will ensure that these criteria are met.

This culvert was 'retro-fitted' with fish baffles to add fish passage.

When approaching someone for outside help in enhancing your crossing, there are a few key topics that a landowner should be aware of: **floodplain location, wildlife and fish species of concern and nearby infrastructure that could be affected.**

For projects that will impact the ecosystems, an environmental consultant can help plan the project. When enhancing a crossing, its ability to convey flood flows must also be analyzed to ensure the safety of those who use the crossing, as well as upstream and downstream neighbors. This analysis and design is typically done by engineers.

For additional information, see the **Resilient Crossings Guidebook** developed by the Fourmile Watershed Coalition:

fourmilewatershed.org/project/crossings-guidebook

Crossing & Culvert Maintenance

TOOLS

- Shovel
- Saw
- Wheel Barrel

* **Permits and heavy equipment may be required:** Depending on the size and/or detail of the project.

Crossing & culvert maintenance includes ensuring the structural integrity and capacity of the structure is intact, and that it functions well under average daily flows, as well as during large storm events. Lasting benefits can include:

- Protection from potential crossing failure
- Providing fish and wildlife passage
- Protection for upstream & downstream property flooding

Clogged culverts can cause flood damage to upstream and downstream properties.

Maintaining crossings and/or culverts located on your property ensures that they will function correctly both on a daily basis and during flood events. This includes large bridge crossings, as well as smaller culverts.

A failed crossing can cause damages to structures or property upstream or downstream of the structure. Ensuring that your crossing doesn't fail during a flood also ensures that there is emergency access to your property. Aquatic habitat connectivity and fish passage is another benefit of a property maintained crossing or culvert.

When investigating a crossing to determine if maintenance is necessary, there are four general areas that need to be evaluated:

1st **Investigate the crossing itself** to make sure that the road, abutments and embankments are all structurally sound and in good condition.

2nd **Regularly inspect the area directly upstream of the crossing** to check for any loose large woody debris that could potentially clog the culvert.

3rd The **structural integrity** of the actual culvert underneath the road crossing is important in your evaluation. Inspect for abrasion or rust on the metal and ensure the bottom of the pipe is in good condition, without holes in it. This includes checking that flows stay in the culvert as opposed to flowing around the culvert.

4th **Inspect the inside of the culvert for debris and clean out as needed.** Many culverts are designed to have a soft bottom, meaning that there will be streambed material in the culvert as opposed to the metal being exposed. This allows for better fish passage and aquatic habitat connectivity.

Do's & Don'ts of Crossing & Culvert Maintenance

Do's	Don'ts
• Familiarize yourself with the original intent / design (when is it clogged, when it is not)	• **Don't** alter the structure of the culvert, abutments or embankment
• Consider wildlife/fish passage accessibility	• **Don't** release sediment into the stream
• If unsure when inspecting, reach out to an engineer or your watershed coalition to help evaluate the capacity/size of the culvert	• **Don't** disturb wildlife homes

Drop Structures

OUTSIDE HELP

- Landscape Architect
- Environmental Consultant
- River Constructor
- Engineer

Potential permits required: CWA 404, Threatened & Endangered Species, Floodplain

Drop structures are grade control structures used when a stream needs to 'fall' over an area of steep slope. Drop structures can stabilize the streambed and limit erosion in these areas**.** They provide many benefits to the stream system and stream ecosystems, including:

- Controls slope of the stream
- Reduces scour/streambed erosion and streambank erosion
- Adds oxygen to the water
- Improves fish habitat

Stream slopes vary greatly not only by region (mountains vs. plains), but also by reach. The slope of your stream may change within your property limits. There may be places where the slope is steep and the streambed and/streambanks are eroding as a result. When both sides of the stream are eroding, this can often be a sign that grade control would help to solve the problem. Drop structures, or 'drops,' are engineered structures that stabilize a quick change in elevation in the stream.

Drop structures can be designed and built in many configurations and from many materials. An engineer will be able to help determine what configuration will be best for your reach of the stream, as well as the organisms living within it. While they can be constructed from concrete, a drop structure built from natural materials like boulders or logs will provide more benefits to the ecosystems. They will also look much more fitting in a natural setting.

Drop structures require careful engineering and design to ensure they function properly. This includes calculating how the water flows will affect the streambed and streambanks upstream and downstream of the project, as well as considering how fish can pass through the structure. When designed a drop structure, it is important to make sure that they fish species living in your area will be able to jump up the structure so they can move upstream and downstream. Sometimes, a constructed riffle can provide similar benefits to drop structures while allowing for better fish passage. The engineers will also need to calculate and analyze the structure's impacts to the floodplain and floodway.

A drop structure will require permitting in both the design and construction phases of the project. Depending on the complexity of the project, it may make sense to work with a multi-disciplinary team. This is especially true if the drop structure is being combined with other work such as bank revegetation, aquatic habitat creation and/or bank stabilization.

When working with outside consultants on a drop structure project, it will be helpful if you can go into the conversation with some ideas about what you want the structure to look like. Doing some initial research online or by looking at other reaches of streams and rivers in person can give you a head start on this. Knowing what types of fish live in your stream will also be useful. The consultants and/or constructors should be able to discuss the design/configuration options with you, as well as the pros and cons of each option. When selecting your outside help, make sure to ask questions about similar projects they have completed. Questions about your role in the permitting process and the anticipated timeframe for permits are also important.

Fish Passage

OUTSIDE HELP

- Landscape Architect
- Environmental Consultant
- River Constructor
- Engineer

Potential permits required: CWA 404, Threatened & Endangered Species, NHPA, Floodplain

Providing fish passage along a stream corridor creates a healthy ecosystem that allows the migration of fish and other aquatic organisms upstream and downstream during different times of the year for feeding and spawning activities. Installing Fish Passages allows lasting benefits such as:

- Providing fish/aquatic organism passage
- Providing healthy, connected ecosystem
- Providing recreational values

As discussed in the aquatic species section of ***'Chapter 2: Evaluating Your Property'*** *[page 33]*, fish and other aquatic organisms depend on the connectivity of a stream corridor to thrive. Along a stream system, there are many potential fish barriers. Incorrectly designed drop structures, culverts or crossings can be fish barriers. Similarly, dams or irrigation ditch diversions can be fish barriers. In order to fix this issue, there are a variety of solutions that will be dependent upon the situation. Engineers, landscape architects, environmental consultants and/or river constructors can help you decide the best path forward.

Because the existing fish barrier could come in the form of a dam, diversion structure, culvert/crossing or a point that dries up, there can be major impacts to the floodplain and ecosystems. Incorporating fish passage or fish ladders into an existing stream can require extensive grading and potential modifications of existing structures, the channel and the floodplain. Fish ladders, which are a specific fish passage technique, can be very large and require a structural evaluation and design as well.

Fish passage can also often be incorporated into an existing crossing structure to ensure the fish can move beyond the structure. There are multiple approaches to doing this, depending on the existing conditions of your culvert/crossing.

When discussing fish passage options with outside resources, it will help to know the types of fish that live in your stream system. Each fish species has unique characteristics that determine how they move upstream. For example, the distance a fish can jump vertically can vary greatly between species. Other criteria include how deep the water must be, the temperature of the water and how fast the water can be moving. After determining the types of fish to design for, the outside resources should evaluate different options and discuss how they will impact existing structures, ecosystems and the floodplain.

Fish passage barrier on the Big Thompson River.

Floodplain Debris (non-woody) & Structure Removal

TOOLS
- Shovel
- Saw
- Demolition Equipment

* **Permit not required** as long as you are not modifying the floodway, floodplain or wetlands.

* **Heavy equipment may be required:** Only start demolition that you are comfortable doing yourself; talk to outside help for projects that are larger/more complex than you are comfortable doing on your own.

Removal of debris (non-woody) and/or structures in the floodplain can range from the removal of small buildings such as outhouses, to trash, to fences located in the floodplain that could potentially become debris or create a debris dam during a storm event. Woody material in the floodplain is often beneficial to the environment, wildlife and flood conditions. Lasting benefits of non-woody debris removal can include:

- Reduced potential for property damage or future debris
- Protection for downstream infrastructures
- Reduced potential for the stream to change direction
- Reduced chance for clogging crossing structures

IMPORTANT: Only remove debris/structures that are on your property.

Having loose debris or a structure in the floodplain can cause many unwanted impacts during a flood. **Because storm flows will reach floodplain areas, a storm event has the potential to wash the debris/structure away, form a debris dam, or find a way around the structure.**

During floods, structures in floodplains could become destroyed and swept downstream, which could lead to additional hazardous debris that could pose threats, clog crossings or cause damage to existing infrastructure.

If the structure can resist a flood, it can still pose negative impacts. The storm flow around the structure could cause the entire stream channel to move/shift or damage nearby properties that would have not otherwise been affected by the flood.

Do's & Don'ts of Debris/Structure Removal

Do's

- Take care to not impact vegetation, wildlife communities, etc.
- Completely remove debris/structure to outside the floodplain
- Contact local agencies if you are unsure about the impacts your project will have.
- If you observe debris on a neighbor's property, talk to them and, if you'd like, offer to help.

Don'ts

- **Don't** disturb wildlife homes - nests, dens, etc.
- **Don't** release sediment into the stream
- **Don't** trespass or remove debris on other people's property
- **Don't** move debris/structure into other areas still within the floodplain

Geotextiles

Materials and Tools needed varies by project.

*** Permits may be required:** Depending on the details of the project that the geotextile is combined with.

*** Heavy equipment may be required:** Depending on project size and details.

Geotextiles are strong synthetic and natural fabrics used to stabilize loose soils and prevent erosion. Installing geotextiles can provide benefits such as:

- Soil stability
- Helps vegetation establish

Geotextiles are usually a combination of synthetic materials and natural materials, such as coconut fibers, woven into blankets. The blankets can be staked into the ground to provide temporary erosion control and help vegetation establish on slopes.

There are many different types of geotextile blankets, including ones specifically for riparian use. Typically, the riparian geotextiles are thicker and are made to hold up to fluctuating stream flows.

Geotextiles usually are not installed on their own, but rather as part of a larger project. They can be installed behind bank stabilization projects like a **boulder toe** or a **vegetated soil lift**. It is also possible to plant willow stakes through the geotextile blanket. This, combined with riparian seed underneath the blanket, will start to create a riparian floodplain bench.

Depending on how close your project is to the stream, as well as what the construction will impact, permits may be required.

Understanding that geotextiles are an option to add to streambank projects is an important first step in talking to outside resources. From there, you can talk about where it makes the most sense to use geotextiles, what types will be best for your project and if vegetation should be installed with it.

Increasing Floodplain Conveyance

OUTSIDE HELP

- Landscape Architect
- Environmental Consultant
- River Constructor
- Engineer

Potential permits required: CWA 404, Threatened & Endangered Species, NHPA, Floodplain

Increasing floodplain conveyance spreads flood flows out across the floodplain, reducing the amount and speed of water flowing through the main stream channel. As a result, the flood has less destructive power when it comes into contact with streambanks and structures like bridges or buildings. Benefits include:

- Reduces main channel velocity and risk of erosion
- Provides greater riparian habitat
- Allows for storage of sediment
- Allows activation of overflow channels

Conveyance: The amount of water moved through an area.

In many stream systems, the stream is confined to its main channel and it is unable to reach its floodplain. Where the situation allows, it is beneficial to re-shape the channel so that flood waters can flow into the floodplain.

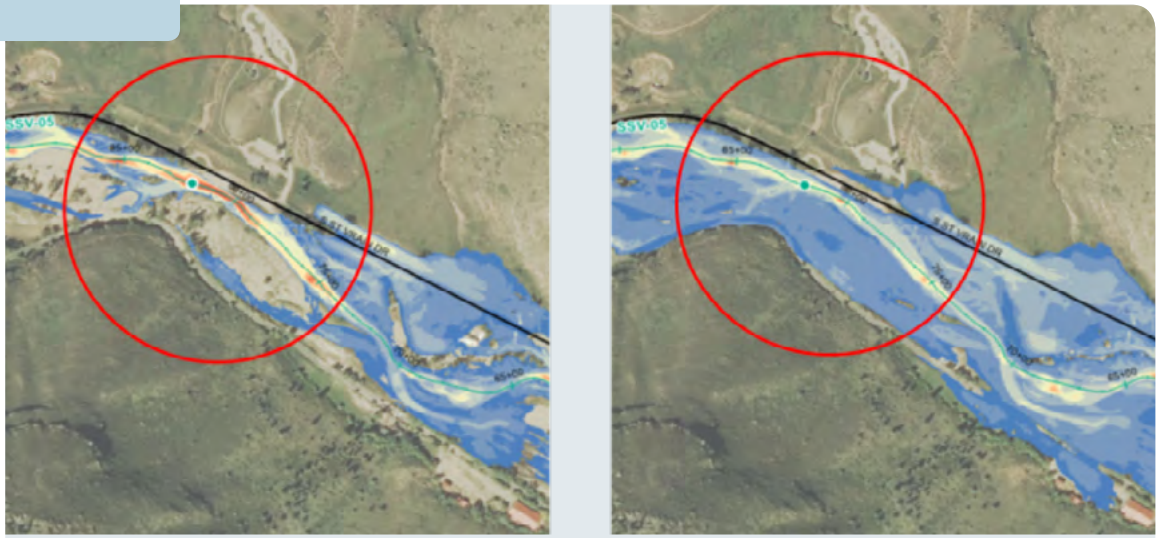
Increasing the floodplain conveyance is changing the floodplain, and therefore will require engineering and floodplain permitting. It is paramount to ensure the main channel carries enough flow to provide a healthy sustainable system, while not conveying so much that erosion and damages are caused during large events.

Increasing floodplain conveyance could also include installing floodplain culverts at a crossing. This allows the water on the floodplain to stay on the floodplain by passing through additional culverts as opposed to the entire flood wave being forced through a single opening.

Discussions with outside resources about floodplain conveyance should include topics such as the extent of the floodplain and your property boundaries, as well as what the proposed floodplain will look like.

As the engineers work on the design, they should be able to tell you how much soil is being moved and where. Try to include other strategies with this project. These could include:

- Overflow channels
- Riparian plantings
- Terraced/natural channel design
- Willow stake plantings



Picture depicting reduction in velocities by increasing the floodplain conveyance. High velocities on left image shown in red.

Invasive Weed Management

MATERIALS

- Herbicides*

TOOLS

- Shovel
- Weed-trimmer/mower
- Gloves

Possible items needed:

- Weed wand, hand sprayer, back-pack sprayer

*** Price and difficulty of install** depends on the weed and the control method used.

*** If Herbicides are needed:** Read label - Herbicide must be rated effective for targeted weed. Certain herbicides must not be used near water, around desirable woody vegetation or under other circumstances as described on label.

Invasive weeds can spread quickly if left unmanaged. The most effective way to control weeds, noxious and otherwise, is to integrate several different control methods targeted to the specific species, size of the population and land use of your property.

To learn more about identifying invasive weed types,visit the Vegetation section in Chapter 2 *[page 45]*.

The four types of weed-control methods are:

1. **Cultural** - The most cost-effective and easiest way to control noxious weeds is to prevent their establishment. Prevention techniques include:
   - Before entering your land, wash construction vehicles coming from another, potentially weed-infested, location.
   - Use only weed-free mulch.
   - Use only seeds free of weeds.
   - After ground disturbance, quickly revegetate the site. Establishing desirable native species first is an effective control method.
2. **Mechanical** - Mowing or pulling weeds can be effective for some noxious weeds, especially if the populations are small. Mechanical methods are not as effective for noxious weeds with extensive root systems, although a combination of mechanical and chemical control can be successful.
3. **Biological** - Grazing can control noxious weeds, especially during specific stages of the weed's life cycle. Some noxious weeds have specific pests that can effectively control that species. Contact the Colorado Department of Agriculture (CDOA) or your county weed manager for information on specific pests. Note: all biological methods help control the amount of a noxious weed species, but generally do not eradicate them.
4. **Herbicides** - Herbicides can effectively control noxious weeds, but care must be taken to prevent damage to desirable plants, humans, livestock or wildlife. Use only the herbicides recommended by the CDOA or your county weed manager. When spraying near a stream, only use herbicides rated as safe near water. Strictly follow the directions on the herbicide's label.

Combining these different methods minimizes potential harm from overuse of chemicals that could damage your property or your neighbors' property. Working with your neighbors or homeowner's association to develop an integrated weed control plan is an effective way to prevent weeds from invading or re-invading your land.

Invasive Weed Management (pg. 2)

MATERIALS

- Herbicides*

TOOLS

- Shovel
- Weed-trimmer/mower
- Gloves

Possible items needed:

- Weed wand, hand sprayer, back-pack sprayer

* **Price and difficulty of install** depends on the weed and the control method used.

* **If Herbicides are needed:** Read label - Herbicide must be rated effective for targeted weed. Certain herbicides must not be used near water, around desirable woody vegetation or under other circumstances as described on label.

To determine what is the best control method for the infestation on your land, first assess the type and size of the infestation on your land with these questions:

1. **What type of weed(s) do you have?** Some (such as annuals) can be controlled by simply pulling the weeds, others (such as ones with extensive root systems) need repeated mechanical treatment and/or herbicide treatments.

2. **What are you using your land for?** Some weeds (especially non-noxious weeds) are not detrimental in small patches or for certain land uses. For example, scattered dandelions are not harmful in riparian woodlands or native meadows. However, extensive dense patches may decrease grazing productivity or may not be considered aesthetically pleasing on a lawn.

3. **How extensive is the infestation?** A few plants can be removed by pulling even if it must be done several times. Large patches may require repeated mechanical treatments and/or herbicide applications.

4. **Does the infestation extend to your neighbor's property?** If the weed infestation occurs over several properties, then a community wide control effort may be needed to prevent re-invasion. For releasing biological control agents, it may be most effective to coordinate releases with surrounding neighbors.

5. **Are the weeds near water?** Herbicide use should be limited because they can detrimentally effect water quality. If possible, other types of control methods should be used near streams and other water bodies. If herbicides are the most effective way of controlling the weed population on your property, then you must use an herbicide rated as safe near water.

6. **Is the infestation near desirable woody vegetation?** Many herbicides will also kill nearby shrubs and trees. Read the herbicide label to ensure that it can be used near non-targeted woody vegetation or use another method such as mowing/pulling.

7. **Is the infestation near a rare plant?** Use best management practices and avoid herbicide applications near populations of rare plants as described in the *Colorado Department of Agriculture – Recommended Best Management Practices for Managing Noxious Weeds on Sites with Rare Plants:* ***www.colorado.gov/pacific/agconservation/noxiousweeds***

8. **After removal – is follow-up needed?** Revegetating with an appropriate seed mix is one of the best methods to prevent re-infestations by the removed weed or invasion by other weeds. Frequent monitoring and quick removal of individual weeds prevents extensive and costly weed control efforts later.

Additional Resources for Invasive Weed Management

Colorado Noxious Weed List - *extension.colostate.edu/topic-areas/agriculture/noxious-weeds-invasive-plant-species/*

Boulder County Noxious Weed Program - *www.bouldercounty.org/property-and-land/land-use/noxious-weeds/identification/*

Larimer County Noxious Weed Program - *www.co.larimer.co.us/weeds/*

Weld County Noxious Weed Program - *www.weldgov.com/departments/public_works/weed_management*

Colorado State University Extension – Noxious Weeds & Invasive Plant Species - *www.colorado.gov/pacific/agconservation/noxiousweeds*

Livestock Management

Materials and Tools needed varies by project.

Successful livestock management near streams aims to find a balance between raising livestock and maintaining a healthy natural riparian corridor. Lasting benefits of livestock management can include:

- Maintained water quality
- Streambank stability
- Healthy riparian vegetation and ecosystems

YouTube

Watch a video on managing livestock creek access at the LWOG YouTube Channel!

http://bit.ly/2yNaPMm

Michigan State University's Acceptable Practices for Managing Livestock Along Lakes, Streams & Wetlands manual:

forage.msu.edu/wp-content/uploads/2014/07/Bulletin-E3066-AcceptablePracticesforManagingLivestockAlongStreams-20081.pdf

Livestock management is a broad field and there are many resources available. This strategy sheet will focus on some of the key considerations for raising livestock near streams.

The most common issues that arise from having livestock along a stream are livestock waste washing into the stream, livestock trampling or overgrazing riparian vegetation. **Livestock can also cause streambank erosion.** In order to reduce these negative impacts, the preferred management practice is to create a buffer between the stream and your livestock. This buffer can be plant materials or fences.

Fencing provides a strong barrier, but can also create problems if it is placed in the floodplain. Fence lines should be placed outside of the riparian buffer and take into account slopes and grading, runoff and vegetation.

Vegetated buffers are sections of heavy vegetation that limit or prevent livestock from reaching the stream. Specific types of vegetation can be used to further deter livestock. Vegetated buffers provide environmental benefits in addition to the livestock benefits. However, they do not provide an impervious barrier and livestock can find ways through.

It is often necessary for livestock to cross a stream or have access to drinking water. To eliminate large scale disturbance, **crossings or access locations** should be **stable** and **limited** to specific areas. Providing livestock with access to alternative drinking water sources such as troughs is also recommended.

As many of the strategies in this Handbook aim to increase wildlife habitat, it is important to consider livestock on your property and your neighbors' properties when creating or increasing wildlife habitat. In order to limit conflicts between wildlife predators and livestock, it is a good idea to maintain a buffer between livestock areas and wildlife predator areas. For example, it would not be recommended to install a chicken coop next to a wildlife tree/snag. Likewise, it is not a good idea to install a wildlife tree/snag next to a chicken coop.

Do's & Don'ts of Livestock Management

Do's	Don'ts
• Keep a buffer or barrier between livestock and wildlife habitat to avoid conflicts	• **Don't** create predator habitat next to livestock
• Restrict livestock access to streambanks	• **Don't** allow livestock to access the entire bank
• Keep the stream free of livestock waste	• **Don't** allow livestock waste, food or carcasses to wash into the stream

Log Rollers

OUTSIDE HELP

- Landscape Architect
- Environmental Consultant
- River Constructor
- Engineer

Potential permits required: CWA 404, Threatened & Endangered Species, Floodplain

Log rollers are large, crisscrossed dead trees spanning across the channel to create fish habitat and control erosion. The trees are anchored into the streambanks. Benefits of installing log rollers include:

- Increased channel complexity
- Improved fish habitat
- Controls flows
- Insect habitat
- Controls erosion

Photo courtesy of: Ben Swigle, CPW

Log rollers are created by burying large dead trees into the streambank. The trunk of the tree goes out into the stream and overlaps with other dead trees in a criss-cross pattern. The trees have to be anchored in place very securely so that they don't become dislodged in flood events. Often, boulders will be placed on top of the logs to help secure them. The logs will usually angle down towards the stream's center, creating a low-flow channel.

Log rollers mimic what happens naturally in stream systems; when floods leave large woody material behind, it is often partially buried by sediment. These dead trees create shelter areas for fish, breeding areas for insects and help to stabilize streambanks. They also add to the complexity of the channel, in turn, making a more stable stream system that can support more types of life.

Installed Log Rollers

Log rollers are complex structures that require engineering and planning to account for the impacts to the upstream and downstream areas, the floodplain and the surrounding ecosystems. Engineers, landscape architects and/or environmental consultants will need to help you by designing the structure and guiding you through the permitting processes. When it comes time to build the structure, a qualified river constructor should be hired.

Log rollers are less common than other stream restoration methods. It will be helpful if you can work with outside consultants who have experience designing and building similar structures. This will also help to expedite the permitting process as they will know the best ways of applying for the permits. Before contacting the outside help, consider if you have large woody material and/or boulders that can be used for the project on your property.

LUNKERS Boxes

OUTSIDE HELP

- Landscape Architect
- Environmental Consultant
- River Constructor
- Engineer

✔ **Potential permits required:** CWA 404, Threatened & Endangered Species, NHPA, Floodplain

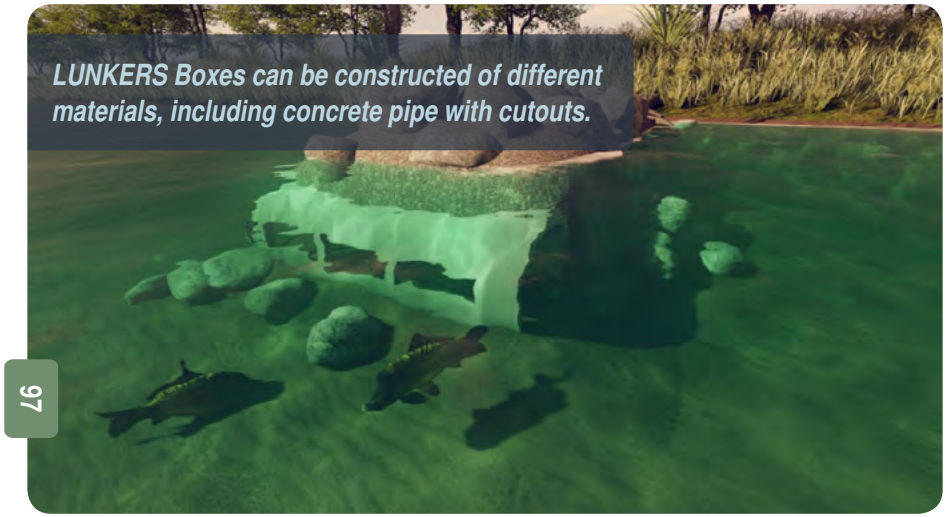
"LUNKERS" is an acronym for **L**ittle **U**nderwater **N**eighborhood **K**eepers **E**ncompassing **R**heotactic **S**almonids. **This is a long way of saying it is a structure that provides cover for fish that face upstream along the streambank.** LUNKERS boxes provide:

- Streambank stability
- Fish habitat

Rheotactic: facing into the current (upstream).

Photo courtesy of: True North Trout [page 188]

Many of the fish species in Colorado face into the current **(Rheotactic fish)**, waiting for food and insects to come floating down. When they see something they want, they will dart out of their shelter to grab it. LUNKERS provide cover along streambanks for fish to rest between spurts of energy for feeding. LUNKERS can be used for many fish species, but they are especially useful for trout (they were originally developed in Wisconsin for trout habitat improvement).



LUNKERS Boxes can be constructed of different materials, including concrete pipe with cutouts.

The actual LUNKERS box usually looks like a wooden crib or pallet. This structure is buried/anchored into the streambank below the water surface. You can often install willow stakes and other vegetated bank stabilization methods on top of it.

LUNKERS require engineering and permitting to make sure the project will not negatively impact the floodplain or direct stream flows towards structures. These processes will also look at the impacts to the surrounding ecosystems and wildlife species. Because it will involve working in the stream, the actual construction of the LUNKERS will require permits as well.

LUNKERS boxes are stream restoration structures that are fairly specialized. Working with professionals that have experience designing and constructing LUNKERS in Colorado will be very helpful. You will want to go into the conversation knowing the types of fish that live in your section of the stream. It will also be helpful if you have an idea of where it may make sense to install LUNKERS. With this information, you can discuss size, type and aesthetic options with the consultants.

Overflow Channels and Backwater Areas

Materials and Tools needed varies by project.

Potential permits required: CWA 404, Threatened & Endangered Species, NHPA, Floodplain

*** Heavy equipment may be required:** Depends on project size.

Overflow channels are sections of stream that do not normally carry water during average daily flows, but will become active during larger flow events to carry excess water. They serve many benefits to the stream system and the surrounding ecosystems, including:

- Reduces velocity in main channel
- Unique backwater ecosystems
- Provides water 'storage' during high flows
- Provides location for sediment to be stored

Little Thompson River on left, overflow/backwater area on right.

Overflow channels are a natural part of many stream systems and they can provide numerous benefits. You may already have overflow channels on your property. If that is the case, you will want to make sure that the overflow channel stays clear enough for higher flows to pass through them. You also want to make sure that the water has a path to return to the main channel of the stream. If you are concerned that the path back to the stream may be blocked by sediment or a landform, contact an engineer, river constructor or your local watershed to help you evaluate the situation. Lastly, if your overflow channels are eroding, you may want to consider stabilizing them with willow stakes and/or other riparian plantings. See the riparian plantings strategy sheet for ideas.

If you don't currently have overflow channels on your property, you may be interested in adding them. **Developing overflow channels can require extensive outside help to design a properly functioning system that does not have negative impacts on the floodplain or private properties.** Overflow channels should be set at or near the annual high water level. When designed this way, the overflow channel will see active flows during spring runoff and during storm events. At other times of the year, the channel will be mostly dry. Care also has to be taken in designing the location of the overflow channel to reduce the chance of erosion or sediment deposition.

If you are interested in creating a new overflow channel, you will want to discuss a number of factors with the engineers designing the project. This includes understanding how often the overflow channel will carry water, how much water will flow through it and where it will be aligned on the property. Overflow channels should be provided to reduce the flow in the main channel but they should not direct flows towards a structure.

People Places Along Your Stream

Materials and Tools needed varies by project.

*** Permits may be required:** CWA 404, Threatened & Endangered Species, NHPA, Floodplain

*** Heavy equipment may be required:** Depending on project size and details.

Similar to any property, creating people places is an important part of your home. Creating them along a stream involves some unique considerations to make sure you are not damaging the stream system or putting yourself or others at risk. Added People Places can provide:

- Access to the stream
- Opportunities for activities, gathering & relaxation
- Wildlife habitat
- Streambank stability

Photo courtesy of: Rick Kauvar

The stream is likely an important piece of what makes your property unique. Most people want to 'use' the stream, whether for recreation, viewing or being next to. This strategy sheet will go over some important considerations to take into account when you are creating people places along the stream, as well as access to the stream.

Access to and across the stream may be a part of your property's plan.

Patios and gathering spaces: Patios can provide your property with a gathering space for friends and family. You may use your patio for barbecues, parties, dinners or just relaxing. Positioning a patio near the stream can create a great atmosphere and setting, but it also puts your patio in a risky spot where it may be damaged by floods.

If you are designing a new patio near the stream, you must be careful to not cause a rise in the floodplain. It is also important the patio is designed to stand up to flood flows it could see. In many cases, a stone patio embedded in the ground will hold up better than a wood patio or deck. Engineers and landscape architects can assist you with properly designing your patio or gathering space.

People Places Along Your Stream (pg. 2)

Materials and Tools needed varies by project.

*** Permits may be required:** CWA 404, Threatened & Endangered Species, NHPA, Floodplain

*** Heavy equipment may be required:** Depending on project size and details.

Play areas and sod: Similar to patios, you will want to be careful to not place play structures in the floodplain where they can be washed away and become flood debris. Play areas are better located outside of the floodplain when possible.

While mowed grass lawns can be great places to play, it's not ideal to have sod go right up to the edge of the streambank. Mowed grass lawns do not provide enough wildlife habitat for riparian corridors, nor do they provide the same streambank stabilization that willows, cottonwoods and other riparian vegetation can provide. In addition, mowed grass lawns are typically fertilized multiple times a year. If the lawn goes to the streambank, some of this fertilizer is going to wind up in the stream. This can cause negative effects on aquatic habitat and vegetation.

Stream access: Accessing the stream may be an important factor for you. When considering stream access points, make safety your first concern. Streams can be very dangerous, especially for young children and small animals. If you are incorporating stream access, consider what areas the access is connecting to and who will be likely to wind up using it. Choosing areas with lower velocity flows can help you to create a safe access point as well.

You can also consider limiting the points of access rather than trying to create access along an entire stretch of streambank. This will help to maintain and improve riparian habitat. Stream access can include formal access such as patios and steps, or it can be informal stone steps/beaches and more natural access points.

Preserving a wide riparian buffer between the stream and manicured play areas is important for stream corridor health and flood risks.

Riparian buffer: For whatever people spaces you desire, consider creating a riparian buffer to separate the stream from the more manicured people spaces. Riparian corridors include a wide variety of plants, animals and natural materials. By giving these inter-connected pieces some space to function, you are limiting the potential conflicts you will have with them. There are many different opinions on how much space is enough for a riparian buffer, but if you can leave at least 25' on either side of the stream, this will go a long way to creating/preserving a healthy stream corridor. This is discussed in more detail in the **Riparian Plantings** strategy sheet.

Riparian Plantings

Materials and Tools needed varies by project.

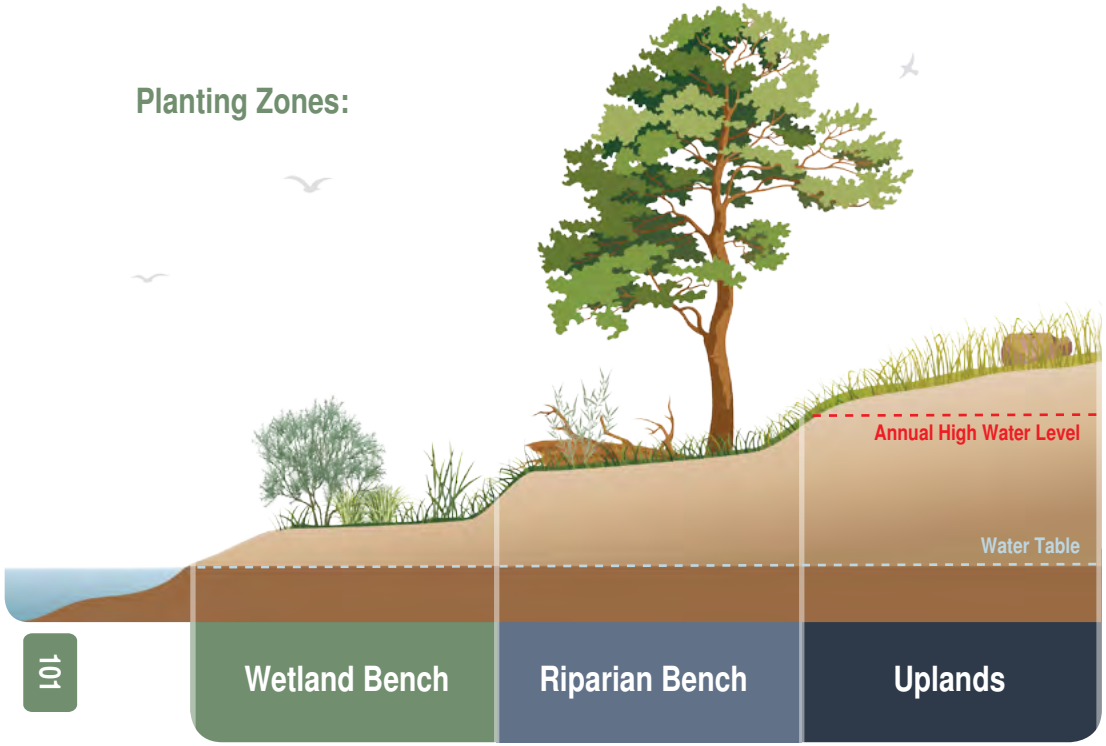
*** Permits may be required:** CWA 404, Threatened & Endangered Species, Floodplain

*** Heavy equipment may be required:** Depending on project size and details.

Riparian vegetation is unique to local areas and its success is highly dependent on being planted at the right elevations. Riparian planting can provide:

- Wildlife Habitat & Food
- Shade
- Stream Access
- Views
- Fall Color
- Streambank Stabilization

Planting Zones:



Similar to upland plantings, there are many benefits to riparian plants. These plants will often include trees, shrubs, grasses, sedges and flowers. Different types of plants will grow at different elevations along the streambank. **Riparian planting materials include wetland/riparian seed, sedges, rushes, flowers, shrubs, willow and cottonwood stakes and trees.** There is also wetland sod, which can be used to quickly establish wetland plant species.

Planting Zones: Prior to planting riparian vegetation, it is very important to assess where the planting area is in relation to the stream. If it is below the annual high water level, you may need to consult your local Corps of Engineers office or watershed coalition to see if you need to apply for a permit. It is also important to understand the relationship to the stream level so that you know what types of plants will survive there. **Will this area be flooded multiple times a year, once a year, or only once every few years?**

Riparian Plantings (pg. 2)

Materials and Tools needed varies by project.

*** Permits may be required:** CWA 404, Threatened & Endangered Species, Floodplain

*** Heavy equipment may be required:** Depending on project size and details.

Stream Corridor Benefits: Riparian plantings can have a number of environmental benefits. Wildlife will use dense plantings for shelter and habitat. Many wetland and riparian plants produce berries that wildlife depend on as a food source. Willows and other shrubs that grow along the streambanks shade the stream, creating areas of cooler water that fish use as shelter.

Riparian plantings will also stabilize the streambanks and create terraced benches that hold up to flood flows better than vertical streambanks. As water flows from upland areas down through these terraces, many of the plants will filter the water, improving the water quality in the stream itself.

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CSU Extension:
extension.colostate.edu/

Sustainable Landscaping:
extension.colostate.edu/docs/pubs/garden/07243.pdf

Landowner Benefits: In addition to the environmental and stream benefits, riparian plantings can improve the quality of your property as well. Many riparian plants flower or have unique foliage that can add interest to your stream edge and make it a more inviting place to spend time.

You can use riparian plantings like willows to create filtered views to the water's edge, or to block unwanted views. Willows can grow tall and dense, but it is possible to cut gaps in them to provide access and create framed views. Lower growing plant species such as riparian grasses and sedges can be planted directly behind the willows to create a layered effect.

Ultimately, the design of riparian plantings should be based on your tastes and available land, as well as working with the existing natural systems on your property. Always consider using native plants when possible as they are suited for survival in your area and they are much less likely to become invasive.

Additional Resources for Riparian Plantings

Sustainable Landscaping: *extension.colostate.edu/docs/pubs/garden/07243.pdf*

When a Landowner Adopts a Riparian Buffer – Benefits and Costs: *extension.umd.edu/sites/extension.umd.edu/files/_docs/programs/riparianbuffers/FS774.pdf*

Wetland and Stream Buffers: A Review of the Science and Regulatory Approaches to Protection: *www-static.bouldercolorado.gov/docs/wetland-stream-buffers-1-201308011516.pdf*

Root Wads

OUTSIDE HELP

- Landscape Architect
- Environmental Consultant
- River Constructor
- Engineer

Potential permits required: CWA 404, Threatened & Endangered Species, Floodplain

A root wad is a bank stabilization and aquatic habitat improvement strategy that involves burying a dead tree into the streambank with the root system still attached. Benefits of installing root wads include:

- Bank stabilization
- Fish habitat
- Insect habitat

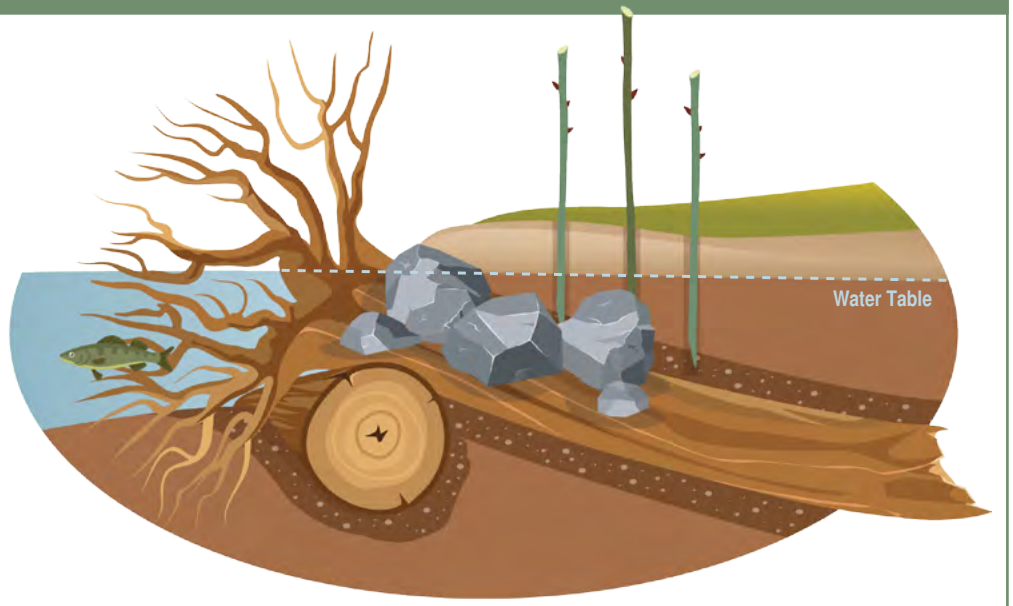
Root wads anchored into the streambank mimic what naturally occurs along streams after floods. Floods often leave behind large woody material that is partially buried into the stream channel. These provide shelter and habitat for fish and insects. If anchored properly, they provide bank stabilization and create changes in water flows.

By working with outside help to engineer and design root wads in key locations, you can stabilize your streambanks while creating valuable aquatic habitat. Root wads can often be combined with log toes and streambank vegetation such as **willow stakes**.

For root wad projects, outside consultants will help you by engineering and designing a project that will not impact the stream, floodplain or ecosystems in negative ways. They should also help guide you through the permitting processes for the design and construction of the project.

Before contacting the outside help, consider if you have large woody material that can be used for the project already on your property. You can also think about if it would make sense to install **log toes** with the root wads. When you speak with the consultants, they can provide you with advice and reasoning for the final placement and design.

Installed Root Wad



Sediment Removal

OUTSIDE HELP

- Landscape Architect
- Environmental Consultant
- River Constructor
- Engineer

Potential permits required: CWA 404, Threatened & Endangered Species, NHPA, Floodplain

The transport of sand, rock and other sediment is part of the natural cycle of flooding. However, in some cases large amounts of sediment left behind can have negative impacts on properties and the stream system. Removing excess sediment can provide benefits such as:

- Increase conveyance
- Provides ecological benefits
- Increases aesthetics

Sediment is regularly and continually deposited by streams. Large flood events can deposit large amounts all at once.

Removal of sediment is a simple process but understanding how much sediment to remove is an important aspect that can have negative impacts if not done correctly.

If too much sediment is removed in the floodplain, the stream might have the potential to erode the entire bank and move to a new location that damages or threatens property. Removing too much sediment can also confine the stream to a channel where it is not connected to its floodplain. **This can cause increased velocities, which cause erosion and damage to nearby properties.**

The actual process of removing the sediment can also be a cause for concern. River constructors need to apply for the proper permits and be very careful to not release the sediment into the stream. They also need to be careful to avoid negative impacts to wetlands and wildlife.

Early conversations with outside resources about sediment removal should discuss what the appropriate amount of sediment to remove is and why.

The outside help should be able to explain what the effects of the sediment removal will be, as well as what the final condition will look like. It is also important to recognize that the sediment might not actually have to be removed from your property. Rather, it could be placed in a more advantageous location, such as providing an additional terrace within the floodplain. This terrace could then be planted with willow stakes and other riparian plantings.

Stream / Channel Re-Alignment

OUTSIDE HELP

- Landscape Architect
- Environmental Consultant
- River Constructor
- Engineer

Potential permits required: CWA 404, Threatened & Endangered Species, NHPA, Floodplain

Stream re-alignment involves moving the actual stream channel to a new location. This could be done to restore the channel to a pre-flood location or to protect existing infrastructure or buildings. Benefits include:

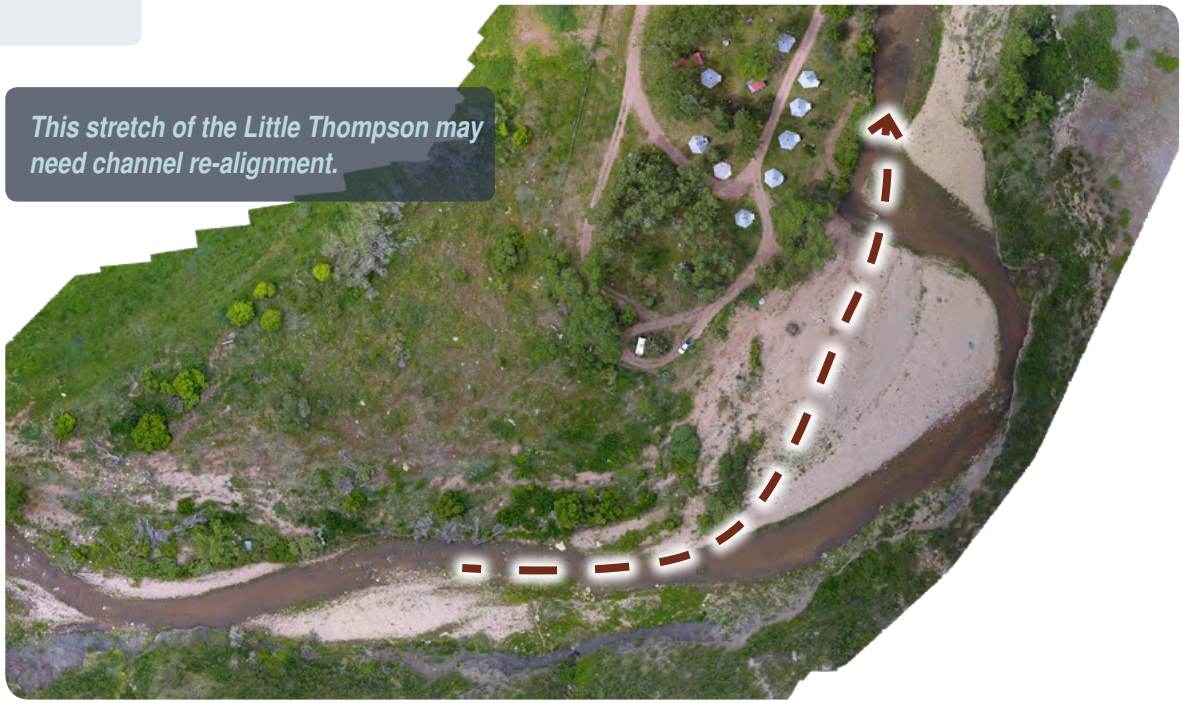
- Increased resiliency of the stream
- Protection for threatened infrastructure and/or habitat
- Restored and stabilized eroded areas
- Encourages bank vegetation and habitat
- Takes advantage of existing flow paths

First discussing stream re-alignment with a representative of a local agency may help you determine whether it is the right approach for your property. It also may guide you to some additional funding opportunities as this can be a costly approach to restoration. Once a local agency has helped you out, you will probably need to contact an engineer or landscape architect to evaluate your property.

When approaching stream re-alignment with an outside source, it is important to know where your property lines are and where important infrastructure needs to be protected. It can also help if you know where the stream has historically run through your property. Further information about what you have seen during average daily flows and during large storm events will help the outside sources understand how your stream functions.

Stream re-alignment is a major undertaking that will have a dramatic change on your landscape. Stream re-alignment not only requires permits from federal and local agencies, but also requires careful planning and design to ensure the new alignment works with the natural processes of the stream corridor.

A resilient alignment is achieved through careful consideration of many factors, including slope, bed material and amount of flow during different times of the year. Often, a multi-disciplinary team will combine their areas of expertise to design a complicated project such as stream re-alignment. Stream re-alignment projects can involve a substantial amount of work, and must not cause negative impacts to upstream or downstream property owners.



This stretch of the Little Thompson may need channel re-alignment.

Terraced/Natural Channel Design

OUTSIDE HELP

- Landscape Architect
- Environmental Consultant
- River Constructor
- Engineer

Potential permits required: CWA 404, Threatened & Endangered Species, NHPA, Floodplain

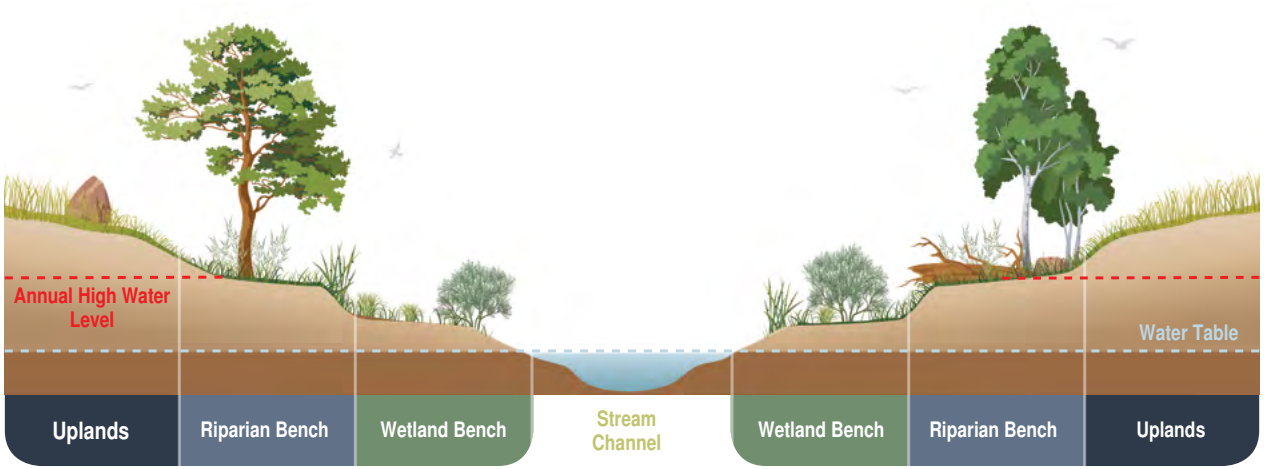
A terraced/natural channel design creates terraces, or benches, between the stream and higher areas such as uplands. This opens the channel, reducing velocities by allowing flood flows to spread out. They provide:

- Channel stability
- Decreased velocity
- Riparian habitat
- Bank stability

Terraced/natural channel designs do not make sense in every situation. There are certainly areas where space is limited and you will not be able to create a series of terraced benches between the stream and more usable spaces where you may have a building. However, there are also many situations where a terraced/natural channel design is possible and will have a lot of beneficial effects.

By creating these terraced riparian benches, you can create benefits for the floodplain, the stream's flows, the vegetation and the wildlife in the area. The lower benches are meant to flood regularly, providing water to valuable riparian plants. The higher benches should flood less regularly and will have plants that can survive with less watering.

Example of a Typical Terraced/Natural Channel Design



Allowing flood waters to spread out across these benches reduces the speed of the flood flows, also reducing damage flows do to downstream properties.

Re-shaping your streambanks into a terraced design requires careful engineering and planning to figure out the correct elevations for the benches, as well as the correct plant species for each bench. It also requires engineering to calculate the impacts to the floodplain and floodway. The actual construction will involve working in the stream and will require permits as a result.

Before hiring outside help, consider if your property has enough space to create terraces along your streambanks. These terraces can vary greatly in width and they can be on one or both sides of the stream. Looking at nearby streambanks that have terraced benches will help you form an idea of what could be built on your property.

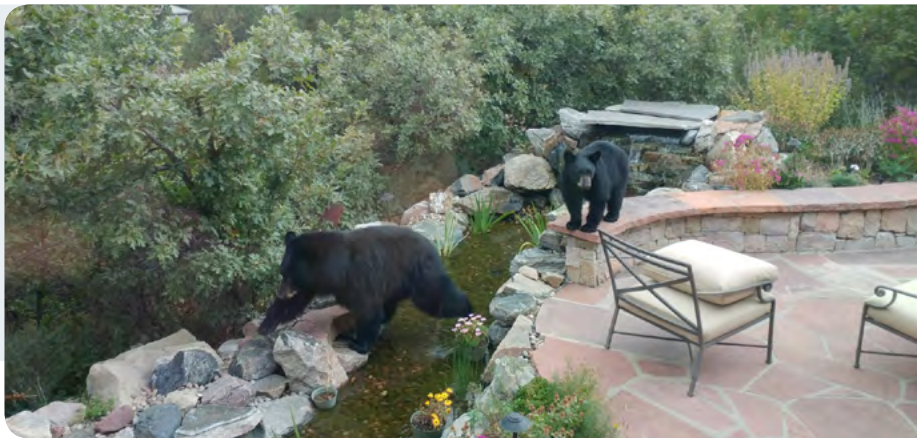
Undesirable Wildlife Management

Materials and Tools needed varies by project.

*** Many wildlife species are protected under federal or state law.** Contact local wildlife officer at Colorado Parks and Wildlife (CPW) before removing or disturbing any wild animal.

Seeing wildlife from a distance is enjoyable, but having bears in your yard or snakes in your house is probably not enjoyable for most people. The key to preventing unwanted wildlife encounters is keeping problem wildlife away from your homes and other structures. This does not mean destroying their habitat, but rather creating appropriate buffers and separations.

Common problematic wildlife include bears, mountain lions, coyotes, raccoons, skunks, small mammals and snakes. Even deer can be a nuisance if they eat your carefully planted shrubs and wildflowers.



Wildlife Deterrent / Prevention Methods:

Remove Food Sources

- **Shrubs and Flowers** – Deer, cottontail rabbits, and other herbivores are attracted to ornamental plants. Almost overnight, deer can wipe out beds full of planted shrubs and flowers. Additionally, bears are attracted to berry laden shrubs. To avoid conflicts, only plant deer-resistant vegetation and avoid planting berry-producing shrubs, such as chokecherry, near your home.
- **Trash** – Leaving even a small amount of garbage outside attracts bears, coyotes, raccoons, mice and other small mammals. A small amount of leftover food on a grill can entice bears. Keep garbage in sealed metal or plastic containers and use bear-proof trash containers if you live in bear habitat.
- **Bird feeders** – Although watching birds feed is an enjoyable activity, bird feeders can entice bears and teach them to come close to human habitat for food. Colorado Parks and Wildlife recommends not putting out bird feeders during the warmer months or placing them at least 10 feet off the ground. The area under the bird feeders should also be kept clean from fallen bird seeds to prevent attracting bears, squirrels, mice, and other unwanted scavengers.

Remove Potential Wildlife Shelters

- **Debris piles** - Don't have piles of boards, leaves or other debris near structures; these piles provide shelter for snakes, coyotes, cottontail rabbits, mice and other mammals.
- **Expanses of large rocks** - Do not landscape with expanses of large rocks, especially in sunny areas, for they can provide habitat for rattlesnakes and other snakes.
- **Beaver dams** - Although beavers provide many ecological benefits, there are times when a beaver dam can pose a potential flood risk. If you are concerned that a beaver dam is blocking the main stream channel or are considering removing it, contact your local Colorado Parks and Wildlife office. They can help you determine if the dam should be removed, as well as the best way to go about removing it.

Undesirable Wildlife Management (pg. 2)

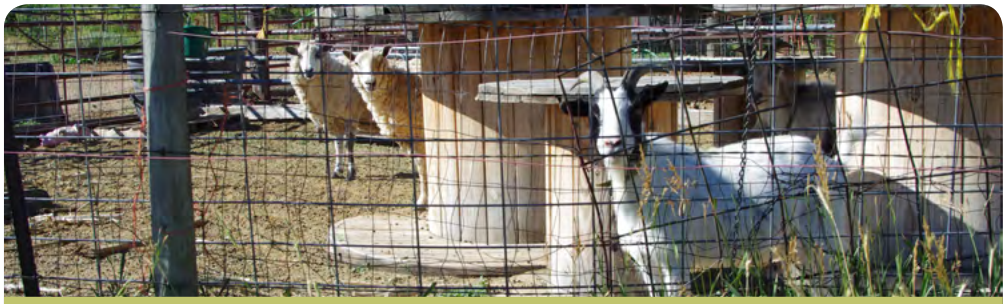
Materials and Tools needed varies by project.

*** Many wildlife species are protected under federal or state law.** Contact local wildlife officer at Colorado Parks and Wildlife (CPW) before removing or disturbing any wild animal.

Create Barriers / Buffers

- **Fencing** – Although you might not want a wildlife-proof fence around your entire property, fencing may be practical around homes, dog kennels/runs or small livestock areas like chicken coops. The size and type of fencing depends on the kinds of wildlife you are trying to keep out. Some good guidelines are:
    - Consider appropriate fence heights. For example, mountain lions – 10-12' high, deer and elk – 6-8' high.
    - Don't have branches overhanging fences, animals such as raccoons can use them to climb over the fence.
    - For more information on fencing see the **Colorado Parks and Wildlife – Fencing with Wildlife in Mind** - *cpw.state.co.us/learn/Pages/LivingwithWildlifeDeveloping.aspx*

- **Mowing** – Keep grasses and other vegetation around your house short to create a visual barrier for snakes, mice and other small mammals
- **Sealing Homes** - plug holes in structures (even a ¼ in hole can allow snakes & other small mammals into your house). Block rooftop openings to deter pigeons and bats.
- **Roosting Exclusion** - There is a wide array of devices to discourage pigeons and other birds from roosting on structures, including nylon netting and sharp-tipped prongs.



Protect Pets and Livestock from Carnivores:

- Keep pets indoors at night or keep them in a kennel with a secure top.
- Place livestock in enclosed sheds or barns at night and keep doors closed.
- Don't feed pets outside; store food and dishes indoors

Contacts for Wildlife Conflicts

If you have conflicts with unwanted wildlife on your land, contact your local CPW Office. **Do not attempt to remove sick animals** (especially – raccoons, skunks, bats and foxes) as they may have rabies.

- **CPW Headquarters** (Denver)**: (303) 297-1192**
- **Northeast Region CPW Office** (Denver)**: (303) 291-7227**

If you encounter an aggressive animal outside of CPW hours, contact the **Colorado State Patrol.**

Upland Plantings

Materials and Tools needed varies by project.

Trees, shrubs, flowers and grasses in the upland landscape can serve many purposes from shade, to access control, to framing views, to providing wildlife habitat. Upland planting can provide:

- Wildlife Habitat & Food
- Shade
- Access
- Views
- Fall Color
- Erosion Control

You may choose to plant trees, shrubs, flowers and seed or sod on your property for a variety of reasons. You may want to define your property boundary, or maybe you want to provide shade over a patio. Regardless of the reason, there are some considerations that you should take into account. **Always consider using native plants when possible as they are suited for survival in your area and they are much less likely to become invasive.**

First, consider what purpose you want the planting to serve, as well as how local wildlife will use them. For example, you may want to avoid planting shrubs or flowers that attract a lot of bees next to a patio. Similarly, it may not be a good idea to plant dense shrubs that wildlife will live in close to trash containers or garages.

Photo courtesy of: The Garden Consultants, Inc. *[page 188]*

As with any planting, it is important to consider the mature size of the tree or shrub. One of the reasons you are planting these is to see them grow; don't forget that as they grow they will become larger and take up more space.

Your property's location, elevation, sun exposure and available water are also other important factors that will determine what type of plants will be successful. Consulting your local nursery is a good first step in selecting plants.

Upland Plantings (pg. 2)

Materials and Tools needed varies by project.

In terms of groundcover, you may want to add grasses to your property. This can be in the form of native grasses or manicured turf. Typically, property owners will not mow native grasses or will only mow them a couple times a season. Native grass is usually installed with seeding and will sometimes have wildflower seeds mixed in.

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CSU Extension:
extension.colostate.edu/

Although pretty, manicured turf is not a good choice for the streambank area next to the creek.

Manicured turf can be installed with seed or sod. Sod will establish quicker, but is more expensive. Manicured turf grasses will require frequent irrigation, mowing and periodic fertilization. As a result, areas next to streams and streambanks are not an ideal location for manicured turf. There are many environmental benefits to keeping a riparian buffer between manicured turf areas and the stream corridor.

In addition to turf grass sod, wildflower sod is available. This sod is more expensive than turf grass and it is meant for different types of applications. Wildflower sod may be a good option if you want to quickly establish native wildflower plants in small areas. Examples could include pockets in or on top of boulder retaining walls, strips next to pathways or areas in between flagstone steppers.

Vegetated Soil Lift

OUTSIDE HELP

- Engineer
- Environmental Consultant
- River Constructor

Potential permits required: CWA 404, Threatened & Endangered Species, Floodplain

A vegetated soil lift consists of wrapping 'lifts' of soil in geotextile fabric to form an edge for the stream. Willow stakes can be planted between the 'lifts' and through the top of them. Benefits of vegetated soil lifts include:

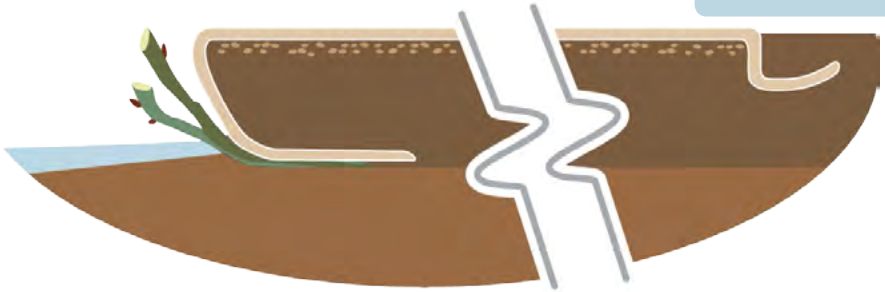
- Streambank stability
- Riparian habitat
- Aquatic habitat improvement

Example of completed vegetated soil lifts.

If the toe of the slope is badly eroded, more structural material such as rocks or riprap may be used to provide toe protection.

Based on location and project details, obtain necessary permit(s) with outside help.

The geotextile blanket wrapped around the soil goes back into the slope and is secured either by soil or wood stakes.



Although you will need outside help for the overall project, you may be able to harvest your own willow stakes.

Harvesting must be done when the willows are dormant - this means harvesting in the fall or spring when there are no leaves on them.

Visit the following link for a more in-depth guide to willow & cottonwood harvesting: ***synergy3.org/includes/Willow_Cottonwood_Guide_2016.01.pdf***

Vegetated Soil Lift
(pg. 2)

OUTSIDE HELP

- Engineer
- Environmental Consultant
- River Constructor

Potential permits required: CWA 404, Threatened & Endangered Species, Floodplain

The geotextile blanket provides structure and stability while the vegetation becomes established. Once vegetated soils lifts grow in, the root systems stabilize the bank and the above ground vegetation decreases flow velocities and shear stresses along the streambank.

Before contacting outside help, you should ensure that the professional you select have experience with stream restoration and bank stabilization. A meeting with the professionals is recommended prior to the beginning of work to discuss the following items:

- Design options and cost estimates
- Required permits
- Design and permitting schedule
- Construction process/what to expect during work
- Construction access
- Duration of the project

Depending on the details of your project, you will likely need an engineer and a river constructor. An environmental consultant and/or a riparian vegetation specialist may be needed as well.

Wetland Creation/Expansion

OUTSIDE HELP

- Engineer
- Environmental Consultant
- River Constructor

✔ **Potential permits required:** CWA 404, Threatened & Endangered Species, NHPA, Floodplain

Wetlands are sensitive ecosystems that provide numerous benefits to the surrounding areas. They can be created (or expanded) on your land to:

- Increase wildlife habitat for aquatic and semi-aquatic animals (such as waterfowl, amphibians and fish)
- Provide storage for flood waters
- Stabilize streambanks

Successful wetland creation requires an in-depth understanding of groundwater, soils, and vegetation. A wetland expert should be consulted to determine if a wetland can be successfully created on your property and what methods are needed to effectively establish wetlands.

Also, streams are active systems. Any wetland creation or expansion should be carefully designed to avoid being "blown out" during the next flood. Consulting with a water resources engineer will evaluate the links between the proposed wetland and the stream system.

Typically, wetlands in the Lefthand, Big Thompson, Little Thompson and Saint Vrain areas are found on terraces along the stream or in depressions within the floodplain (including abandoned stream channels or oxbows). They can range from cattail marshes, to wet meadows, to sandbar willow shrub lands, to alder shrub lands. Often, wetlands can form quickly (i.e. after just one growing season) if there is sufficient water.

Creating wetlands require three inter-connected conditions:

1 **Hydrology (water) -** This is the most critical condition. Without enough water to saturate or flood the soils for a sufficient period of time, wetlands won't develop. Typically, wetlands are created or expanded by grading down to the existing water table or the stream elevation. Determining where to grade to depends on:

- **Adjacent existing wetlands** (either a streambank terrace floodplain depressions/oxbows) – A wetland expert will determine the exact depth, but it should generally match the existing wetlands elevation.

A groundwater sampling device such as a **"piezometer"** can measure the groundwater level at multiple times during a growing season.

- **Creating a wetland in an upland** – Hydrology may be much more difficult to determine in existing uplands, because you would need to know where the groundwater elevation is. Using the existing stream elevation is not always useful because the groundwater levels may be above or below the existing stream levels. Additionally, you will need to know the ground water fluctuations over the growing season. Typically, streams and groundwater are highest in spring after run-off and lowest in late summer/fall. Wetland specialists and engineers can help you determine the appropriate wetland elevation.

Wetland Creation/Expansion (pg. 2)

OUTSIDE HELP

- Engineer
- Environmental Consultant
- River Constructor

Potential permits required: CWA 404, Threatened & Endangered Species, NHPA, Floodplain

2 **Soils (topsoil) -** The type of soil affects what kind of wetland can develop on a site. A wetland specialist or your local NRCS office can help you determine your soil type (NRCS contact info at bottom of sheet).

- **Sandy/gravelly soils -** Vegetation may be difficult to establish in these soils without adding additional topsoil.
- **Loams (sandy loam to clayey loam) -** Loamy soils are the best growth medium for vegetation.
- **Clay (loamy clay to clay) -** Clayey soils can be a good medium for wetlands because they will hold water for longer periods of time. However, clayey soils may be high in salts – many plants cannot tolerate high salts.

3 **Vegetation -** What wetland plants will grow depends on the hydrology, soils and other conditions at your site:

- Some species (such as cattails and bulrushes) grow only in areas saturated or inundated during the growing season; others (such as foxtail barley and fowl bluegrass) can grow in areas that are periodically dry.
- Many wetland plants grow best in loamy soils. However, there are others that tolerate salty soils, such as saltgrass and alkali muhly. Others, grow in sandy soils, including sandbar willows and switchgrass.
- Many wetland plants do not grow well from seeds, including most sedges and rushes; they grow best from plugs. Some plants grow easily and quickly from seeds, including Canada wildrye and other grasses. Wetland tree and shrubs, such as alders and willows should be grown from cuttings or containerized plants.

You can find out more about evaluating wetlands in the Wetlands section of Chapter 2 *[page 46]*.

NRCS Office Contact Information

Longmont Field Office - Boulder County (Boulder Valley CD-709, Jefferson CD-739, Longmont CD-743)
9595 Nelson Road, Box D
Longmont, Colorado 80501-6359

Ph: 303-776-1242

Fort Collins Field Office - Larimer County (Fort Collins CD-730, Big Thompson CD-706, Home Supply Watershed Project)
150 Centre Ave., Bldg. A, Ste. 116
Fort Collins, Colorado 80526-8121

Ph: 970-295-5656

Greeley Field Office - Weld County (West Greeley CD-791)
4407 29th St., Suite 300
Greeley, Colorado 80634-9519

Ph: 970-356-8097

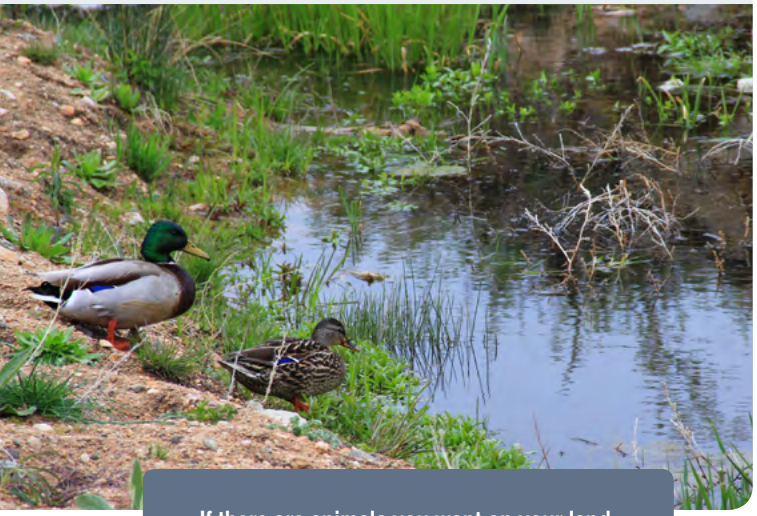
Wildlife Habitat Preservation, Creation & Enhancement

Materials and Tools needed varies by project.

If you would like to attract and provide a healthy home for wildlife, you need to ensure that the following interconnected elements are in place on your property:

- **Food**
- **Water**
- **Shelter / cover**
- **Connections** (corridors and patches)

Different species have different specific needs, but they require all of these elements to survive and thrive.



If there are animals you want on your land, but others you don't (such as bears), please see the Unwanted Wildlife Strategy Sheet and avoid some of the recommendations on this sheet, such as planting berry-producing shrubs.

The following will provide good quality habitat on your land for wildlife:

Food

Provide as many food sources on your land as possible.

- Keep or add pines / conifers; pine cones provide food for squirrels and a variety of birds.
- Keep or add berry producing shrubs for birds and other animals. Other native shrubs such as mountain mahogany provide food for deer.
- The nectar of wildflowers is a good food source for bees, hummingbirds & other pollinators.
- Meadows provide food for elk and other grazers. Minimize mowing and intensive livestock grazing to allow for the growth of flowers and tall grasses.
- Plant native grasses and wildflowers to add additional food sources.

Water

Provide easy access to as many water sources on your land as possible.

- Minimize barriers between wildlife habitat and water.
- If possible, provide an unfrozen, open water container for birds during the winter.

Wildlife Habitat Preservation, Creation & Enhancement
(pg. 2)

Materials and Tools needed varies by project.

Shelter

Preserving multiple types of shelter where wildlife can rest, nest, and hide from predators is essential for their survival.

- Preserve tall trees, even dead ones, wherever safely possible as nesting habitat for birds and bats and perching areas for raptors. Planting seedlings in open areas will provide future habitat for birds.
- Avoid removing dense patches of shrubs - they provide shelter for deer, their fawns and small mammals. Expand existing shrub patches by planting additional native shrubs.
- Grazing livestock can eliminate willows and other woody vegetation that hang over water-providing shelter for beavers and fish. Restricting livestock to outside of the riparian area or to 1-2 access points allows for the growth of healthy stands of woody vegetation.
- Provide hiding places for rabbits and other small mammals - allow tall grasses / wildflowers to grow and leave un-mowed. Un-mowed meadows also provide nesting areas for grassland birds.

Connections

Animals need to move freely from food to shelter to water without barriers. These connections likely go beyond just your property.

The following actions will help preserve the existing wildlife habitat on your land:

- Preserve a minimum width of 25 feet of woody vegetation and tall grasses along streambanks.
- Do not mow to the top of banks (leave a wide buffer).
- Plant trees and shrubs in gaps between existing vegetation to allow for continuous travel corridors.
- Minimize intense livestock grazing on streambanks.
- Minimize barriers, such as roads, between riparian areas and surrounding meadow and shrub land habitat for deer and other animals.
- Locate fences to avoid restricting wildlife movement and harming wildlife. (See Bird Conservancy of the Rockies resource for more information.)

Additional Resources for Wildlife Habitats

Information about specific species and about wildlife corridors in general go to the **Colorado Parks and Wildlife Webpage - *cpw.state.co.us/learn/Pages/LivingwithWildlifeDeveloping.aspx***

Additional information on native vegetation to plant for wildlife habitat can be found: **Audubon Rockies - Regional Office of the National Audubon Society - *rockies.audubon.org/get-involved/resources***

Bird Conservancy of the Rockies - www.birdconservancy.org/

Colorado Native Plant Society – Gardening with Native plants. *conps.org/*

Colorado State University Extension - *extension.colostate.edu/*

Wildlife Tree/Snag (Dead Wood)

MATERIALS

- Hollow log or dead tree with branches attached
- Boulders
- Duckbill anchor, cable & rod set
- 1-3' diameter limbs

TOOLS

- Shovel
- Sledge Hammer
- Fasteners/Hardware

*** Permit may be required:** If desired placement is located below the annual high water level, a CWA 404 permit and/or a floodplain permit may be required.

*** Heavy equipment may be required:** YES if burying is required & tree requires a hole that is larger than feasible by hand, an **excavator** is needed. NO if hole can be hand dug or anchors can be used instead.

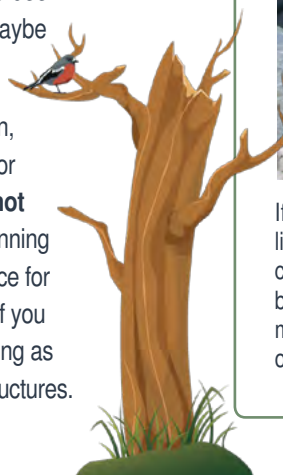
A "Wildlife Tree" is a secured dead tree that can provide valuable wildlife habitat and shelter while reducing the potential for flood debris. These are also sometimes referred to as wildlife "snags." Lasting benefits include:

- Minimized potential of hazardous dead wood flood debris
- Natural wildlife habitat/shelter
- Wildlife food source

Photo Courtesy of: BHA Design [page 188]

Creating a Wildlife Tree is a great way to re-use large dead woody material on your property. This material may have been left on streambanks on your property by a flood event, or maybe some of your trees have simply died.

As discussed in the ***'Large Woody Material'*** *[page 41]* section, these dead trees are highly valued homes and food sources for wildlife. You will want to make sure that these dead trees **do not become debris** in the next flood event. With proper planning and attachment methods, you can create a secured place for birds, mammals, insects and amphibians to call home. If you have standing dead trees, it is safe to leave them standing as long as they are secure and don't threaten people or structures.



Step 2 Determine **how you will install your wood (Bury or Anchor):**

Burying for Tree Stabilization

If you have large boulders available, or if you would like the wildlife tree to be partially buried, you should consider the **Burying** method. This method is also better for **areas closer to the stream**. However, this method may require digging machinery depending on the necessary hole size.

Anchoring for Tree Stabilization

Depending on your site conditions, the **Anchoring** method may be better for you. Rather than digging a trench/hole to bury part of the tree, duckbill (or similar) anchors are driven into the ground. This method is also more suitable for **upland areas further away from the stream.**

Photo courtesy of: Arctic Wire Rope [page 189]

Wildlife Tree/Snag
(pg. 2)

MATERIALS

- Hollow log or dead tree with branches attached
- Boulders
- Duckbill anchor, cable & rod set
- 1-3' diameter limbs

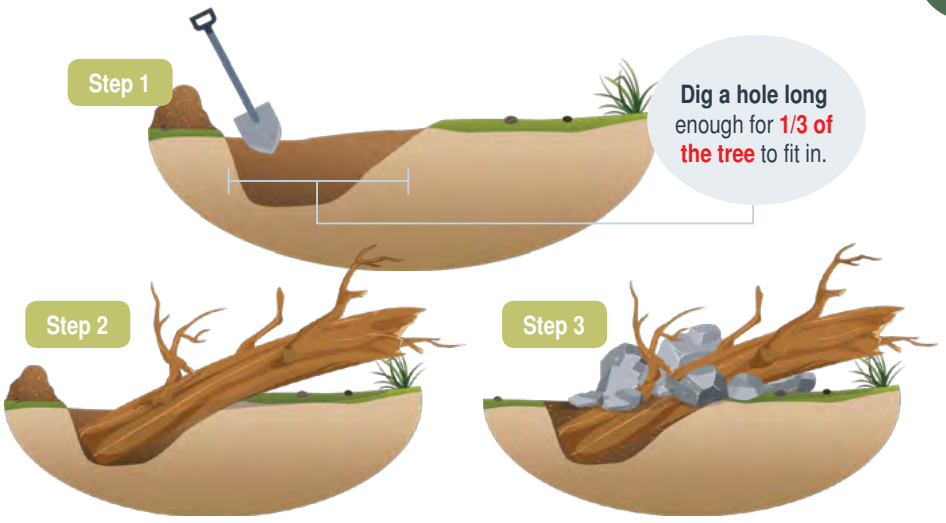
TOOLS

- Shovel
- Sledge Hammer
- Fasteners/Hardware

*** Permit may be required:** If desired placement is located below the annual high water level, a CWA 404 permit and/or a floodplain permit may be required.

*** Heavy equipment may be required:** YES if burying is required & tree requires a hole that is larger than feasible by hand. NO if hole can be hand dug or anchors can be used instead.

Burying for Tree Stabilization Instructions:



Lower one end of tree inside of hole and **bury** with compacted soil.

Add additional branches and **weigh down** with **boulders** around the top.

OR

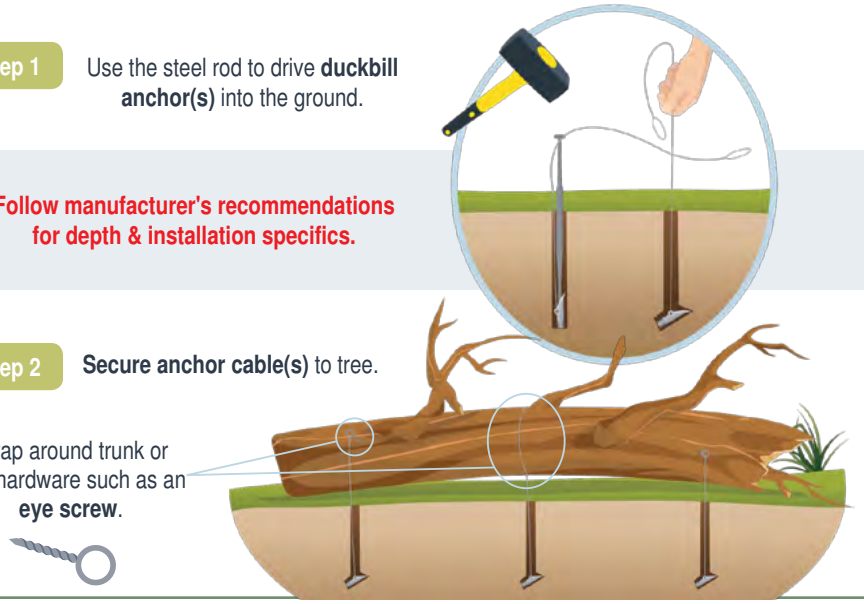
Anchoring for Tree Stabilization Instructions:

Step 1 Use the steel rod to drive **duckbill anchor(s)** into the ground.

Follow manufacturer's recommendations for depth & installation specifics.

Step 2 **Secure anchor cable(s)** to tree.

Wrap around trunk or use hardware such as an **eye screw**.



Finishing Steps **Compact** soil around project site.

Test for tree stability - it **should not shift** when rocked by hand.

Plant or seed disturbed ground around the tree.

Do's & Don'ts of Wildlife Trees/Snags

Do's

- Re-use dead woody material that is already on your property
- Place the wildlife tree well outside of the annual high water level of the stream
- Regularly check that anchoring hardware (bolts, cables, etc.) are secure and intact.

Don'ts

- **Don't** place the wildlife tree where you do not want wildlife to live (i.e. next to a dog run)
- **Don't** place the wildlife tree in the stream channel

Willow Stake Plantings

MATERIALS

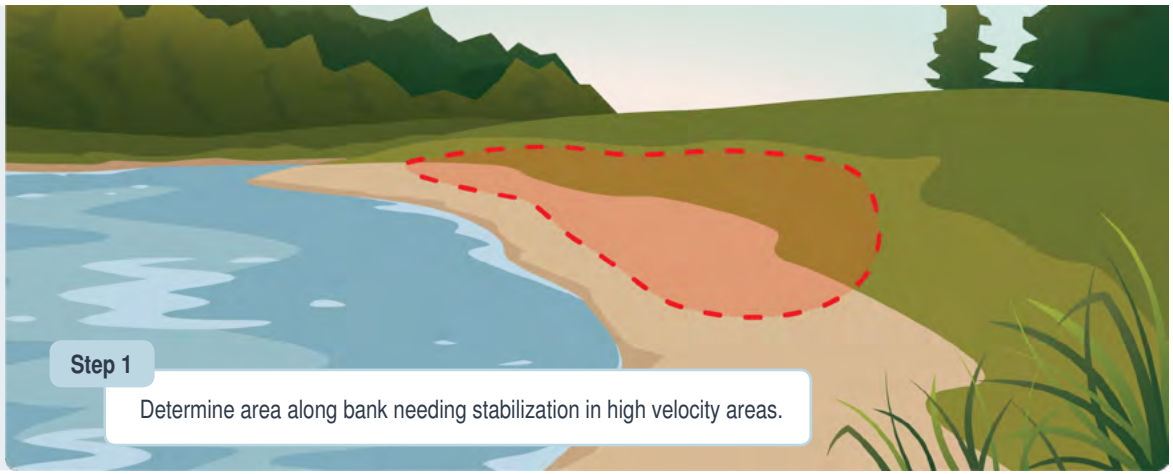
- 3' Length Rebar
- Twine
- Natural Marking Paint
- Clean Soil Fill

TOOLS

- Sledge Hammer
- Shovel
- Shears / Lopers

Installing live willow stakes in streambanks is a simple, yet effective and sustainable solution to eroding bank areas. Lasting benefits include:

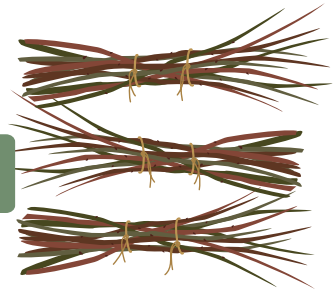
- Stabilized banks with root growth - Can stand up to lower velocity flows
- Increased habitat & food source for birds, insects & terrestrial animals
- Increased fish habitats from cooler water temperatures with willow shade
- Naturally framed streambank views with tactfully placed willow stands
- Restricted area access to the stream for people, wildlife or livestock



Willows grow naturally along waterways - you can often harvest willows right on your own property.

Harvesting must be done when the willows are dormant - this means harvesting in the fall or spring when there are no leaves on them.

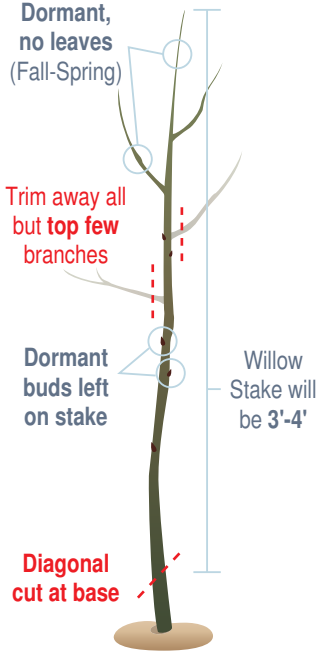
When selecting a stand to harvest from, pick a healthy group of the type of willows that you want to use. Cut the willows at a diagonal angle near the base and **never harvest more than 30%** of any given willow stand.



After harvesting, the willows should be grouped into bundles & soaked prior to planting (see Step 4 image).

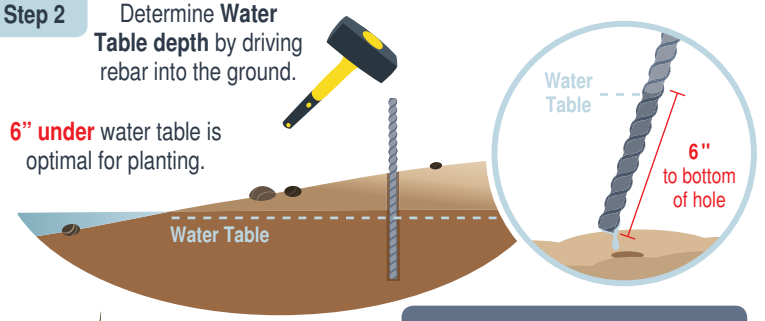
Soaking stakes stimulates root growth at the diagonal cut.

Harvesting Willow Stakes



Step 2 Determine **Water Table depth** by driving rebar into the ground.

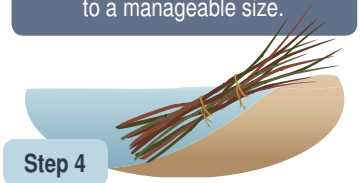
6" under water table is optimal for planting.



Step 3 Look for natural **Willow Stands** for harvest.

Never take more than **30%** of population.

Harvest **dormant** Willow Stakes & **bundle** with twine to a manageable size.



Step 4 Soak cuttings prior to planting for **7-14 days**. Submerge **at least 50-80%** of each stake.

Visit the following link for a more in-depth guide to willow & cottonwood harvesting:
synergy3.org/includes/Willow_Cottonwood_Guide_2016.01.pdf

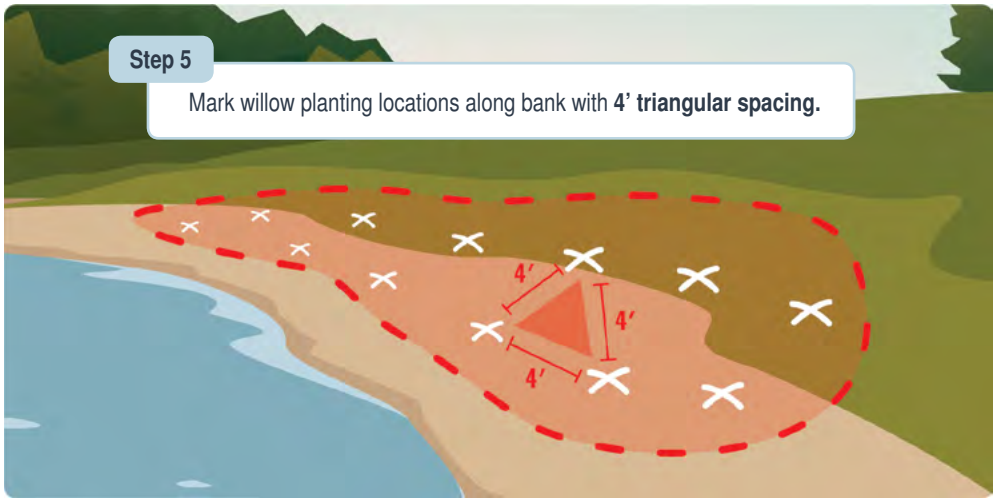
Willow Stake Plantings (pg. 2)

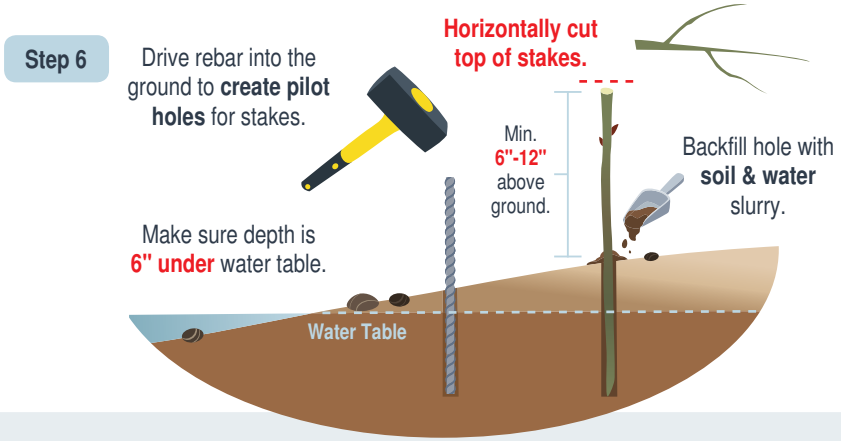
MATERIALS

- 3' Length Rebar
- Twine
- Natural Marking Paint
- Clean Soil Fill

TOOLS

- Sledge Hammer
- Shovel
- Shears / Lopers





Following installation of the willows, cut off the top of the willow stake. At a minimum, leave **6-12" of the stake above the ground.** Leave them tall enough that the top 2 buds will be above water during that season's high water. Backfill the hole with a slurry of water and soil.

Step 7 Compact soil to create a finished grade around area.

For a successful project, you want to pick an installation area that is susceptible to erosion and close to the stream. With this in mind, look for areas that you would like to have a stand of willows by considering the following:

- Views to the stream
- Desired look of the area
- Access to the stream
- Proximity to other vegetation

After determining the area you want to plant your willows, you can identify how close to the stream the willows need to be for survival. You can drive rebar into the ground to get an idea for where the water table is. You can also look around to see where vegetation is naturally growing on nearby banks.

If you are still wondering where the water table is, you can look at the level of the stream - the water table will be fairly close to the level of the stream. Mark out your planting locations (4' spacing is typical) and begin planting!

YouTube

Watch videos on installing willow stakes at the LWOG YouTube Channel!

http://bit.ly/2yNaPMm

Do's & Don'ts of Willow Planting

Do's	Don'ts
• Harvest & plant willows while dormant	• **Don't** harvest willows with leaves on them
• Plant with diagonal cut going into ground	• **Don't** plant willow upside down
• Plant stake with bottom 6" into water table	• **Don't** plant too far from stream
• Keep top of stake above seasonal high water	• **Don't** cut stake too short
• Harvest willows nearby project site when possible	• **Don't** take more than 30% of a willow stand
• Determine planting area & size before harvesting	• **Don't** block desired views & access with willows

Permitting Requirements

When working in streams or surrounding landscapes, certain regulations may need to be followed. These regulations include protecting wetlands under the Clean Water Act, protecting endangered species and other wildlife, regulating floodplains and controlling noxious weeds as directed by the Colorado Noxious Weed Act. Below is a table that summarizes what actions initiate permits, the name of the permit and who administers it and what type of consultant could help you through the permitting process. The following pages contain detailed explanations of when the permit may be needed, who to contact if you have questions about the permit and why the permit requirement was put in place.

Action	Permit Responsible Agency	Consultant to Assist with Permitting Process
Project will make changes to regulated floodplains or floodways. Certain towns and counties require floodplain permitting in other scenarios as well.	**Floodplain Permitting** FEMA, Local (County or City/Town) Floodplain Administrator *Floodplain Development, No-Rise Certification, CLOMR and/or LOMR*	Engineer
Project is funded or partially funded by State funds	**Senate Bill 40** Colorado Parks and Wildlife	Environmental Consultant
Project requires federal permit and could impact a historic site.	**National Historic Preservation Act** Advisory Council on Historic Preservation	Environmental Consultant
Project will impact a threatened or endangered species (plants and animals) or its habitat.	**Endangered Species Act** U.S. Fish and Wildlife	Environmental Consultant
Project involves placement of fill material into Waters of the U.S., including wetlands or streams below the Ordinary High Water Mark (OHWM).	**CWA 404 Permit** Army Corps of Engineers *Nationwide, Regional or Individual permit depending project details*	Environmental Consultant Engineer River Constructor

Floodplain Development Permits - County and City/Town Regulations

If your project will impact the official Federal Emergency Management Agency (FEMA) or local floodways or floodplains, it will require floodplain permitting through the local Floodplain Administrator (typically a City or County employee). In certain localities, such as Boulder and Fort Collins, the local Floodplain Administrator also has jurisdiction over local floodplains and floodways. Any project that will alter Federal or local floodways and/or floodplains should undergo a hydraulic analysis to determine the impacts of the proposed improvements. The type of permit needed is often dependent on how significant the floodway/floodplain impacts are. A hydraulic engineer can assist you both with determining this impact and communicating with the Floodplain Administrator during the permitting process.

Each city/town, and some counties, have their own set of floodplain development regulations. For example, the City of Loveland requires that the finished floor elevation of new buildings be above the 100 year base flood elevation. On the other hand, the City of Fort Collins has regulations for the elevation of new structures that vary by river (ranging from 12" to 24" above the 100 year base flood elevation).

If you determine that your project will require floodplain permitting, hydraulic analysis is often required to identify the extent of the impacts. A hydraulic analysis is done by hydraulic engineers and it estimates the impacts of your project on the existing floodway and floodplain. Based on the outcome of the analysis, the project will either need to pursue a **No-Rise Certification** or a **Conditional Letter of Map Revision (CLOMR).** This permitting process can often be a lengthy and expensive (several thousand dollars) process, but it ensures that the work you do does not have a negative impact on your neighbors. It also ensures that work done by other property owners does not negatively affect the floodplain on your property. If you are not sure if your project will require Floodplain Permitting, reach out to your local floodplain administrator, watershed coalition or a hydraulic engineer. Floodplain administrators are typically city or county employees and can be contacted through the appropriate agency's website.

No-Rise Certification

In cases where the work in the floodway will result in a zero-rise or a decrease in base flood elevations, it may be possible to avoid the step of the CLOMR. A zero-rise or no-rise means that hydraulic modeling shows the project will not cause a negative impact to the floodplain (or less than a 0.5 foot rise if there is no floodway defined). In these instances where the hydraulic analysis can show that a project will not cause a rise in the floodplain, the project can achieve a **No-Rise Certification**. This process is typically much less expensive and take less time than a CLOMR process. The local Floodplain Administrator is responsible for making the decision whether a CLOMR is required in these cases. If you are pursuing a No-Rise Certification, your engineer should talk with the local Floodplain Administrator early in the process so that they have a clear understanding of the project and its impacts.

CLOMR/LOMR

However, when projects will cause a rise in the floodway or floodplain, they will have to undergo a full CLOMR process and receive comments regarding the impacts of the proposed project. A CLOMR is typically prepared by the hydraulic engineer and presents the projected floodway/floodplain impacts.

A survey of the final condition must be produced after construction, from which a new hydraulic analysis is created. The new hydraulic analysis is then submitted to the local Floodplain Administrator in the form of a **Letter of Map Revision (LOMR).** Once accepted, the official FEMA Flood Insurance Rate Map (FIRM), Flood Boundary and Floodway Map (FBFM), or both, are updated by FEMA to reflect the new floodway/floodplain conditions.

For some cases in which a no-rise certification is achieved but the floodway and/or floodplain is significantly affected, the local floodplain administrator may still require a LOMR process after construction. A LOMR review process can cost several thousand dollars.

Unique Land Use Codes - Boulder County

Most cities and towns, as well as many counties, have developed land use codes specific to floodplain and riparian areas. Certain municipalities have also developed 'special use' permits that must be approved for specific activities.

Limited Impact Special Use (LISU) Review

For example, Boulder County has a Limited Impact Special Use (LISU) Review. This permit is required for developments or uses that may potentially have a significant impact on the property, such as large earthwork projects (more than 500 cubic yards), wind powered electric generators (wind turbines) or accessory dwellings for agricultural units. This permit is approved by the Board of County Commissioners and a pre-application appointment must be made with a County Planner through the Land Use Department.

Hazard Mitigation Review (HMR)

Another land use code unique to Boulder County is the Hazard Mitigation Review (HMR). This set of regulations was created following the 2013 flood and applies to rebuilding homes in its aftermath. The goals of the program include rebuilding resilient and sustainable communities through wise decisions, assessing the safety of the proposed restoration/construction and educating owners on risks with respect to future events. The HMR process involves evaluating the hazards on a property in order to allow safer and more resilient properties. If you are the owner of a destroyed or severely damaged **structure** in unincorporated Boulder County, you can contact the Flood Rebuilding & Permit Information Center to begin the process.

Land Use Department:
(303)441-3930

Flood Rebuilding & Permit Information Center:
(303)441-1705

floodrecovery@bouldercounty.org

Noxious Weeds – State and County Regulations

Noxious weeds are aggressive non-native plants that invade an area, displacing native vegetation and reducing agricultural productivity. These invasive plants can threaten wildlife habitat and recreational use of your land. Both the State of Colorado and individual Counties have specific regulations on noxious weeds. They also provide helpful guides and resources for identifying and controlling these weeds.

Within the Lefthand, St. Vrain, Big Thompson and Little Thompson watersheds, noxious weeds can range from Russian Olive, a thorny tree that can form thick clumps replacing native trees, to Canada Thistle, a very aggressive species that forms dense stands on stream banks and in fields. Noxious weeds should be controlled using integrated methods that are effective and minimize harm to your land and surrounding neighbors' land. These methods are described in detail in the ***'Weed Identification and Management'*** *[page 48]* section of **Chapter 2** and in the stewardship and recovery strategies in ***'Chapter 3: Stewardship and Recovery Strategies'***.

State Noxious Weed Regulations

Because of the harm noxious weeds can cause to native ecosystems and agricultural lands, the State of Colorado has implemented the Colorado Noxious Weed Act (Act). Under this Act, the Colorado Department of Agriculture (CDA) has implemented a noxious weed control program. The aim of this program is to prevent the introduction of new invasive species, eradicate species with isolated or limited populations and manage well-established and widespread noxious weeds. The CDA produces lists of noxious weeds categorized by severity of invasion and potential threats. These lists are reviewed every year and can be found on the Colorado noxious weed program web page (listed on the next page).

County Weed Control Management Programs

Every Colorado county (and many cities and towns) has a weed control program. Each weed control program works closely with the CDA and manages noxious weeds through education and development of noxious weed management plans specific to the needs of the county. Contact information for your county's weed program can be found on the Colorado noxious weed program web page (*https://www.colorado.gov/pacific/agconservation/county-weed-programs*).

www.colorado.gov/pacific/agconservation/noxiousweeds

Boulder, Weld and Larimer County weed program websites are below:

Boulder County Weed Program:
www.bouldercounty.org/property-and-land/land-use/noxious-weeds

Weld County Weed Program:
www.weldgov.com/departments/public_works/weed_management

Larimer County Weed Program:
www.larimer.org/weeds

Identifying Noxious Weeds

The Colorado Noxious Weed Program has fact sheets with descriptions and photos for most of the noxious weeds listed by the state. You can find examples of these fact sheets for some of the noxious weeds you are most likely to encounter in the *'Weed Identification and Management'* *[page 48]* section of **Chapter 2.** All of the fact sheets are available on the CDA website at *https://www.colorado.gov/pacific/agconservation/noxious-weed-species*. Your county weed manager would also be able to provide additional information for identifying noxious weeds.

Colorado Noxious Weeds Mobile App *(by State of Colorado)*
itunes.apple.com/us/app/colorado-noxious-weeds/id833042035?mt=8
play.google.com/store/apps/details?id=com.coloradostate.coweedid&hl=en

Senate Bill 40 (SB40) Wildlife Certification - Colorado Regulation

If your stream project is being funded or partially funded by State government funds, you will be required to complete a Senate Bill 40 Wildlife (SB40) Certification. The SB40 Certification requires projects with State funds to coordinate with Colorado Parks and Wildlife to protect fish and wildlife resources associated with streams in Colorado. Drainage ditches do not fall under the jurisdiction of SB40. In order to obtain an SB40 Certification, you or professionals working on your project will need to submit a letter detailing the anticipated impacts to wildlife habitat and how the project will mitigate those impacts. A common example is replacing trees that would be removed as a result of the project.

The Colorado Department of Transportation (CDOT) has produced a short document (14 pages) that describes the background, determining factors and process of the SB40 Certification. It is available online at:

www.codot.gov/programs/environmental/documents/senate-bill-40-guidelines

Clean Water Act (CWA) – Section 404 – Federal Regulation

Section 404 of the CWA regulates discharge of materials into waters of the U.S., including wetlands, and is administered by the Army Corps of Engineers (the Corps or COE).

History

By the 1970's, some of the nation's rivers and lakes had become so degraded from sewage, toxic chemicals and other pollutants that they were virtually lifeless. The American public's growing concern about this water pollution led to the amendment in 1972 of the Federal Water Pollution Control Act of 1948. This amended act is commonly referred to as the Clean Water Act or CWA. The CWA's objective is to maintain and restore the integrity of the nation's waters by regulating pollutants discharged into them.

The CWA has several sections. The main section affecting landowners in the Northern Colorado area is Section 404, commonly called the wetland permit (although Section 404 also regulates discharges into some streams and water bodies).

When is a CWA permit needed?

Generally, a CWA permit is always needed before discharging dredged or fill material into any jurisdictional waters of the U.S., including wetlands (there are some exemptions for farming and forestry activities). The type of permit needed varies, depending on the size and type of project and amount of impacts on jurisdictional waters of the U.S. as described under the Type of CWA Permits section below.

What is a jurisdictional water of the U.S. (including wetlands)?

US Army Corps of Engineers®

www.nwo.usace.army.mil/Missions/Regulatory-Program/Colorado

9307 S. Wadsworth Blvd
Littleton, CO 80128

(303) 979-4120

The definition of jurisdictional waters of the U.S. has changed over the years because of Supreme Court decisions. The current Army Corps of Engineers and EPA guidance defines jurisdictional waters as traditionally navigable waters, their tributaries, and associated wetlands. For the Lefthand, Saint Vrain, Big Thompson and Little Thompson watersheds, jurisdictional waters include the four main drainages (Left Hand Creek, St. Vrain Creek, Big Thompson River and Little Thompson River), their tributaries and associated wetlands. The Corps' jurisdiction also includes some irrigation canals. If you are uncertain if a small tributary (such as a dry sandy wash), irrigation canal or an isolated cattail pond on your land is jurisdictional, call the Denver Regulatory Office or a wetland specialist for information.

What part of a stream or waterbody does the Corps regulate?

The Corps regulates the areas of streams, canals, and some ponds that occur below the normal annual high flow line (called the ordinary high water mark). The ordinary high water mark can sometimes be easy to distinguish because it is a distinct line in the dirt with vegetation growing above and bare soil below. However, after a flood event such as the 2013 flood, it may be hard to distinguish between the annual ordinary high water mark and the extraordinary high water mark of a big flood event. Other types of disturbances may also make it difficult to distinguish where the annual high water mark is on the stream banks. If you are unsure of the location of the ordinary high water mark, you can call the Corps Denver Regulatory Office or a wetland specialist for information.

What is a wetland?

The Corps defines wetlands as:
…those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances to support, a prevalence of vegetation typically adopted for life in saturated soil conditions.

In more common terms, wetlands are areas where water is present at or near the soil surface for a long enough periods to form wetland soils that support wetland plants. The Corps regulations require that all three of the following criteria be present to be classified as wetlands. If only one or two of these criteria are present, then the Corps does not consider the area a wetland. (However, other entities such as Boulder and Larimer Counties do consider these wetlands when only meeting one or two of the three criteria). If you live in Boulder or Larimer County, you may need to adhere to wetland permitting requirements even if your property only meets one or two of the criteria.

Hydrology (water)

Water needs to saturate the soil during the growing season for long enough to support wetland plants. This period can range from one month to the entire growing season. Surface water can be present, but does not have to be.

Wetlands along a stream can be difficult to delineate. Where would you draw a line between wetlands and uplands on the photo at right?

Hydric Soils

When soils are saturated for long enough, anaerobic conditions (lacking oxygen) develop. **Hydric soils** can have visible indicators such as mottles or iron depletion. The soil in the photo at right displays iron depletion (seen as the rusty orange color).

Photo courtesy of: U.S. Army Corps of Engineers *[page 189]*

Vegetation

Certain kinds of plants are adapted to saturated soils. The common **hydric plants** include cattails, reed canarygrass and sandbar willow. Other wetland plants are not as easy to identify, such as fowl bluegrass, redtop and Canada wildrye. Some plants can grow in both wetlands and uplands.

Wetlands can range from easily identifiable types, such as cattails growing in standing water, to less obvious wetlands, such as grassy meadows that are only saturated for a month or so in the spring. The edge of wetlands can also be difficult to identify. For example, sandbar willows growing along the edge of a stream may be wetlands, but sandbar willows growing on the top of a slope may be uplands.

If you have an area that you are planning on doing construction and you are unsure if it is a wetland, call the Corps Denver Regulatory Office or a wetland specialist to get more information.

Wetlands along a pond near the Little Thompson River

Type of CWA Permits

There are three types of CWA permits depending on the size and complexity of your project:

Nationwide 404 Permit (NWP)

Streamlined review process for projects that meet certain criteria and can be determined to have minimal environmental effects/ impacts. Intended for projects that fit into overall categories and can be approved or denied based on a quicker review.

Regional General 404 Permit (RGP)

Streamlined review process similar to Nationwide 404 Permits. Regional General Permits are issued for specific activities and entities, such as natural disaster mitigation, fisheries or channel/bank stabilization.

Individual 404 Permit (NWP)

Lengthier and more in-depth review process for projects that do not fit into the Nationwide criteria or the Regional General Permits. These permits are typically for larger and more complex projects.

Nationwide 404 Permit (NWP)

This is the type of permit most private landowners will use. NWPs are streamlined Corps permits for activities that have minor impacts on jurisdictional waters, such as roads and bank stabilization. These NWPs are for five years and the current permits were issued in March 2017. Each of the 45 NWPs has a different set of limits. Generally, but not always, these limits include not impacting more than 0.5 acre of jurisdictional waters (including wetlands) or impacting less than a certain number of linear feet of streambed. Many of the NWPs require notification to the Corps before impacting wetlands or other waters, but some do not. Please note that NWP projects can only be self-verified (meaning there is no pre-construction notice required) if all NWP general conditions are followed/met, including Section 106 Historic Properties and the Endangered Species Act.

The **Summary of the 2017 Nationwide Permits Chart** (example page below) summarizes the 2017 NWPs, limits, whether pre-construction notification is needed and other details.

Summary of the 2017 Nationwide Permits[1]

Nationwide Permit	Statutory Authority	Limits	Pre-Construction Notification (PCN) Threshold	Delineation Required?	Applicable Waters	Changes	Other Information
NWP 1 – Aids to Navigation	10	none	PCN not required	no	navigable waters of the U.S.	none	
NWP 2 – Structures in Artificial Canals	10	none	PCN not required	no	navigable waters of the U.S.	none	
NWP 3 – Maintenance	10/404						
(a) Repair, rehabilitation, or replacement of previously authorized, currently serviceable structures or fills		authorizes only minor deviations for maintenance	PCN not required	no	all waters of the U.S.	Clarify that NWP authorizes removal of previously authorized structures and fills.	Does not authorize: maintenance dredging for the primary purpose of navigation; beach restoration; or new stream channelization or stream relocation projects. Limits stream channel modification to the minimum necessary for the maintenance activity.
(b) Discharges associated with removal of accumulated sediments and debris in the vicinity of existing structures, including intake and outfall structures and associated canals		200 feet from structure; minimum necessary to restore capacity intake or outfall or associated canal	all activities	yes	all waters of the U.S.	Remove provision authorizing the placement of new or additional riprap to protect the structure (riprap may be authorized by NWP 13).	
(c) Temporary structures, fills, and work necessary to conduct maintenance activity			PCN not required	no	all waters of the U.S.	Clarify that NWP authorizes use of temporary mats, if regulated by the district.	Temporary fills must be removed in their entirety and the affected areas returned to pre-construction elevations
NWP 4 – Fish and Wildlife Harvesting, Enhancement, and Attraction Devices and Activities	10/404	none	PCN not required	no	all waters of the U.S.	none	Does not authorize impoundments or artificial reefs. Does not authorize covered oyster trays or clam racks.
NWP 5 – Scientific Measurement Devices	10/404	25 cubic yards for weirs and flumes	PCN not required	no	all waters of the U.S.	none	Devices and any associated structures or fills be removed upon completion of the use and restored to pre-construction elevations to maximum extent practicable.
NWP 6 – Survey Activities	10/404	1/10-acre	PCN not required	no	all waters of the U.S.	none	Does not authorize fills for roads. Does not authorize permanent structures. Does not authorize fill associated with recovery of historic properties. Backfilling of exploratory trenches must not drain a water of the U.S.

Page from the 2017 NWP Summary Chart. Full chart can be accessed at:
www.usace.army.mil/Portals/2/docs/civilworks/nwp/2017/nwp2017_sumtable_Jan2017.pdf?ver=2017-01-06-091151-173

If you have a project that would impact any known or suspected jurisdictional wetlands and other waters, outside assistance is strongly advised. The Corps Denver Regulatory Office would be glad to provide assistance or recommend a professional wetland consultant.

Regional General 404 Permit (RGP)

The Corps has issued RGPs for specific activities in Colorado. Similar to NWPs, Regional General Permits are a more streamlined process for projects that fit within certain criteria. The two RGPs that are most likely to be used by landowners within the Lefthand, St. Vrain, Big Thompson and Little Thompson watersheds are:

- **RGP 12 – Aquatic Habitat Improvements for Stream Channels in Colorado** – Authorizes certain fish habitat improvements as long as no more than 0.5 acre of wetlands is impacted. Habitat improvements include constructing boulder or log weirs, woody debris and other structures, as described online at ***http://www.spa.usace.army.mil/Missions/Regulatory-Program-and-Permits/Stream-Management/***. The Corps must be notified before construction of these devices and the RGP is effective until October 21, 2021.
- **RGP 96 – Natural Disaster Mitigation and Flood-Related Activities in Colorado** – For flood and other natural disasters, this RGP can generally be used within one year of the event. This RGP can be used to repair certain existing structures, stabilize streambanks and conduct other activities. Pre-construction notification is required for this RGP. As discussed throughout this Handbook, always consider upstream and downstream affects of any work you do. The ***'Post-Flood Evaluation'*** *[page 30]* in **Chapter 1** provides questions to ask yourself after a large flood in order to evaluate what work needs to be done immediately.
- **RGP 96 – Stream Stabilization Projects in Colorado** – This RGP will become effective October 2, 2017 and authorizes stream stabilization activities necessary for erosion control or prevention. This includes a wide range of project types such as vegetative stabilization, bioengineering and sills, as well as others. The RGP limits the activity based on lineal feet of streambank impacts, as well as wetland impacts and impacts below the Ordinary High Water Mark (OHWM). The RGP is also only available for streams with a measured width of no less than 20 feet at OHWM.

The Corps has a webpage dedicated to Post-Flood Permitting at:
www.nwo.usace.army.mil/Media/Fact-Sheets/Fact-Sheet-Article-View/Article/714856/post-flood-permitting-co

Individual 404 Permit

If your project is too large or the type of work is not included in the NWPs, the project will need an **Individual Permit**. These permits are a lengthy process that can take a minimum of four to six months to complete, and the Corps has to determine that the project is the least environmentally damaging, practicable alternative, or they will not issue the Individual Permit.

Some activities, such as drop structures that contain greater than 25 cubic yards of material, do not fit under a NWP and would require an Individual Permit.

Endangered Species Act (ESA) – Federal Regulation

The ESA protects animals and plants that are in danger of extinction (endangered) or are threatened to become endangered (threatened) and the habitat upon which they depend. Consultation with the U.S. Fish and Wildlife Service (FWS) is required if a threatened or endangered (T&E) animal species occurs on your property or your project could potentially affect a T&E species. For plants, consultation with the FWS is required if a CWA permit or another federal permit is needed for your project.

Currently, the FWS lists 11 species that have potentially suitable habitat in Boulder, Larimer or Weld County or where projects in these counties could affect these species. Other species proposed or under review may be added to the list in the future. If you would like to determine if your land has suitable habitat for a T&E species, a good tool is the FWS IPaC (Information for Planning and Consultation) website (***https://ecos.fws.gov/ipac/***). Enter the location of your property, and the website will list the ESA species and other species of environmental concern in that area.

Below are a few of the more common T&E species that occur within the Lefthand, St. Vrain, Big Thompson and Little Thompson watershed areas or could be affected by projects in the these areas. These are also mentioned in **Chapter 2** as part of the ***'Landowner Assessment Questionnaires'*** *[page 34]*.

Preble's Meadow Jumping Mouse (Preble's) – Listed as Threatened

Description: Preble's is a small mouse with large hind feet and a long tail for jumping. This mouse occurs along streams and rivers along the Front Range in Colorado at elevations below about 7,500 feet. Preble's typically occurs under shrubs and other dense vegetation that protects it from predators. Usually Preble's occurs near running water; although it has been found more than 300 feet from the floodplain.

Potential habitat for Preble's occurs throughout the drainage systems of the areas discussed in this Handbook. It is known to occur along three of the four river systems – Big Thompson River, Little Thompson River, St. Vrain Creek and some of their tributaries.

Regulation: If your property is below 7,500 feet in elevation and your project is near a stream, then you might have suitable habitat for Preble's. A professional ecologist/wildlife biologist would be able to help determine the likelihood of Preble's occurring on your property. If Preble's is known to occur or your land potentially has suitable habitat, then coordination with the FWS would be required.

Colorado Butterfly Plant – Listed as Threatened

Description: Colorado Butterfly Plant is a short-lived perennial that occurs along streams in the Front Range and into the plains in Colorado at elevations below 6,500 feet. This threatened species usually occurs in active meandering stream channels. Suitable habitat for Colorado Butterfly Plant may occur within the areas discussed in this Handbook.

Regulation: If your property is below about 6,500 feet in elevation and occurs along a stream, then you could have Colorado Butterfly Plant on your land. If your project requires a CWA permit, coordination with the FWS would be required to determine if suitable Colorado Butterfly Plant habitat occurs on your property. A professional ecologist/wildlife biologist would be able to assist with this coordination.

Ute Ladies' Tresses Orchid – Listed as Threatened

Description: This small orchid with numerous white flowers grows along streams and open meadow wetlands. Ute Ladies' Tresses Orchid has been found in the St. Vrain watershed, and suitable habitat may occur along all streams within the other three watershed areas below about 7,000 feet in elevation. This threatened species may also occur within wetlands and along canals in Boulder and Larimer Counties.

Regulation: If your property is below about 7,000 feet in elevation and has wetlands near streams, you may have Ute ladies' tresses orchid on your land. If your project requires a CWA permit, coordination with the FWS would be required to determine if suitable Ute ladies' Tresses Orchid habitat occurs on your property. A professional ecologist/wildlife biologist would be able to assist with this coordination.

Platte River Threatened and Endangered Species

Several T&E species in Nebraska are threatened by the reduction of flows in the Platte River system. The Left Hand Creek, St. Vrain Creek, Big Thompson River and Little Thompson River all eventually flow into the Platte River system. Species impacted within the Platte River system include the least tern, piping plover, whooping crane, pallid sturgeon, and western prairie fringed orchid. If your project would result in water-related depletions to tributaries to the Platte River system, it may affect these species. Any project that would result in removing water from the system would require outside help, including a professional ecologist/wildlife biologist that would be able to assist with this coordination.

Migratory Bird Treaty Act (MBTA) and Bald and Golden Eagle Protection Act (BGEPA) – Federal Regulations

Raptors and other **migratory birds** are protected under the MBTA. **Bald** and **golden eagles** are also protected under the BGEPA. These acts prohibits anyone without a permit from the FWS from "taking" any part of these birds, their eggs or their nests. This includes removing an active nest or disturbing an adult bird so that it abandons the nest, causing the eggs or young to die. When performing work on your property, you must watch for these important birds and avoid impacting them as part of your work.

The FWS and Colorado Parks and Wildlife (CPW) also recommend buffers during the active breeding season to prevent disturbing these birds. The active breeding season and the recommended width of buffers **differs** for each bird species. If nests are on your property near your planned project, call your local CPW representative (***http://cpw.state.co.us/aboutus/Pages/ContactUs.aspx***) to determine what steps should be taken to prevent the take of migratory birds (including bald and golden eagles).

Section 106 of the National Historic Preservation Act (NHPA) – Federal Regulation

If your project requires a federal permit, the regulatory agency must consider the effects of the project on historic properties. For a CWA permit, the Corps will provide information about how the NHPA affects your specific property. While most private landowner projects are far less likely to require an NHPA permit, it is a permit you must be aware of if your project requires other federal permits.

The Advisory Council on Historic Preservation (ACHP) has created a Section 106 Applicant Toolbox online that provides more information on the Section 106 review process: ***www.achp.gov/apptoolkit.html***

CHAPTER

4

Engaging Outside Help

As you have learned in the previous chapters, there are times when you may need to engage outside help for a project on your property. This outside help could be for design and engineering assistance, permitting assistance, or both. This chapter will discuss the different types of paid professional consultants and contractors, as well as how they would be able to help you. We will also discuss what to expect when working with these professionals and what questions to ask when selecting someone to hire. The **Strategy Sheets** in **Chapter 3** discuss project-specific details you will want to know before talking to the consultant or contractor. With this knowledge, you will be more prepared and confident when you go into conversations with these professionals. It will also help both you and the professional to have a clear understanding of what the expectations are from both parties.

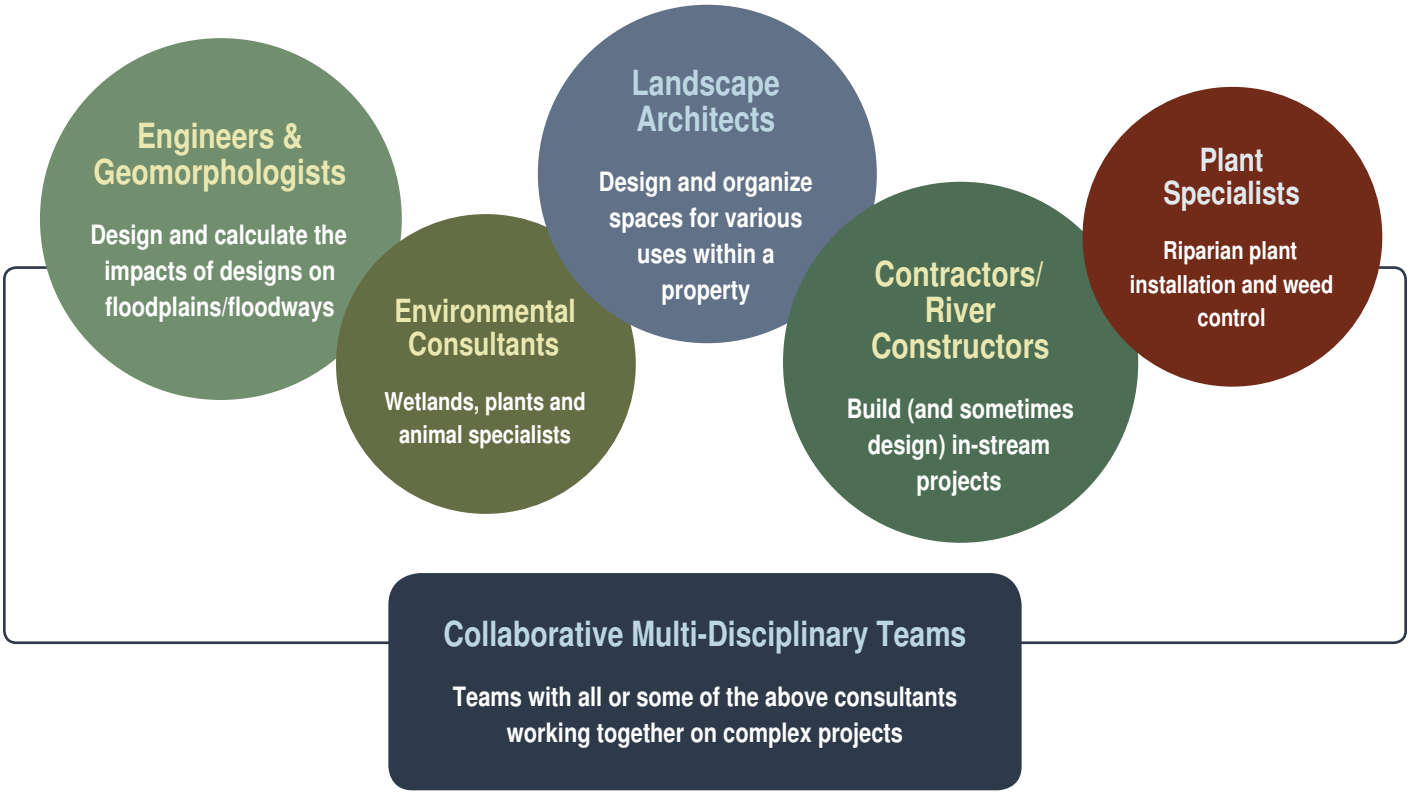
Whether you know of them or not, there are a number of outside resources already available to you. These resources range from educational workshops or handouts, to permitting assistance, to funding assistance, to design and installation of projects. The purpose of this chapter is to give you an overview of many of the resources that are currently available, as well as to show you how to go about engaging these resources. The chapter is organized into two categories: ***'Professional Consulting and Construction Services'*** *[page 134]* and the ***'Resources Directory'*** *[page 144]*.

The second category of outside help discussed in this chapter is professional resources that don't fit into the typical consulting industry. These include government agencies from the federal level down to local agencies, as well as watershed coalitions, university extension programs, nonprofit organizations and volunteer groups. These groups can help you with a variety of matters including permitting and funding assistance, plant and animal identification guides, weed management, education, legal issues such as water rights, construction of projects and emergency help during a flood. The ***'Resources Directory'*** *[page 144]* provides a brief summary of how/when a landowner would be likely to engage with the organization, as well as website links.

When considering contacting outside help for a specific project, it is important to remember that the reason permits are required is to protect the stream corridor **and** the landowners living along it. In many cases, contacting the agency responsible for approving or denying a permit in advance is a smart idea. This is true both for projects that you know will need permits and projects that you are unsure of the permit requirements. By making the most use of these outside resources, you can learn more about your watershed and stream, meet neighbors and fellow stream stewards and be a good steward yourself.

Professional Consulting and Construction Services

An important part of living along a stream is knowing when you can or should contact outside help. While there are many government and non-profit resources available to you (discussed in the ***'Resources Directory'*** *[page 144]*), certain projects or concerns will require you to engage a paid professional. When you engage these paid professionals, there are certain things that will be helpful to know or keep in mind, including what you should be looking for when selecting a paid professional. The following pages include information about each of the four main categories of professional consulting and construction services you may need to work with.



While each section lists some ways of finding a qualified consultant or contractor, one of the best ways is to talk to your local watershed coalition, your neighbors and anyone else you meet within your watershed. Chances are that one of them will have had an experience with a similar type of project and they may have a recommendation for who to contact.

Engineers and Geomorphologists

Type of work/when to contact:	Projects that impact the floodplain or floodway. Projects that require floodplain permitting. Projects that require structural engineering (such as walls or bridges).
Licenses/Education:	Professional Engineer (PE)/Bachelor's and/or Master's degree in Civil Engineering, additional certifications and courses in their specialized field (such as geomorphology or river function).
Where to find an engineer:	Speak to local watershed coalitions, local agencies you will need permits for or neighbors who have had engineered projects completed.
Cost:	Can vary greatly depending on type of work and size of project. Typically billed hourly, often with a not-to-exceed total for the project.
What to ask:	Experience with similar projects, experience with required permits, timeframe for work.

While there are many types of civil engineers, there are specialized categories that work specifically on stream systems. **Water resource engineers** and **geomorphologists** deal with a variety of water related issues and many specialize in river restoration and channel design. These engineers often design projects that restore streams, increase flood resiliency and balance other objectives such as protecting property and enhancing the riparian environment. Water resource engineers balance the dynamic hydrology and hydraulics of a site with ecology and biology, as well as public safety. Engineers also provide a wide range of services in support of stream restoration work, including floodplain evaluations, detailed design of structures and utilities such as water and sewer lines.

Engineers can help you design and permit in-stream restoration projects.

Engineers and Geomorphologists (pg. 2)

An engineer should be contacted when you realize you have a project that will require substantial work in the floodplain or if you think the project may require substantial floodplain work. This will typically require local (city or town), county and/or federal permitting which the engineer will be able to assist you with. When looking for a suitable engineer to work with, you will want to make sure they have multiple years of experience in stream restoration and natural channel design projects. They should also be licensed professional engineers (PEs) and their company should carry **commercial liability insurance**, **general liability insurance** and **professional liability insurance** (often called **errors and omissions insurance**).

Fluvial geomorphologists study how streams interact with their surrounding landscapes.

When engaging an engineer, it is helpful have an idea of the issues along your stream, as well as any restrictions or constraints that you may have. This will help the engineer to make an assessment of the most appropriate improvements. As they progress through the design, they should be able to provide a cost estimate for your specific project. Engineers can also assist in grant applications if outside funding is needed to complete the restoration work.

Often, part of the engineers' responsibility will be to create digital models of the stream and the surrounding areas to ensure the project will not have negative impacts on the floodplain. This process is called **hydraulic modeling** and it is usually required for floodplain permitting submittals. This will be done during the design period of the project. Following the design process, the engineer can assist you with submitting the permits. These permits typically include floodplain permits and a USACE 404 Clean Water Act permit.

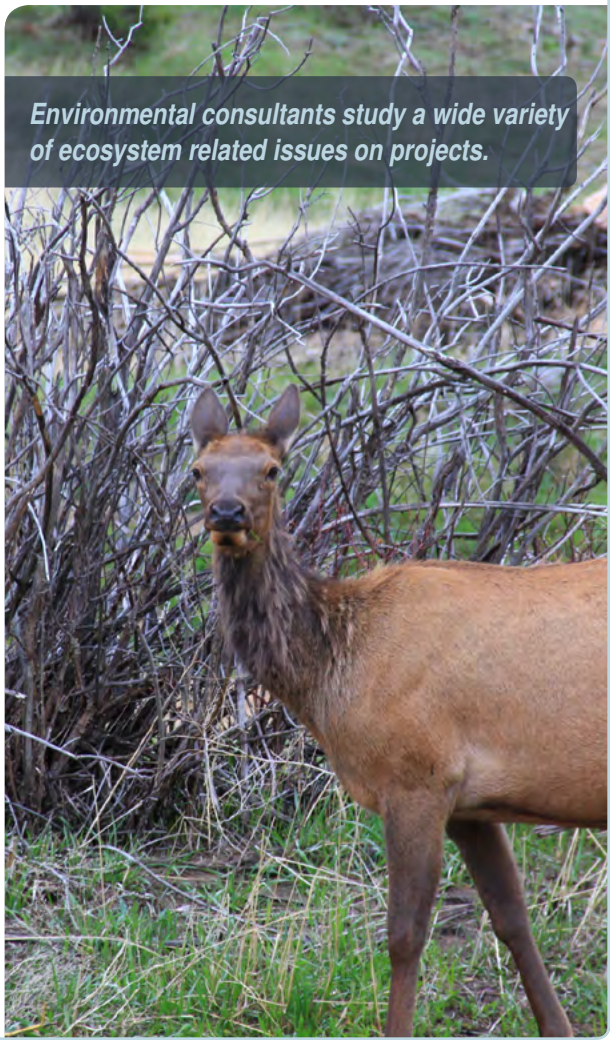
If desired, most engineers can also be hired to oversee/observe the river constructor during the construction of the project. This can be helpful because they will make sure the constructor understands the construction drawings and is installing the project per the approved plans.

Environmental Consultants (Ecologists, Biologists and Archaeologists)

Type of work/when to contact:	Projects that impact wetlands, including streambanks below the annual high water level. Project sites with threatened or endangered species. Projects that require Army Corps of Engineers (COE) 404 permits. Projects with unique wildlife or vegetation considerations. Any project that will impact natural systems.
Licenses/Education:	No official licenses, but the COE maintains a list of wetland consultants. Bachelor's and/or Master's degree in biology, ecology or cultural resources. Local experience identifying and working in Colorado, including wetlands.
Where to find environmental help:	The Denver Regulatory Office of the COE maintains a list of wetland specialists. Call (303)979-4120 to obtain the list.
Cost:	Can vary greatly depending on type of work and size of project. Typically billed hourly, often with a not-to-exceed total for the project.
What to ask:	Local experience with similar projects and species, experience with required permits, timeframe for work.

Virtually all stream projects can benefit from consultation with ecologists and biologists as they consider opportunities to protect and restore habitat for fish and wildlife and can frame the project in the context of regulatory requirements.

Various regulations may apply to the wildlife, vegetation and other natural resources on your property. Certain projects may also involve cultural and/or historical resources that will require a permitting proecess. A professional environmental consultant with knowledge of these resources can help guide you through these regulations and processes. There are a variety of types of environmental consultants and you will need to determine which one best fits your needs. If you are unsure, don't be afraid to pick up the phone and ask an environmental consultant who you should contact.



Environmental consultants study a wide variety of ecosystem related issues on projects.

Wetland Specialists

Wetlands, streams and other water bodies on your property may be protected under the Clean Water Act. Determining if you have a wetland and if it is jurisdictional (regulated by the Corps) may be difficult. It can also be difficult to discern what specific regulation may apply to the activity planned within your wetland, stream, or other water bodies. A wetland consultant, with knowledge of the wetlands found in the Northern Colorado area and the current local regulations, can provide valuable assistance.

When looking for the wetland specialist to assist you, look for specialists that have experience (preferably more than 3 years) **delineating wetlands** in your general area. **Wetland delineation** is a well-defined process that is required for

Environmental Consultants (Ecologists, Biologists and Archaeologists) (pg. 2)

certain permits. As a result, these wetland delineations must follow the U.S. Army Corps of Engineers regional guidelines. They should also have a proven track record with the Corps' Denver Regulatory office, as well as knowledge of the current federal and local regulations. The Corps' regulations change frequently and the different regulatory offices (Denver Regulatory Office compared to the Grand Junction Regulatory Office) may have slightly different regulatory requirements. In addition to the Corps' regulations, they should also be familiar with any local (county, city or town) wetlands requirements and permits.

Environmental consultants can assist you in selecting proper plant species for various distances from the stream.

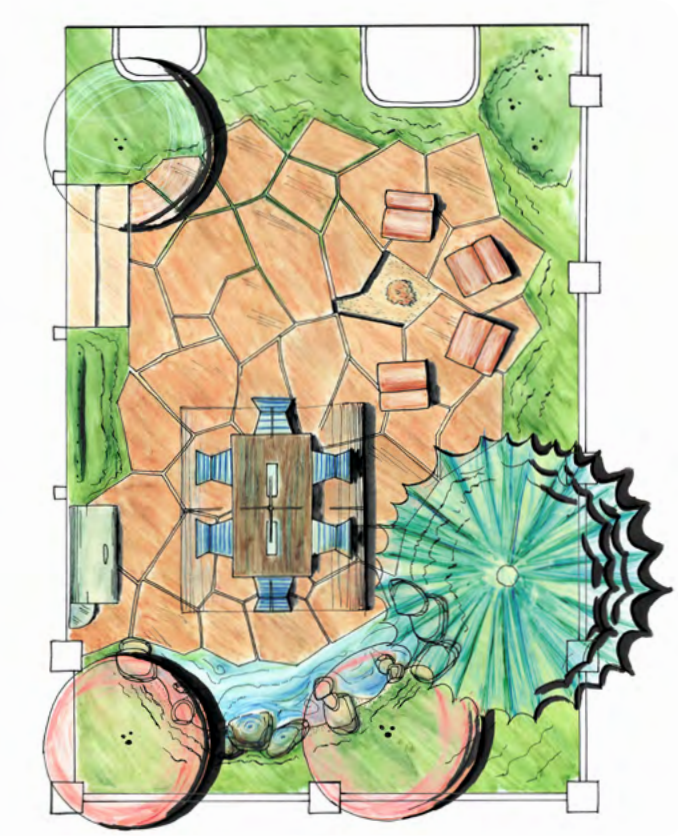
Threatened and Endangered Species Specialists (T&E Specialists)

Most wetland specialists can also provide assistance for threatened and endangered species. If you potentially have habitat for a threatened and endangered (T&E) species, consultation with the Fish and Wildlife Service may be required. For example, if you live along the St. Vrain River and Preble's meadow jumping mouse (a threatened species) has been found nearby, there is a good chance you will need to meet certain T&E requirements when working on a project on your property. Sometimes, contracting with a T&E consultant will be needed to determine if your land has a T&E species present or not.

Similar to the wetland specialists, you will want to look for someone who has proven experience working in your area with the Fish and Wildlife Service on T&E issues. They will also need to be knowledgeable about the current regulations. Ideally, you will be able to find someone with recent working experience in your area. The experience will often give the specialist a head-start on what work will be required for your project.

Landscape Architects

Type of work/when to contact:	Projects that will require layout and planning of spaces. Projects requiring multi-disciplinary teams.
Licenses/Education:	Registered/Professional Landscape Architect (RLA/PLA). Bachelor's or Master's degree in landscape architecture or landscape design and contracting.
Where to find a landscape architect:	ASLA Colorado website: ***www.asla.org/ISGWeb.aspx?loadURL=firfin***
Cost:	Can vary greatly depending on type of work and size of project. Typically billed hourly, often with a not-to-exceed total for the project.
What to ask:	Experience with similar projects, experience with required permits, timeframe for work.



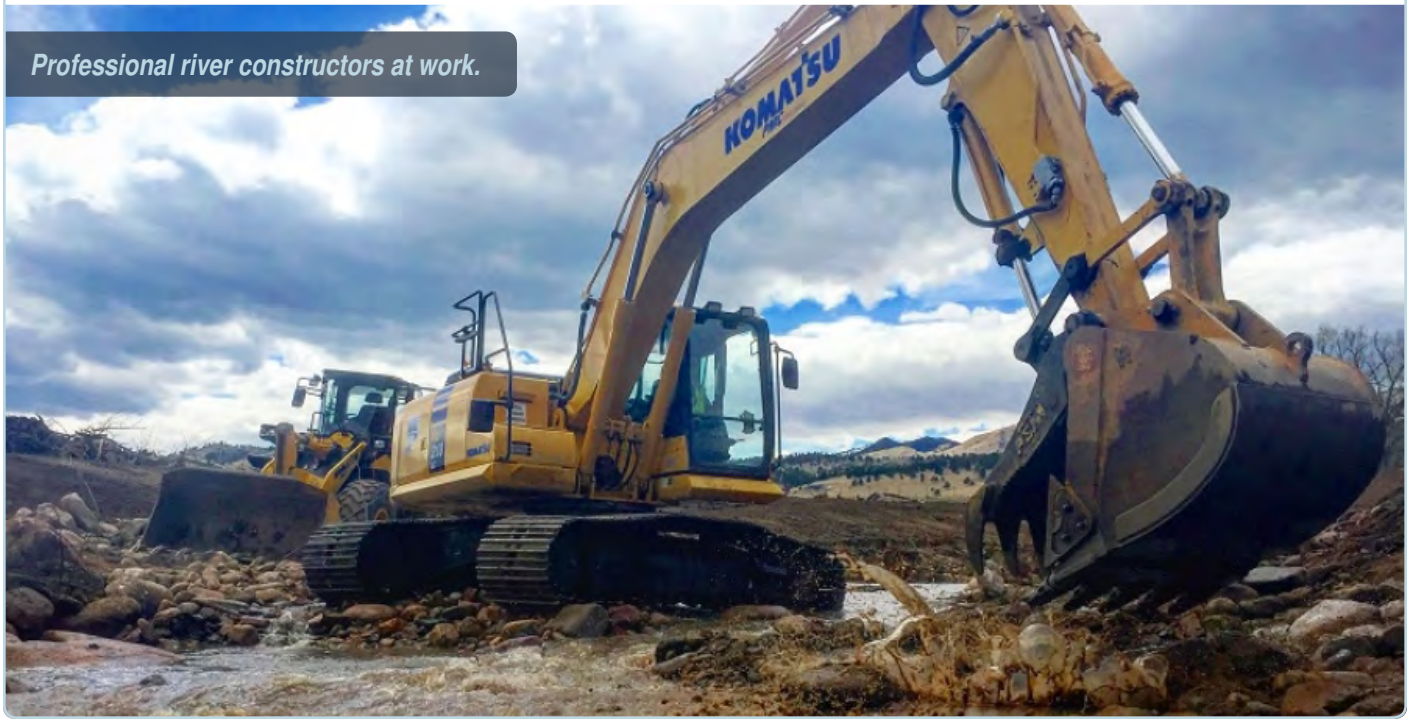
Landscape architects and designers can play a key role in your project when it comes to defining spaces, vegetation, access and aesthetics. Depending on your project, the landscape architect can help you figure out how to organize your property, or they can create a planting plan that is beneficial to the stream corridor while meeting your view, aesthetic and access needs. Often, they can also assist you with applying for certain permits and any required local design reviews such as HOA or city submittals. While landscape architects are required to hold a license for commercial property designs, residential design work does not require a license. Licenses are required for commercial design work in order to ensure the design accounts for the public's **health**, **safety** and **welfare**.

When looking at landscape architects/designers, you will want to make sure they have multiple years of experience designing similar types of projects. They should be able to share pictures of the finished projects with you. If you are hiring them to create a riparian corridor planting plan, make sure that they have successfully completed other similar projects in the area. Riparian vegetation can vary greatly from area to area and its success will depend on how close it is planted to the water. Not knowing these details can mean the difference between a healthy area of vegetation and an area that will die off. As mentioned above, you may want to consider hiring a licensed landscape architect; this will depend on your project. In either case, their company should carry **commercial liability insurance**, **general liability insurance** and **professional liability insurance** (often called **errors and omissions insurance**).

River Constructors and Contractors

Type of work/when to contact:	Projects that will require construction work in the stream. Projects that require construction methods in line with permits. Projects that will require construction beyond what you are comfortable doing yourself.
Licenses/Education:	Although not required, many river constructors come from an engineering background and hold PE licenses, as well as a Bachelor's or Master's degree in engineering.
Where to find a river constructor:	Speak to local watershed coalitions, local agencies you will need permits for or neighbors who have had engineered projects completed.
Cost:	Can vary greatly depending on type of work and size of project. The fee can be determined by lump sum or by time and materials. You should receive a detailed summary/breakdown of the proposed construction costs prior to work beginning.
What to ask:	Experience with similar projects, experience with required permits, client/ landowner references, references of designers the constructor has worked with, timeframe for work.

Following the design and permitting of your project, you may need to hire a river constructor to actually build the project. Depending on the company and the project, they may be able to help you design and permit the project as well. The river constructor will be responsible for following the construction document plans properly and clearly communicating with both you and the designer(s) if they are still involved. This communication will typically involve accurate cost estimates and schedules, as well as updates on any delays from weather, equipment problems, etc. Both the cost estimates and schedule should be detailed to show the steps involved with each step. If a river constructor provides you with a very simplified cost estimate or schedule, it is very reasonable to ask for a more detailed version.



Professional river constructors at work.

River Constructors and Contractors (pg. 2)

River constructors re-shaped this entire reach of Clear Creek to form natural floodplain benches and in-stream fish habitat.

Similar to the other professions, you will want to look for someone with extensive experience installing similar types of projects. When talking to river constructors about the project, they should be familiar with the terminology used on the construction document plans and they should be able to tell you exactly how they will construct the project. They should also be able to show you pictures from other completed projects and provide references if requested. The contractor should have general liability insurance, specific licenses may be needed depending on the municipality of the work.

YouTube

Watch videos on how to safely interact with heavy equipment operators at the LWOG YouTube Channel!
http://bit.ly/2yNaPMm

Plant Specialists (Riparian Plant Installation and Weed Control)

Type of work/when to contact:	Projects that you need help with planting or seeding riparian areas. If you need assistance with weed control, especially herbicide application.
Licenses/Education:	Herbicide applicators should have proper licenses for applying the chemicals.
Where to find a plant specialist:	Speak to local watershed coalitions, look for companies online and read reviews.
Cost:	Can vary greatly depending on type of work and size of project. The fee can be determined by lump sum or by time and materials. You should receive a detailed summary/breakdown of the proposed construction costs prior to work beginning.
What to ask:	Experience with similar and nearby projects, client/landowner references, what are their best management practices.

Riparian Plant Installation

While there are many good landscape companies, finding one that has experience in riparian restoration plantings can be very important. Companies that specialize in riparian work will know details such as willow stakes can only be planted while dormant, or how close to the water table and stream different types of plants need to be. These companies should also be much more capable of reading riparian restoration construction documents, as well as being able to install vegetative streambank stabilization projects such as vegetated soil lifts.

Weed Herbicide Applicators

Although some herbicides can be applied by the landowner, others are labeled “restricted use” and must be applied by a commercial applicator that is licensed by the state. If you plan to use a commercial applicator for a weed infestation on your property, there are a few things that the applicator should know. They should be knowledgeable of applying herbicides in nearby rangeland and riparian settings. They should also have the appropriate equipment for spraying near/around desired vegetation that you want to keep. They should be familiar with noxious and invasive weeds as well.

Collaborative Multi-Disciplinary Teams

Type of work/when to contact:	Projects that involve multiple disciplines such as engineering, wetlands, landscape architecture and construction.
Licenses/Education:	See previous sections for requirements on individual consultant types.
Where to find a multi-disciplinary team:	Speak to local watershed coalitions, neighbors who have had engineered projects completed.
Cost:	If a project is large enough to involve multiple disciplines, it is generally a larger and more complex project. This typically means a higher cost project. Most lead consultants will not mark up the fees of the rest of the team members, but they will need to include extra time (fees) to account for managing the team.
What to ask:	Experience with similar projects, experience with required permits, if the members of the team have worked together, references for projects that they have worked on together, time frame for work.

On some projects, multiple professions will form a single team to assist you. This is especially true for larger and more complex projects. For example, if you need engineering, environmental permitting and planting plans for a project, you may hire a team that includes all of these professions. If you want the same team to install your project, a river constructor can be added to that team.

When considering this option, you will want to talk to whichever profession will have the most work on your project first. This consultant will typically be the 'lead' or 'prime' consultant. They will be your direct contact and they will manage the other consultants for you. Often, this prime consultant will make recommendations to you about who they could add to the team to help the outcome of the overall project.

In addition to the requirements recommended for each profession in the previous pages, it is also important that these consultants have worked together on other similar projects. If they are not familiar with each other, there is a higher risk that items will not be coordinated correctly. When talking to a potential team of consultants, it is important to define the lines of communication at the beginning of the project, as well as project costs, schedule and impacts to your property.

Resources Directory

In addition to consultants, there are a number of other outside resources available to you as a landowner. These range from watershed coalitions, to government agencies, to University Extension services, to non-profit organizations and volunteer groups. The following pages contain a 'directory' of the outside resources that are most likely to be of use to you. The 'directory' contains a brief description of how they may be able to help you, as well as contact information.

Watershed Coalitions

Your local watershed coalition is a great resource for learning more about your watershed, connecting with other landowners along your stream and working to better the overall stream corridor. The watershed coalitions identify funding methods and work with a diverse range of stakeholders including private landowners, governments and non-profit organizations to implement restoration projects. The coalitions also play a major role in distributing and allocating federal funding for flood recovery projects. Contact your local coalition to see if they can help you secure resources to implement a project.

LEFTHAND WATERSHED oversight group

www.lwog.org

The Lefthand Watershed Oversight Group (LWOG) works with residents and partners along Lefthand, James and Little James Creeks in Boulder County. The mission of the Lefthand Watershed Oversight Group is "*to assess, protect, and restore the quality of our watershed, and to serve as a hub for watershed issues through the fostering of stakeholder collaboration.*" *(lwog.org)*. The LWOG Master Plan can be viewed at: **lwog.org/your-watershed/master-plan**

The Big Thompson Watershed Coalition (BTWC) is a coalition consisting of governments, private landowners, and non-profit organizations that are working together to implement sustainable restoration of the Big Thompson River after the 2013 flood. Their mission is "*to protect and restore the ecological health of the Big Thompson Watershed for the use and enjoyment of our community today and for future generations.*" *(bigthompson.co)*. The BTWC Master Plan can be viewed at: **www.bigthompson.co/master-planning**

BIG THOMPSON WATERSHED COALITION

www.bigthompson.co

Little Thompson Watershed Restoration Coalition

www.ltwrc.org

The Little Thompson Watershed Restoration Coalition (LTWC) is a group of landowners and stakeholders whose mission is "*to restore and maintain the resiliency, ecological integrity and agricultural heritage of the Little Thompson River watershed for future generations.*" *(ltwrc.org)*. The LTWC Master Plan can be viewed at: **www.ltwrc.org/master_plan_level_1.html**

The Saint Vrain Creek Coalition's (SVCC) mission is "*to implement the Saint Vrain Creek Master Plan and pursue recovery from flood impacts, resiliency to natural hazards, and protection of the natural character and multiple uses of the Saint Vrain watershed, through broad stakeholder engagement and collaboration.*" *(saintvraincreekcoalition.org)*. The SVCC Master Plan can be viewed at: **www.saintvraincreekcoalition.org/master-plan**

SAINT VRAIN CREEK COALITION

www.saintvraincreekcoalition.org

Colorado Watershed Assembly

coloradowater.charityfinders.com

In addition to the four watershed coalitions that were involved in the creation of this Handbook, there are over 80 watershed coalitions across the state of Colorado. The Colorado Watershed Assembly has a directory of all active watershed coalitions, as well as many other watershed related resources.

Government Agencies

Government agencies, from the federal level down to your local county and town/city, are the ones who regulate and administer the permits that may be required for your project. These permits are discussed in more detail in the *'Permitting Requirements'* *[page 121]* section of **Chapter 3** and they have been put in place to protect the stream corridor, the plants and animals that depend upon the stream and landowners that live along the stream such as yourself. If you are unsure if your project will require permits, you should contact the regulating agency to find out more information. Depending on the project and the permit, the agency may even help you through the permit application process.

In addition to regulating and administering permits, government agencies also support the watershed coalitions and private landowners by funding recovery projects, monitoring our streams, creating educational resources and offering grant programs. In fact, this Handbook is funded by government funds in order to provide landowners with information and resources for stewardship and recovery projects.

Federal Government Resources

EPA

www.epa.gov/cwa-404

The Environmental Protection Agency (EPA) established Section 404 of the Clean Water Act, which regulates the discharge of materials into waters of the U.S. and their tributaries. This permit is required when doing work that affects wetlands, including streambanks below the annual high water level. When the EPA refers to the Ordinary High Water Mark (OHWM or OHW), this is the same as the annual high water level.

While the EPA develops Section 404 policy, the United States Army Corps of Engineers (COE or the Corps) administers the program. This includes reviewing and approving or denying permit applications. The Corps splits the country up into geographical regions or districts. Northern Colorado is within the Omaha District and there is a regulatory office in Denver. The Denver Regulatory Office can be reached at **(303) 979-4120**.

US Army Corps of Engineers®

www.nwo.usace.army.mil/Missions/Regulatory-Program/Colorado

U.S. FISH & WILDLIFE SERVICE

www.fws.gov/

The U.S. Fish and Wildlife Service (FWS) regulates and monitors a wide range of animals and animal habitats, including fish and aquatic habitat, across the country. The FWS administers and enforces the Endangered Species Act (ESA), the Migratory Bird Treaty Act (MBTA) and the Bald and Golden Eagle Protection Act (BGEPA). This includes Threatened and Endangered Species permitting.

The Advisory Council on Historic Preservation (ACHP) is a federal agency that oversees the nation's historic resources. In order to do this, they administer and enforce Section 106 of the National Historic Preservation Act (NHPA). If you project requires a CWA 404 permit, it has the potential to also require a Section 106 permit through the ACHP.

ACHP

www.achp.gov/index.html

FEMA

www.fema.gov/

www.fema.gov/states/colorado

The Federal Emergency Management Agency (FEMA) is not only responsible for responding to emergencies, but also preparing for them. FEMA manages the floodplain and floodway databases and the Flood Insurance Rate Maps (FIRMs). These determine the location and extents of all flood zones, including floodways and floodplains. As a result, floodplain permitting through your local floodplain administrator will be involved with your project if you are impacting floodways or floodplains. FEMA also manages the National Flood Insurance Program.

FEMA's website provides a number of helpful resources for flood preparedness, recovery assistance and flood fact sheets, as well as information on current disasters.

The Natural Resources Conservation Service (NRCS) is a service of the United States Department of Agriculture (USDA). They provide financial and technical assistance for a variety of topics relating to the conservation of plants, animals, soils, agriculture and ecosystems. Their website also provides a number of educational resources that range from basic information to technical manuals on topics such as streambank stabilization, plant information, agricultural practices and water resources. You can access a number of these resources at: ***go.usa.gov/BvNA***

NRCS

www.nrcs.usda.gov

FOREST SERVICE U.S. DEPARTMENT OF AGRICULTURE

www.fs.fed.us

The United States Forest Service (USFS) is an agency of the United States Department of Agriculture. As they administer national forests and national grasslands, many landowners access their properties through USFS land. The USFS also has many great online and in person resources for learning about forest management, stream restoration and ecosystems.

The Bureau of Land Management (BLM) is an agency within the United States Department of the Interior. They administer over 200 million acres of public lands across the country. Many of these acres are used for private livestock grazing through permits and leases. The BLM also leases land for oil and gas production. Certain private landowners may also deal with the BLM for access to their properties. The BLM website maintains an online library with many good resources on land management, livestock grazing management and open lands management.

U.S. DEPARTMENT OF THE INTERIOR BUREAU OF LAND MANAGEMENT

www.blm.gov

State (Colorado) Government Resources

Colorado Parks and Wildlife (CPW) is a great resource for learning more about the wildlife and habitats that are found in Colorado. In addition to regulating hunting and fishing within the State, they also have resources for learning about animal species, fish species and insect species. Their staff is a good resource to consult with if you have questions about how your project may impact local wildlife populations.

cpw.state.co.us

The Colorado Water Conservation Board (CWCB) is a division of the Colorado Department of Natural Resources (DNR). They oversee the local watershed coalitions as part of their overall mission to '*represent each major water basin, Denver and other state agencies in [a] joint effort to use water wisely and protect our water for future generations*' *(cwcb.state.co.us)*. The CWCB also serves as Colorado's coordinating agency for FEMA's National Flood Insurance Program.

In addition to these responsibilities, the CWCB provides resources for flood preparedness and response. This includes the Flood Threat Bulletin which alerts people around the state of the daily flood potential.

cwcb.state.co.us

Flood Threat Bulletin:
www.coloradofloodthreat.com/

water.state.co.us

The Colorado Division of Water Resources (DWR) oversees issues dealing with water rights, wells and represents Colorado in interstate water compact proceedings. The DWR also approves construction and repair of dam structures in Colorado.

The Colorado Department of Local Affairs (DOLA) administers Colorado's Community Development Block Grant - Disaster Recovery (CDBG-DR) funds received from the Department of Housing and Urban Development (HUD). These funds reimburse *'local governments, communities, small business owners, farmers and homeowners for expenses associated with recovery projects and services.' (colorado.gov/pacific/dola/disaster-recovery)*

www.colorado.gov/dola

sites.google.com/a/state.co.us/coloradounited

The Colorado Resiliency and Recovery Office (CRRO) provides a number of links and resources for creating more resilient properties and recovering from disasters such as floods. The CRRO helps to coordinate between recovery and resiliency projects that may have overlap. The CRRO operates under the Colorado Department of Local Affairs (DOLA).

The Conservation Districts work to maintain and improve water, soil and wildlife resources by providing technical and educational resources to support conservation practices on a local basis. Conservation Districts in Northern Colorado include the Fort Collins, Big Thompson, Longmont and Boulder Valley Districts. You can find your District by web searching or visiting the Colorado Association of Conservation Districts website.

www.coloradoacd.org/

County Resources

Boulder, Larimer and Weld Counties all have valuable resources for private landowners. These resources can help you with permitting information and guidance, invasive weed management and flood resiliency and recovery. Each county has their own regulations for floodplain development permits, which apply to projects that will have impacts on the floodplain or floodway. If you live within city or town limits, the city or town will often have their own set of floodplain requirements (discussed in the ***'City/Town Resources'*** *[page 148]* section). In most cases, County staff will discuss your project with you to help you in determining what permits will be required. All three counties also have weed management programs that will help you to identify and control weeds. Lastly, each of these counties has an Office of Emergency Management to assist with flood preparedness and help during an emergency event such as a flood. Many other counties in Colorado provide these same services. Please contact your county government with these types of questions/requests.

www.bouldercounty.org

Boulder County Weed Program:
www.bouldercounty.org/property-and-land/land-use/noxious-weeds

Boulder County Floodplain Management:
www.bouldercounty.org/transportation/floodplain-management

Boulder County OEM:
www.boulderoem.com

www.weldgov.com

Weld County Weed Program:
www.weldgov.com/departments/public_works/weed_management

Weld County Floodplain Management:
www.weldgov.com/departments/planning_and_zoning/floodplain_management

Weld County OEM:
www.weldgov.com/departments/office_of_emergency_management

www.larimer.org

Larimer County Weed Program:
www.larimer.org/weeds

Larimer County Floodplain Management:
www.larimer.org/engineering/floodplains.htm

Larimer County OEM:
www.larimer.org/emergency

City/Town Resources

If you live within a city or town, such as Boulder, Longmont, Loveland or Fort Collins, there may be specific regulations or permits that you need to adhere to for certain projects. Often, the permitting process for these is very similar or identical to federal or county permits. For example, most cities and some towns have their own floodplain administrator who is responsible for floodplain permitting. If you live within a city or town, you can contact the appropriate department for advice and guidance on the permits required for your project.

Along with permits and regulations that are more specific to your area, a city or town will often also provide many services similar those provided by counties. These often include weed management and emergency management, as well as resources for property development, zoning and neighborhood associations.

University Extension Programs, Nonprofit Organizations and Volunteer Groups

Colorado State University EXTENSION
State of Possibilities

extension.colostate.edu

The Colorado State University Extension is a division of Colorado State University that provides an incredible wealth of information. This information ranges from agriculture, to veterinary/animal health, to insects, to natural resources, to finances, to yard and garden. The Extension website has a wide variety of online tools, publications and links to other websites. The website even has an 'Ask an Expert' page where you can submit questions for experts to reply to. The website is also available in Spanish.

The Colorado State Forest Service (CSFS) is a service and outreach agency of Colorado State University. Their mission is *"to achieve stewardship of Colorado's diverse forest environments for the benefit of present and future generations."* *(csfs.colostate.edu)*. They provide valuable assistance and resources on forest and land management, tree species, insects and wildfire mitigation. They also have a seedling tree nursery which provides landowners with bare root and container seedlings for conservation efforts at a low cost. This includes areas that need reforestation as a result of fire or floods.

COLORADO STATE FOREST SERVICE
COLORADO STATE UNIVERSITY

csfs.colostate.edu

COLORADO WATER TRUST

www.coloradowatertrust.org

Similar to many of the other nonprofit organizations, the Colorado Water Trust focuses on restoring streams and rivers throughout Colorado. They differ from the other nonprofits in that they are able to restore flows on streams and rivers by using market-based transactions. This means that they are dealing with historical water rights more than on-the-ground improvement projects. The Colorado Water Trust uses three program areas: Water Rights Solutions, Infrastructure Solutions and Consulting Services. If your project involves water rights, the Colorado Water Trust is a great resource for learning more about the implications of your project, as well as creative solutions to challenges you may face.

The Colorado Natural Heritage Program (CNHP) is a nonprofit organization that is sponsored by Colorado State University's Warner College of Natural Resources. More specifically, they are sponsored by the College's Department of Fish, Wildlife and Conservation Biology. They focus on Colorado's rare, threatened and endangered species and habitats. As mentioned in the *'Vegetation'* *[page 45]* section of the Questionnaires in **Chapter 2**, the CNHP website provides access to two great guides on Colorado wetlands and wetland plant species, as well as a rare plant guide. The CNHP also offers environmental review services to a variety of clients.

COLORADO NATURAL HERITAGE PROGRAM

www.cnhp.colostate.edu

Colorado Trout Unlimited is a state chapter of the National organization Trout Unlimited. Within the state chapter, there are 23 local chapters. These nonprofit organizations work with landowners, government agencies and consultants to improve the fisheries and fish habitat throughout the state. This often includes stream restoration projects, as well as educational workshops and fundraising events. Donating to or volunteering with Trout Unlimited can lead to new knowledge and connections within the Colorado fly fishing network. If your project has a heavier fishery or fish habitat aspect to it, Trout Unlimited may be able to offer you some assistance with completing the project.

coloradotu.org

www.tu.org

The Nature Conservancy

www.nature.org

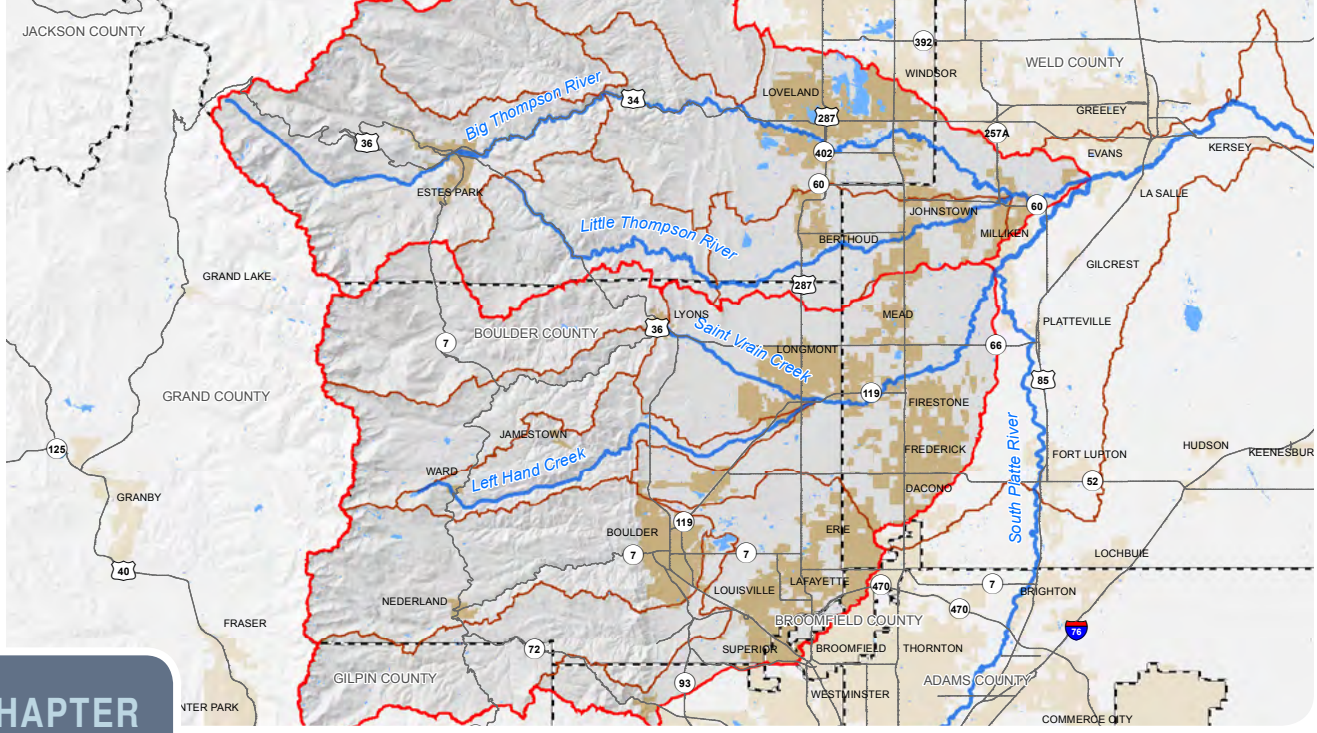
The Nature Conservancy is an international nonprofit organization focused on the conservation and preservation of ecological resources. Their activities include purchasing land for conservation, as well as helping to fund conservation projects. In addition to this, The Nature Conservancy also publishes educational pieces that many landowners use to learn about conservation methods being used across the globe. The Nature Conservancy is headquartered out of Virginia and they do have a Colorado field office in Boulder.

Wildlands Restoration Volunteers (WLRV) is a Colorado nonprofit organization that builds and installs conservation projects in Colorado and Wyoming. Their projects range greatly in size and timeframe. As a landowner within a watershed, you can consider volunteering to help build projects with the WLRV. This can be a great way to learn about restoration and stewardship techniques, as well as meet other local people interested in stream and land conservation. If you have a project that you need installation help with, WLRV may be able to help you.

Wildlands Restoration Volunteers

www.wlrv.org

Project Selection Criteria:
www.wlrv.org/land-managers/tell-us-about-your-project/project-selection-criteria



CHAPTER

5

Master Your Watershed

For those of you who wish to learn even more about your stream, watershed and/or ecosystems, there are plenty of resources available to you! If you are interested in learning more about these subjects, Colorado is a great place to learn. Because of the abundance of streams and rivers, our state is one of the leaders for research on riparian systems and restoration.

Colorado State University has many programs dedicated to water resources in both the Warner College of Natural Resources and the College of Engineering. The University itself, as well as its Extension program and Forest Service, offer publications, workshops and faculty contacts that you can contact to learn more. The Colorado State Forest Service (CSFS) has great resources that discuss how forest fire mitigation can have a direct impact on stream health. We will discuss this relationship between forests and streams, as well as where to access these CSFS resources.

There are many books available in print and online about stream and river functions, riparian ecosystems, aquatic organisms and non-aquatic organisms. There are also a number of nonprofit organizations dedicated to educating and protecting these valuable natural resources. The Nature Conservancy, Trout Unlimited and the Audubon Society are three national nonprofits that have local offices in Colorado. You can find educational material on their websites and you can also become involved with them by volunteering or attending local workshops. This is also a great way to meet other landowners who are trying to do their part to be good stream stewards.

As you learn more about these fields, you will likely find that you can find resources as basic or as technical and advanced as you wish. Finding resources that teach you new things is key to staying interested in the material.

On the following pages, we will take a more in-depth look at two of the most widely-accepted stream classification systems and how your stream relates to them. These systems are used by engineers, geomorphologists, environmental consultants, landscape architects and river constructors to better understand what a stream is doing. They then use this information to create plans and designs for stream restoration projects. Using an accepted classification system also allows for better communication between different professional fields and the range of offices you may interact with.

Forest and Forest Fire Management

Stream health and stability is dependent on the health of its contributing watershed, including its upland and forested areas. Burn areas resultant of wildfires in the headwaters of streams in Colorado can significantly alter the amount of both water and sediment flowing into local streams. Not only can wildfires cause water quality issues but they are likely to impact the health and stability of the stream and adjacent riparian areas. Flood risk may also increase in the years following a significant wildfire in the upstream watershed. As a landowner, it is critical to practice ongoing wildfire mitigation efforts to minimize the chance and potential impacts of a burn on your property. The Colorado State Forest Service provides a useful library of publications on management recommendations for both plains and forested areas within the state that is geared towards landowners.

Colorado State Forest Service Publications:
csfs.colostate.edu/csfspublications/

Technical Stream Classification Systems

Technical stream classification systems have been developed to provide a general framework for documenting, evaluating, and understanding different types of stream corridors. These systems are often used by water resources engineers, geomorphologists and stream restoration experts. The classification of a stream often categorizes information about its stability and how it is evolving. This is often referred to as a stream's evolutionary stage. All of this information can be used as a tool for communication and stream management, especially for projects that require complex engineering.

Two of the most recognized technical stream classification systems are the 'River Styles Framework' and 'Rosgen Stream Classification System'. Though each system has their differences, both are based on assessing the physical characteristics of a reach of stream such as valley type, channel proportions, geomorphic properties and the bed material within the stream. Both the River Styles and the Rosgen systems begin by looking at the larger context in which the stretch of stream lies. This is done by classifying the 'valley setting' or 'valley type.' The valley type is an important first step because it dictates other characteristics of the stream including its total power and its ability to transport sediment.

After assessing the valley in which the stream lies, both classifications systems evaluate the characteristics of the channel bed and banks, including the alignment, slope and streambed material. Together, these attributes are used to classify the stream, enhancing our understanding of its processes. Classification can also make it easier to communicate the current state of a stream, understand why things are happening along the stream, and even provide insight into the best restoration practices for that specific site.

Valley Setting/Type

Referred to as the 'Valley Setting' in the River Styles Framework and 'Valley Type' in the Rosgen Classification System, this characteristic alludes to the overall confinement of the stream corridor. A confined stream is one that is unable to spread across a floodplain area during high flow flood events. Generally, streams in mountainous areas have a more confined valley, whereas reaches along the plains often have a more open valley.

River Styles Framework:
www.riverstyles.com

Rosgen Stream Classification:
www.wildlandhydrology.com

With the *'Stream Classification Guide'* [page 68] in this Handbook, landowners such as yourself can assess the **Entrenchment**, **Slope** and **Primary Streambed Material** on their property. These are three key factors evaluated in both the River Styles and the Rosgen systems, in addition to many more criteria that may not be as easy for a landowner to evaluate on their own. These include the alignment/sinuosity of the stream, a width/depth ratio and channel complexity. These technical classification systems also have more options to choose from. For example, this Handbook's **Stream Classification Guide** provides 3 classifications of **Stream Slope** to choose from; the Rosgen system has 7 options sometimes requiring the evaluator to be able to differentiate between 1% and 0.5% slope. Being able to do this will often require survey equipment to measure accurately.

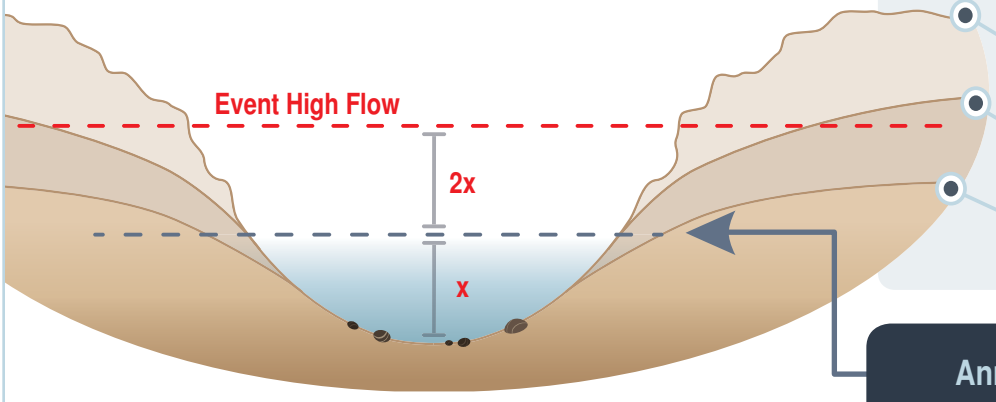
The **Entrenchment**, **Slope** and **Primary Streambed Material** of your stream can provide insight into its overall characteristic and can help determine appropriate stewardship and restoration techniques. The classification can also be a powerful tool in communicating issues found on your specific site with outside help, as discussed in *'Chapter 4: Engaging Outside Help'*.

Entrenchment

An understanding of the relationship of a stream to its floodplain is very important in developing a broader understanding of the processes that shape the stream. Entrenchment is a way of determining if a stream is 'connected' to its floodplain. A stream that is connected to its floodplain will allow water to flow onto the floodplain during seasonal runoffs and storm events. This is considered a natural and healthy function of a stream system.

Similar to a confined valley, an **entrenched** stream is one that cannot readily access its floodplain during flood flows. This confines the energy of the stream to the main channel, rather than allowing the energy to slow down and spread out into the floodplain. Conversely, streams that can easily access the floodplain are considered **not entrenched** and are able to disperse this energy across a greater area. This reduces the erosive forces within the main channel.

3 Types of Entrenchment:



**This graphic shows the differences of each type of possible entrenchment overlaid to demonstrate the physical differences between each type of entrenchment.*

Annual High Water Level

The level a stream will rise to from seasonal flows annually, not from a large flood. This is often called the Ordinary High Water Mark (OHWM or OHW).

What does your stream's entrenchment tell you?

Entrenched

An **entrenched** stream will often have high rates of erosion within its main channel during high flow events. The risk for erosion could be worsened when coupled with a finer streambed material, such as sand. Entrenched streams often naturally occur in mountainous areas with steeper valleys. Entrenched streams are also found in areas where a stream has experienced significant erosion.

Moderately Entrenched

A **moderately entrenched** stream will often exhibit erosive forces similar to entrenched streams. However, they can be minimized if and when flow spills onto the floodplain. Moderately entrenched streams can be seen throughout a watershed, but are most common in eroded areas. They will also be seen in transitional areas, where the mountains meet the plains.

Not Entrenched

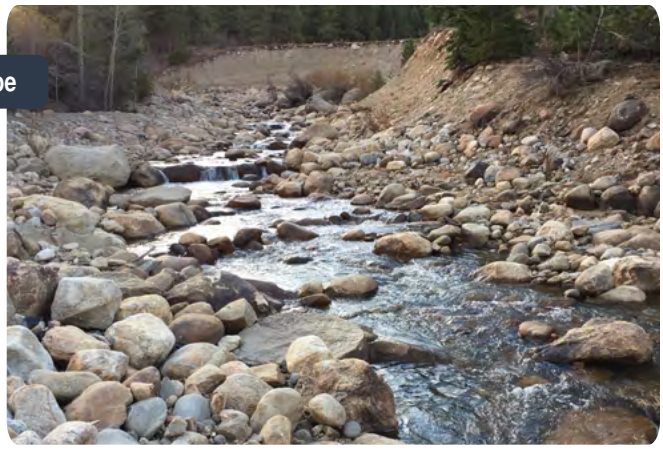
Streams that are **not entrenched** are most often found along the plains. These reaches disperse the power of high flows across a floodplain, reducing the potential for erosion. They can also be found in wider valleys and pockets between more confined stretches of the stream.

Stream Slope

The slope of a stream directly influences the velocity and characteristics of the stream's flow. This impacts the shape and behavior of this reach of the stream. Streams naturally shift to reach a balanced slope where the alignment and shape of the stream settles into a stable state. This balance, or equilibrium, is often achieved by meandering in unconfined valleys. Steeper slopes can also achieve a stable equilibrium in confined, mountainous valleys where the streambed material is large enough to withstand the erosive forces caused by the increased velocities. Ultimately, the slope of a stream can provide some indication of its stability. The slope of a stream can change quickly, and your property may have multiple ranges of slopes.

What does your stream's slope tell you?

Steep slopes are usually found in mountainous areas, and often result in increased velocities in the channel. Erosion from this can be a concern in areas with finer streambed materials like sand. Steep slopes are frequently associated with more entrenched streams where the flow is confined to the channel on either side.



Moderate slopes are common along the foothill areas where the mountainous terrain begins to flatten onto the plains. Flow velocities in reaches with a moderate slope can still cause erosion under certain conditions, especially when the stream is entrenched. Erosion of the stream may be less of a concern in non-entrenched reaches with a moderate slope.

A stream with a **gentle slope** will generally have lower velocities and reduced energy compared with steeper slopes. Streams with gentle slopes are usually found along the plains where they are able to find their equilibrium slope by meandering through their unconfined valley. Due to reduced velocities and overall energy, these streams can deposit any sediment picked up in higher energy (faster) areas upstream. Sediment deposition at these locations may cause shifts in the general stream alignment and shape.

Primary Streambed Material

The primary bed material of a stream refers the predominant size of rock or sand within the channel and along the streambanks. The streambed material affects the stream's capacity to resist erosion, transport and deposit sediment and the general shape of the channel. Generally, streams with gravel and sand bed material are more susceptible to changes during high flow events than streams with larger bed material such as cobble and boulders. Streams with finer bed material are more likely to erode and increase the amount of sediment in the water under high energy conditions. Similar to its slope, a stream will naturally adjust with its bed material to try to find a state of stable equilibrium.

What does your stream's entrenchment tell you?

Boulders

Streams with a primary bed material of **boulders** are usually found high in the watershed, in mountainous areas with steep hillsides. When stable, boulders have a strong resistance to erosion and usually dictate the path of the stream. Boulders are often associated with high energy streams that are frequently found in an entrenched setting with steep slopes.

Cobble

Cobble streams also have a higher resistance to erosion. Like boulders, cobble streams are typically found in mountainous areas where the energy within the stream is relatively high. Cobble has a lesser ability to dictate the path, so changes in stream alignment are still possible in less entrenched areas.

Gravel

Gravel bed streams can be found throughout a watershed. While they are less likely to transport fine sediment such as sand, they often do transport gravel size sediment.

Sand

Sand streambeds are the most susceptible to erosion and changes in path and channel shape. Finer bed material like sand can better host riparian vegetation, which may provide some additional channel stability.

CHAPTER

6

Stewardship Site Plans

This chapter looks at five actual sites within the Lefthand, Big Thompson, Little Thompson and Saint Vrain watersheds and demonstrates how the concepts presented in the Handbook can be applied to them. Each site is a privately-owned property with its own unique set of conditions. While all of the properties were impacted by the 2013 flood, each one was impacted differently and they have undergone varying levels of restoration efforts in the years since. Some of the properties were heavily damaged and others saw major changes in the floodplain but the houses and structures were undamaged. Some properties have already had large-scale restoration projects, while others have not had any outside assistance.

In order to demonstrate how the Handbook concepts could be applied to each site, the following pages will provide a brief introduction and a high resolution aerial image of the property. The aerial images were collected during the creation of this Handbook and are therefore in line with what the authors observed on-site. The pages then call out specific areas within the property and discuss what was observed. The observations range from large woody material, to streambank erosion, to crossing and culvert conditions, to upstream and downstream considerations.

Based on the observations, a list of possible strategies is provided. These strategies align with the strategy sheets in Chapter 3. Each landowner will need to review the strategy sheets in order to determine what options are the best for them and their property. In observing the properties, the authors not only considered projects the landowner can do themselves, but also projects that will require outside help. When this is the case, the area descriptions explain what type of outside help will be needed and why it is important to use them.


Oxford Reach (Left Hand Creek)
N. 81st St.
Scale
Feet
0
125
250
Oxford Rd.
K
J
I
H
G
B
D
F
C
E
B
A
A Revegetate Banks and Upland Areas
B Remove Debris Blocking Overflow Channel
C Structure in Floodplain
D Pedestrian Bridge across Creek
E Invasive Weed Management
F Revegetate Overflow Channel
G Stabilize Eroding Banks
H Remove Unused Fence Posts
I Concrete Rubble along Banks
J Remove Log Jam Blocking Overflow Channel
K Monitor Bridge Crossing

Oxford Reach (Left Hand Creek)

The Oxford Reach is comprised of five different property owners along Left Hand Creek. The creek generally stayed in the same location during the 2013 flood, although when it overtopped its banks, new overflow channels were formed, woody material collected in the floodplain and large amounts of sediment were deposited causing many trees in the area to die. Large areas of vegetation were also removed leaving many areas bare. Since the 2013 flood, some revegetation work has taken place but most of it is untouched. Many native grasses have returned although invasive weeds have also colonized the areas left bare of vegetation. Historically, the landowners have kept up with invasive weed management, but certain areas have had less management in recent years.

Entrenchment:	**Not Entrenched**
Stream Slope:	**Gentle**
Streambed Material:	**Cobble/Sand**
Environment:	**Rural Plains**
Land Use:	**Residential Neighborhood**

Recommended Strategies/Actions

- Monitor Large Woody Material
- Willow Stake Plantings
- Riparian Plantings
- Upland Plantings
- Wildlife Tree/Snag
- Overflow Channel/Backwater Area Management
- Monitor flood structure
- Floodplain Structure/Debris Removal
- Monitor pedestrian bridge and N. 81st bridge
- Crossings and Culvert Maintenance
- Invasive Weed Management
- Coir Log with Tubelings

Strategies/Actions Requiring Outside Help (Engineering & Permitting)

- Vegetated Soil Lift
- Terraced/Natural Channel Design
- Bank Stabilization

A **Revegetate Banks and Upland Areas:** Riparian and some upland areas on both sides of the creek lack vegetation or have been slow to revegetate naturally. Some revegetation work has been done around these areas but additional work can fill in the gaps to help bank stabilization and wildlife habitat. Native shrubs, willow stakes, cottonwood poles and upland and riparian seed should be considered for revegetation. This area is also very shady, so shade tolerant understory plants should be considered.

Strategies: *'Willow Stake Plantings'* [page 119], *'Riparian Plantings'* [page 101], *'Upland Plantings'* [page 109]

Creek banks can benefit from willow and riparian plantings

B **Remove Debris Blocking Overflow Channels:** Woody material has accumulated between trees in the overflow channel and formed debris dams in some places. While woody material does provide valuable wildlife habitat and you generally want to leave woody material in place if it is not in the direct flow of the creek, this material is blocking overflow channels that should see active flows. These dams have the potential to redirect water in the floodplain causing unforeseen effects and potential damage. These blockages should be removed as soon as possible to prevent future issues and allow water into the overflow channels, activating the plant communities and creating a healthier floodplain.

Strategies: *'Wildlife Tree/Snag (Dead Wood)'* [page 117], *'Overflow Channels and Backwater Areas'* [page 98]

Debris dam blocking overflow channel should be removed

C **Floodplain Structure:** A small building is located approximately 10 yards back from the creek, just west of the pedestrian bridge crossing. The structure does not have electricity or utilities and is mostly used as a covered space to spend time near the creek. Remarkably this structure survived the 2013 flood with no structural damage. Sediment was deposited inside of the structure and minor aesthetic issues occurred. While this structure is often enjoyed by the landowner, it does provide an example of how structures function in a floodplain and potential challenges they can face. If the structure becomes unused, the landowner should consider removing it to avoid complications in future flood events.

Strategies: Monitor structure, ***'Floodplain Debris (non-woody) & Structure Removal'*** *[page 90]*

Small shed near the creek is in the floodplain

D **Pedestrian Bridge Across Creek:** The original pedestrian bridge crossing at this location was built by the landowner's son. Unfortunately, it was destroyed during the 2013 flood and is currently being rebuilt. While it functions well at low and moderate flows it has the potential to either catch debris or become debris in high flow events. The landowner should pay close attention to how it functions during a high flow and determine if it is at risk of catching debris or becoming structurally unstable. The original bridge was designed so that it could be raised from one side, avoiding the risks of catching debris or becoming debris itself during a flood. The landowner should consider adding a similar design feature to the new bridge as they complete design and construction. The bridge could either be designed so it can be raised from one side, or it can be designed as a 'break-away' bridge. A 'break-away' bridge would allow the connection at **one side** of the bridge to break away during a flood. The bridge stays attached at the other side and is designed to swing to that side of the creek, out of the path of the heaviest creek flows. These designs would involve working with engineers to ensure proper structure design and avoiding floodplain impacts. Bridge crossings such as this should be permitted by the County for floodplain impacts.

Strategies: Monitor bridge, ***'Crossing & Culvert Maintenance'*** *[page 87]*, ***'Crossing/Culvert Enhancements'*** *[page 86]*

E **Manage Invasive Plant Species:** There are invasive plants throughout the entire reach, but the area outlined on the map is particularly established with invasive plants since the 2013 flood. Native plants have been out-competed and the invasive plants have taken over. Canada Thistle is one of the most prevalent invasive plants here. After removing the invasives either physically (pulling them out of the ground) or chemically with an aquatics approved herbicide, the landowners should plant desirable species so that the invasive plants have more difficulty returning.

Strategies: *'Invasive Weed Management'* [page 95], *'Upland Plantings'* [page 109]

Invasive plants, including Canada Thistle, must be continually managed

F **Revegetate Overflow Channel:** Within this area, the overflow channel would greatly benefit from revegetation. There were large amounts of sediment deposited from the 2013 flood, which could be a reason why plants have died off here. Plants such as Sandbar Willows will grow very well in this sediment as long as they are close enough to the water table. Riparian seeding is also a good option in this area. For plantings further away from the water table, organic matter and/or soil amendments may be required to help native upland plants establish.

Strategies: *'Willow Stake Plantings'* [page 119], *'Riparian Plantings'* [page 101], *'Upland Plantings'* [page 109], *'Overflow Channels and Backwater Areas'* [page 98]

Overflow channel can be revegetated to provide stabilization and wildlife habitat/food

Vertical cut bank on the outer bend of the creek

G **Stabilize Eroding Banks:** Overall there is very little erosion on this reach. However, the southern bank on the downstream end is eroding and should be stabilized. The water has been cutting into the bank during periods of high flow creating a vertical bank. No infrastructure is affected by this erosion but if not checked it will continue to erode reducing private property and negatively impacting the creek by releasing more sediment into it. It is recommended that the bank be rebuilt to be sloped or terraced with a hardened toe such as a boulder or log toe. These strategies will involve working in the creek and will require outside help, such as engineers, to help design and permit the project. This will ensure that the project does not impact neighboring lands or downstream properties negatively. Depending on the landowner's experience, they may be able to install some of these strategies on their own **after** going through the design and permitting process with outside help.

Strategies: ***'Vegetated Soil Lift'*** *[page 111]*, ***'Coir Logs with Tubelings'*** *[page 83]*, ***'Bank Stabilization'*** *[page 79]*, ***'Terraced/Natural Channel Design'*** *[page 106]*

Vertical cut bank on the outer bend of the creek needs stabilization

H **Remove Fence Posts From Channel:** At this location in the property, there are a handful of older fence posts that appear to be unused. They are within the floodplain and some are within the main channel. These fence posts should be removed in order to avoid creating blockages during flood events. The fence should not be rebuilt across the creek.

Strategy: *'Floodplain Debris (non-woody) & Structure Removal'* [page 90]

I **Concrete Rubble Along Banks:** Concrete rubble has been placed along the bottom of the banks most likely to prevent erosion. While this approach is effective, it has no benefits to water quality or the ecosystem. Removal at this point in time may be problematic and not feasible for the landowner, however planting willow stakes in between the pieces of concrete will add additional support to the structures and improve habitat by shading the water. If/when the landowner decides to remove the concrete, an engineer or qualified river constructor should be contacted to develop a plan for removing the concrete while stabilizing the bank and avoiding negative impacts to the creek.

Strategies: *'Floodplain Debris (non-woody) & Structure Removal'* [page 90], *'Bank Stabilization'* [page 79], *'Willow Stake Plantings'* [page 119]

J **Remove Log Jam Across Overflow Channel:** Large woody material has fallen across the creek directly upstream of N. 81st Street and is collecting debris creating a blockage. This large woody material should be removed immediately and relocated to be used as a wildlife snag elsewhere on the property if possible.

Strategies: *'Wildlife Tree/Snag (Dead Wood)'* [page 117], *'Overflow Channels and Backwater Areas'* [page 98]

Large woody material fallen across the creek and creating a blockage

K **Bridge Crossing:** North 81st Street crosses Left Hand Creek directly downstream of this project area. The landowners need to aware of this crossing and should be quick to contact their local Office of Emergency Management if they have questions about large woody material or debris on their property. If there is large woody material or debris that is in the creek channel and poses an immediate risk of creating a blockage at the bridge, the Office of Emergency Management should be contacted. Large woody material should be relocated on-site to areas away from the creek channel. They can then serve as valuable wildlife habitat.

Strategies: Monitor bridge, Contact OEM if threat seems imminent, *Floodplain Debris (non-woody) & Structure Removal'* [page 90], *'Wildlife Tree/Snag (Dead Wood)'* [page 117]


Floyd Property (Little Thompson River)
CR 17
N
Scale
0
75
150
Feet
A
G
F
E
C
D
B
C
C
A
A Overly Wide Channel
B Dead Wood in Floodplain
C Stabilize Pond Inlet/Outlet
D Newly Formed Pond
E Riparian Buffer
F Vegetate Riparian Bench
G Invasive Weed Management

Floyd Property (Little Thompson River)

The Floyd Property is a private residence located outside of Berthoud along the Little Thompson River. The 2013 flood widened the channel and deposited sediment, raising the elevation of the river. Much of the aquatic habitat was destroyed and some bank erosion occurred as the river widened. A new pond and wetland areas were created by the flood. While the stream is generally 'healing' itself, the landowners do want to know what they can do to improve habitat and ecosystem function along the river and around the new pond/wetlands.

There is an irrigation diversion downstream of this property, and the landowners need to be aware of the diversion and its operations. This could impact the property by changing the channel's slope and creating a need for grade control structures.

Entrenchment:	**Not Entrenched**
Stream Slope:	**Gentle**
Streambed Material:	**Sand**
Environment:	**Plains**
Land Use:	**Rural Residential**

Recommended Strategies/Actions

- Willow Stake Plantings
- Riparian Plantings
- Wildlife Tree/Snag
- Bank Stabilization
- Invasive Weed Management
- Upland Plantings

Strategies/Actions Requiring Outside Help (Engineering & Permitting)

- Terraced/Natural Channel Design
- Sediment Removal
- Wetlands Creation/Expansion
- Bank Stabilization

A **Sedimentation and Overly Wide Channel:** The Little Thompson River experienced heavy sedimentation and channel widening during the 2013 flood. This has resulted in the post-flood river having multiple channels with minimal flows. Despite the sedimentation, vegetation is re-establishing along the banks and the stream is trying to establish a new single channel, which is what you would expect to see in this area. The landowner should continue to allow the river to re-form into a single channel, but they can also do some simple things to help it along. With the help of engineers, environmental scientists and/or river constructors, they can create a plan to remove select areas of sedimentation, re-shape the banks to create bankfull and floodplain terraces. They can also use willow stakes, riparian seed and wetland sod to establish vegetation quickly in these areas.

Strategies: *'Terraced/Natural Channel Design'* *[page 106]*, *'Sediment Removal'* *[page 104]*, *'Willow Stake Plantings'* *[page 119]*, *'Riparian Plantings'* *[page 101]*

Multiple wide channels are resulting in shallow flows and sediment deposits

B **Dead Wood in Floodplain:** Woody material was deposited by the river during the 2013 flood and existing cottonwood trees have since died due to sedimentation, resulting in additional dead woody material. Much of this material was already removed or relocated by the landowner. This woody material can still provide valuable habitat for wildlife, as well as organic matter to the soils. This material is not in a location that poses a hazard to the downstream bridge.

Strategies: *'Wildlife Tree/Snag (Dead Wood)'* *[page 117]*

Dead wood can provide valuable wildlife habitat and organic material for plant growth

C **Stabilize Pond Inlet/Outlet:** When the new pond was created, inlets and outlets that connect the pond to the river were created. Because these are newly formed, increased stabilization will help them to stay in place. It will also limit the amount of sediment that is released into the river as the result of erosion. A wetland specialist and/or engineer should be contacted to develop a comprehensive strategy for the pond, including creating stabilizing inlets/outlets. Currently, the pond is not stagnant and any inlet/outlet changes should avoid creating stagnant water.

Strategies: *'Wetland Creation/Expansion'* [page 113], *'Bank Stabilization'* [page 79], *'Willow Stake Plantings'* [page 119]

D **New Pond Management:** The landowner would like to improve the wetland habitat in and around the new pond and use it for aesthetic, wildlife viewing or fishing opportunities. Wetlands are sensitive environments and although this one formed naturally, the landowner must first understand what can be done to wetlands before addressing the associated issues. An environmental scientist and/or hydraulic engineer should be engaged to discuss possible strategies ranging from revegetation, to weed management, to wildlife habitat improvements, to stocking the pond with fish. As the pond holds water, any changes to the volume of the pond would need to involve outside assistance to address any possible water rights concerns that arise.

Currently, the new pond is over-colonized with cattails lining the banks. When a vegetation community has only one main type of plant, it discourages other plants from establishing. One of the reasons that they have not taken over the entire pond is because the pond is deep enough to limit their growth. The landowner may be allowed to remove a portion of the cattails themselves, but they need to contact their local permitting agency first. After removal, wetland plants such as bulrush, burreed and arrowhead should be considered to vary the types of plants growing around the pond. Willow stakes and cottonwood poles can be planted further away from the standing water of the pond.

Aerial view of the pond

Strategies: *'Wetland Creation/Expansion'* [page 113], *'Bank Stabilization'* [page 79], *'Willow Stake Plantings'* [page 119]

Dense cattails along the pond banks discourage other plants from establishing

E **Add Riparian Buffer along River:** Currently there is not much of a buffer between the mowed area of the yard and the top of the river bank. By simply not mowing as close to the river bank, the landowner can create a better riparian buffer for wildlife and vegetation. The landowner can also plant additional upland plants such as wild plum, wildflowers or showy milkweed. Showy milkweed is both a host plant and a nectar source for monarch butterflies.

Strategy: ***'Riparian Plantings'*** *[page 101]*, ***'Upland Plantings'*** *[page 109]*

A wider buffer along the river will promote bank stability, riparian vegetation and wildlife habitat

F **Riparian Bench:** Riparian benches are starting to form along the entire river. In some of these areas, vegetation is coming back naturally and should be left to continue growing. The riparian bench directly upstream from the County Road 17 bridge is still being formed and has been slow to revegetate. In this area, the landowner can help promote the revegetation by planting willow stakes and seeding with a riparian seed mix with species that grow well in sandy soils. These willow stakes will also filter/sift sediment out of the river over time. This will create more of a riparian bench that will stabilize the ground between the river and the vertical bank that currently exists on the south side of the river.

Strategy: ***'Riparian Plantings'*** *[page 101]*, ***'Willow Stake Plantings'*** *[page 119]*

Riparian bench will form quicker with added vegetation

G **Russian Olives and Canada Thistles:** A few Russian Olive trees and some patches of Canada Thistle have established just upstream of the County Road 17 bridge and on the north side of the river. The Russian Olive trees should be removed and the stumps should be ground or removed to prevent re-establishment. The stumps can also be treated with an aquatics approved herbicide. The Canada Thistle can be removed either physically by pulling the plants out of the ground, or chemically with an aquatics approved herbicide. Care must be taken to not dump any soil or sediment into the river when removing the plants, or to not spray herbicide into the water. In order to prevent re-establishment, the landowner should plant the weeded areas with willows near the river and upland trees and shrubs further away from the river.

Strategy: *'Invasive Weed Management' [page 93]*, *'Upland Plantings' [page 109]*


Parrish Property (Little Thompson River)
A
E
E
F
D
Parrish Rd.
D
C
B
A
N
Scale
Feet
0
100
200
A Add Channel Complexity
B Remove Fence
C Re-align Channel and Revegetate
D Stabilize Banks
E Willow Revegetation
F Monitor Grade Control Structures and Diversion

Parrish Property (Little Thompson River)

The Parrish Property is a working cattle ranch and event center on the Little Thompson River between Lyons and Berthoud. The property has been in the family since the 1950's and the property owner is heavily involved in the community. The 2013 flood saw the river shift to the southeast, eroding into the adjacent Rabbit Mountain. The flood also caused heavy sedimentation, a reduction in aquatic habitat and the loss of large amounts of vegetation. A rare plant species (Bells Twin Pod) is present on the property. While not listed as a location specific strategy, care should be taken across the entire property to avoid impacting this species and it's habitat. This includes preventing invasive weeds from spreading into it's habitat.

An Emergency Watershed Protection (EWP) project has been approved for this area and plans have been developed although no funding is currently available for construction. These engineered plans use root wads and grading to re-align the river channel and stabilize the banks, which is a crucial first step to restoring this area.

Entrenchment:	**Not Entrenched**
Stream Slope:	**Gentle**
Streambed Material:	**Sand**
Environment:	**Rural Plains**
Land Use:	**Commercial Ranch**

Recommended Strategies/Actions

- Livestock Management
- Floodplain Structure/Debris Removal
- Riparian Plantings
- Willow Stake Plantings
- Upland Plantings
- People Places Along your Stream
- Monitor and Observe in-Channel Structures

Strategies/Actions Requiring Outside Help (Engineering & Permitting)

- Constructed Riffles
- LUNKERS Boxes
- Root Wads
- Boulder Clusters
- Log Rollers
- Stream/Channel Re-Alignment
- Sediment Removal
- Vegetated Soil Lifts
- Bank Stabilization
- Drop Structures

A **Add Channel Complexity:** The main channel in this reach lacks a variety of in-river features such as riffles, pools and boulder clusters. This makes it much tougher for aquatic organisms to survive in the river. If the landowner would like to improve fish habitat, they should consider adding boulder clusters, riffles and/or log rollers. Other options include cross-vanes, j-hooks and root wads. Cross-vanes and j-hooks have already been installed downstream of this stretch of the river. The EWP plans propose a number of root wads, which would greatly improve the channel complexity of the river in this area. As all of these involve working directly in the river and some of these structures would affect the river's slope, they would require engineering and permitting for environmental and floodplain impacts.

Strategies: *'Constructed Riffle'* [page 85], *'Root Wads'* [page 103], *'Log Rollers'* [page 96], *'LUNKERS Boxes'* [page 97], *'Boulder Clusters'* [page 82], *'Drop Structures'* [page 88]

Adding channel complexity elements will improve aquatic habitat

B **Remove Fence:** Currently, there is a barbed wire fence crossing the river for cattle/livestock control. Unfortunately, this design of fence can also catch debris very quickly and cause a blockage on the river. This will push the water out to the sides of its main channel and could cause damage. If there is a need to control livestock in this area, there are other fence designs that will allow debris to pass through them. The most common is a single wire high above the water with vertical pieces (such as PVC pipe) that hang down from the wire. They are not connected at the bottom, which prevents them from catching debris and creating a blockage. There are also electrified versions (similar to electric cattle fences) of these 'floodgate' fences that are designed to turn off the electricity once they come into contact with the water.

Strategy: *'Livestock Management'* [page 95], *'Floodplain Debris (non-woody) & Structure Removal'* [page 90]

The current fence can catch debris and create a blockage

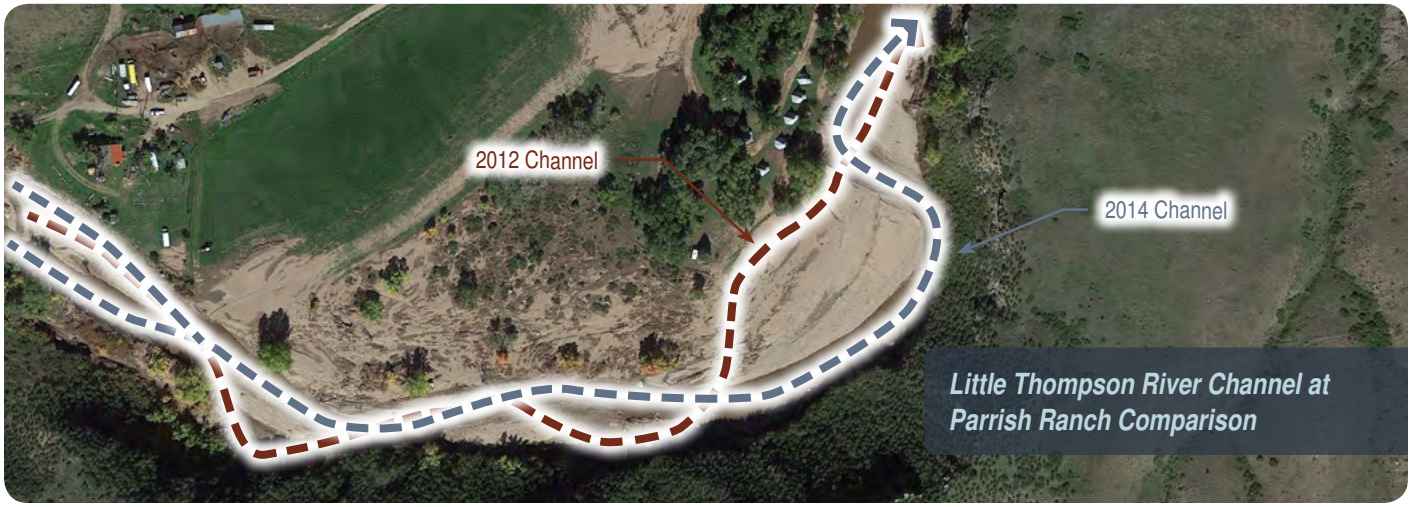
C **Re-align River and Revegetate:** In this area, the Little Thompson River shifted to the southeast during the 2013 flood. Not only did this deposit large amounts of sediment on the inner bend of the river, but it also removed a lot of healthy plant communities in the same area. On the outer bend, the river moved and eroded into Rabbit Mountain. This brought even more sediment into the river and is an immediate concern for erosion and bank stability. The engineered plans developed by EWP address these issues by re-aligning the river closer to its pre-2013 flood alignment and stabilizing the banks with root wads. If possible, this work should be installed to address the most immediate concerns.

After this work is completed, the new banks should be vegetated with wetland sod, riparian seeding, willow stakes, cottonwood poles and other riparian plantings. Disturbed areas further away from the creek should be re-seeded with native grassland seed mixes and planted with native drought tolerant plants.

If funding does not become available for the EWP plans to be installed, the landowner should still work with the Little Thompson Watershed Coalition (LTWC) to find a solution to stabilize the erosion on the outer bend and create a more stable river system. This will require outside engineering and permitting help to properly address environmental and floodplain impacts. In the meantime, the landowner can work on revegetating the inner bend that used to be the main river channel. Given that this area may change with future work, they could consult with the LTWC and the engineer who prepared the EWP plans to develop a strategy that will have some positive immediate effects between now and when the final project is installed.

Strategy: *'Stream / Channel Re-Alignment' [page 105], 'Root Wads' [page 103], 'Sediment Removal' [page 104], 'Riparian Plantings' [page 101], 'Willow Stake Plantings' [page 119], 'Drop Structures' [page 88], 'Geotextiles' [page 91]*

2012 Little Thompson River Channel at Parrish Ranch



Little Thompson River Channel at Parrish Ranch Comparison

D **Stabilize Banks:** On the west side of the river, immediately downstream of the campground, the banks are eroding heavily in some areas. The area behind these banks is used for performances and as an activity space during events. The bank erosion is decreasing this valuable space and limits the potential for safe river access. There is also some bank erosion on the east side of the river, just downstream of the event space. For all of these areas, both "hard" and "soft" bank stabilization measures should be considered to prevent further erosion while increasing habitat, access and views/aesthetics. Some of these strategies can impact the river's floodplain and environment and outside help will be needed for design and permitting.

Strategies: *'Bank Stabilization'* [page 79], *'Root Wads'* [page 103], *'Vegetated Soil Lift'* [page 111], *'LUNKERS Boxes'* [page 97], *'People Places Along Your Stream'* [page 99]

Bank erosion is compromising desirable activity space

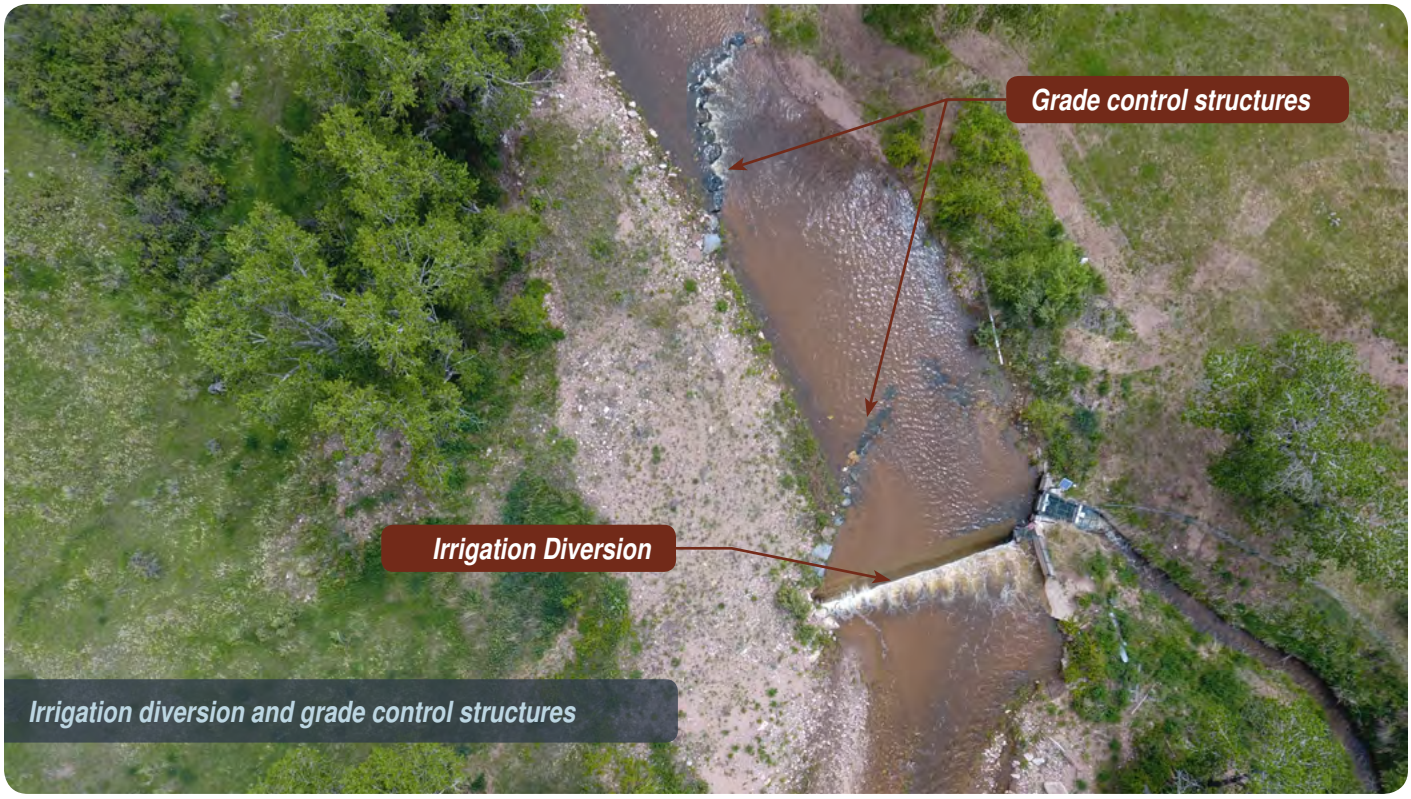
E **Willow Revegetation:** In these areas, some willows and other riparian plants are beginning to re-establish. The landowner can help these area re-establish quicker by adding some more willow stakes. The area is close enough to the water table that they will be able to easily reach water and grow quickly.

Strategy: *'Willow Stake Plantings'* [page 119]

Riparian bench area will benefit from willow plantings

F **Grade Control Structures and Diversion:** At the downstream end of this project area, a number of grade control structures have been installed. There is also a large irrigation diversion structure. The landowner needs to continue to be aware of the diversion structure as it could impact the property by changing the channel's slope and how the river transports sediment. The landowner can also observe the grade control structures (cross-vanes and j-hooks) during varying flows to see how they affect the water and how they protect areas from erosion.

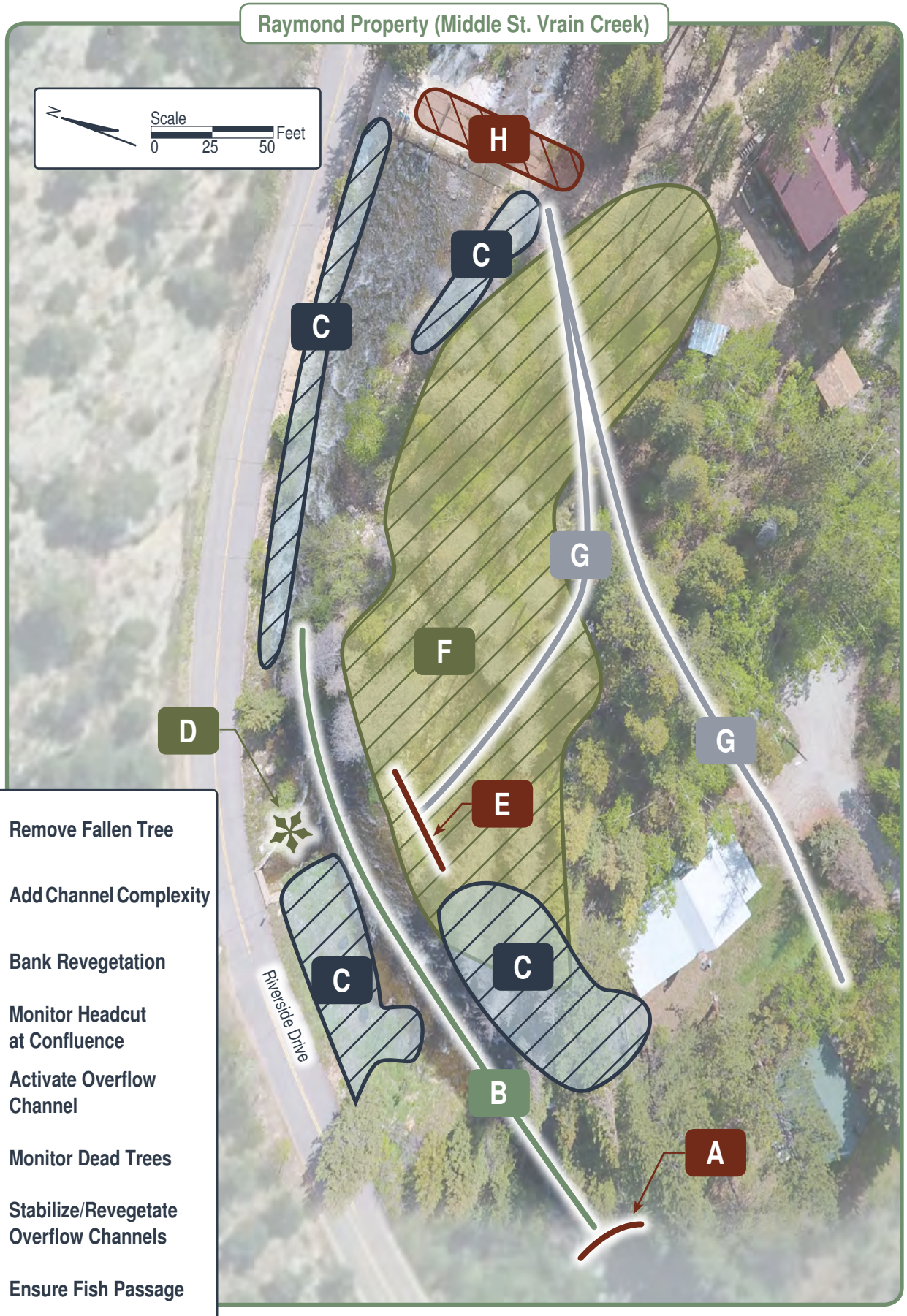
Strategy: Monitor and Observe Structures



Irrigation diversion and grade control structures

Grade control structures on the Little Thompson River

Raymond Property (Middle St. Vrain Creek)



- **A** Remove Fallen Tree
- **B** Add Channel Complexity
- **C** Bank Revegetation
- **D** Monitor Headcut at Confluence
- **E** Activate Overflow Channel
- **F** Monitor Dead Trees
- **G** Stabilize/Revegetate Overflow Channels
- **H** Ensure Fish Passage

Raymond Property (Middle St. Vrain Creek)

This property is situated in the small mountain community of Raymond. Most of the creek banks in the area are under the ownership of a single person and there are several landowners adjacent to the creek banks. This reach of the Middle St. Vrain Creek was dredged after the 2013 flood and some of that sediment was moved to protect houses and structures that are in the floodplain. Some bank revegetation work has been done and it is beginning to establish in some areas. A tributary, Cave Creek enters Middle St. Vrain Creek within this project area.

Entrenchment:	**Moderate**
Stream Slope:	**Steep**
Streambed Material:	**Boulder & Cobble**
Environment:	**Mountain valley**
Land Use:	**Rural residences**

Recommended Strategies/Actions

- Call local Office of Emergency Management (OEM) if fallen trees pose immediate risk
- Wildlife Tree/Snag
- Willow Stake Plantings
- Riparian Plantings
- Monitor creek confluence
- Monitor standing dead trees
- Overflow Channel/Backwater Area Management

Strategies/Actions Requiring Outside Help (Engineering & Permitting)

- Boulder Clusters
- Log Rollers
- Constructed Riffle
- Overflow Channel/Backwater Area Management
- Fish Passage

A **Remove Fallen Tree across Creek:** At the western limit of this project area, a large evergreen tree has recently fallen and is blocking the creek. If this is not removed quickly, it will continue to back up flows and force the water towards cabins. The tree should be removed from the channel as soon as possible.

Strategies: Remove fallen tree, *'Wildlife Tree/Snag (Dead Wood)'* *[page 117]*

Fallen tree is blocking water and creating a dam

B **Add Channel Complexity:** From the fallen tree to just downstream of the Cave Creek confluence, the creek channel does lack complexity. The channel is fairly straight with uniform banks and there are not many areas for fish to hide. If the landowner would like to improve fish habitat, they should consider adding boulder clusters. Other options may include log rollers or constructed riffles. As all of these involve working directly in the creek and riffles would affect the creek's slope, they would require engineering and permitting for environmental and floodplain impacts.

Strategies: *'Boulder Clusters'* *[page 82]*, *'Log Rollers'* *[page 96]*, *'Constructed Riffle'* *[page 85]*

Stretch of creek lacking complexity for fish habitat

C **Bank Revegetation:** In the areas west of Cave Creek, there are many grasses becoming established after the 2013 flood. While it is good to have vegetation growing here, introducing larger, woody vegetation will provide more stabilization for the bank, as well as providing shade and cover on the creek for fish habitat. Areas east of Cave Creek have less vegetation in general and would benefit from bank revegetation. The area on the south side of Middle St. Vrain Creek and just west of the driveway crossing has a deeper pool along the edge of the creek, but no vegetation to shade it. Adding woody vegetation will shade the creek and provide better fish habitat in the pool.

Strategy: *'Willow Stake Plantings' [page 119]*

Grasses established along the north bank, west of Cave Creek; willow plantings will stabilize the bank and provide shade on creek

D **Monitor Headcut at Confluence:** As Cave Creek flows into the Middle St. Vrain Creek, it creates the potential for headcutting on Cave Creek. A headcut is an abrupt vertical drop in a stream and it will typically erode upstream as it progresses. A headcut could threaten the bridge by eroding the area around the abutments. The landowners should monitor the area and if they observe a headcut forming, they should engage their coalition and/or hydraulic engineers to help develop solutions to the problem. In the immediate future, the landowners can plant willow stakes in the area on the north side of the Middle St. Vrain Creek, just downstream of the bridge abutment (see picture above).

Strategies: Monitor Cave Creek upstream of confluence, *'Willow Stake Plantings' [page 119]*

Willows can stabilize the shaded area

E **Activate Overflow Channel(s):** Just downstream of the Cave Creek confluence there is a low spot on the south side of Middle St. Vrain Creek that feeds overflow channels. However, field observations showed that the overflow channel is partially blocked off and is not quite low enough to fully activate the overflow channel. In order to better activate the plant communities in these areas and spread out high flows, lowering this barrier should be considered. This will impact the creek and the floodplain and an engineer should be consulted to evaluate how much the barrier should be lowered in order to minimize any negative impacts to the properties.

Strategies: *'Overflow Channels and Backwater Areas' [page 98]*

Overflow channel spurring off of the main channel

F **Dead Tree Monitoring:** On the south side of Middle St. Vrain Creek, there are a number of very large dead trees, most of which are still standing. While these do not pose a risk currently, they should be monitored. Landowners should monitor the area and be prepared to remove or relocate the dead wood if it falls across the creek, causing a blockage. Additionally, if the dead standing trees become a potential risk to a house or structure, the landowner should consult an arborist about removing the troublesome branches/trees.

Strategies: Monitor the dead trees and once they fall, *'Wildlife Tree/Snag (Dead Wood)' [page 117]*

Dead trees can fall and block channels

Dead trees on the south banks

G **Stabilize and Revegetate Overflow Channels:** South of Middle St. Vrain Creek, there are a few different overflow channels that likely see water during higher flows. Currently, these have some eroding banks which can be easily stabilized with vegetation. Some of these bank areas are cobble, which willow stakes will grow in well, as long as they are planted close enough to the water table. The landowners will need to careful not to create large blockages in the overflow channels and should be aware of changes happening in these areas. They should pay close attention to when water is flowing into the overflow channels and how far it reaches on their land. This will provide them with better information to discuss with outside help if they decide to make more significant changes to the land that would require engineering.

Strategies: *'Willow Stake Plantings'* *[page 119]*, *'Overflow Channels and Backwater Areas'* *[page 98]*, *'Riparian Plantings'* *[page 101]*

Overflow channel/backwater area in need of vegetative stabilization

H **Ensure Fish Passage:** At the downstream end of this project area there is a driveway low water crossing of Middle St. Vrain Creek. The landowners should observe the crossing both at high and low water to try to determine if fish can move upstream through the crossing. At high water, they can visually observe how quickly the water is moving and if fish are visible. During low water, they can take note of how high a fish would have to jump to move upstream at any vertical drops in or around the structure. In order to jump this height, they also need a deep enough pool below the drop to build up the energy. Local conservation groups, as well as Colorado Fish and Wildlife can be consulted about if fish can pass through the structure. If the low water crossing is a fish barrier, outside help (engineers, biologists and/or river constructors) should be contacted to help the landowner design, permit and built a fish ladder or fish passage structure.

Strategies: Monitor and Ensure Fish Passage, *'Fish Passage'* *[page 89]*


Toland Property (Big Thompson River)
N County Road 31D
N
Scale
0
75
150
Feet
E
D
C
B
A
Highway 34/Big Thompson Road
A Handy Ditch Diversion
B Revegetate Riparian Bench
C Add Channel Complexity
D Bank Revegetation
E Monitor Downstream Bridge

Toland Property (Big Thompson River)

This project area is situated directly downstream of the Handy Ditch Diversion and 'The Narrows' of the Big Thompson River canyon. The area includes 3 residential properties that are owned by the same person. The 2013 flood cause major damage to the properties, including the destruction of 2 100+ year old homes. The landowner built two new cottages further away and higher up from the river. While some areas of the properties are well vegetated with riparian trees, grasses and shrubs, other areas are having difficulty with establishing plant communities.

Entrenchment:	**Moderate**
Stream Slope:	**Moderate**
Streambed Material:	**Cobble**
Environment:	**Foothills transition**
Land Use:	**Rural residences**

Recommended Strategies/Actions

- Become familiar with diversion flows & functions
- Willow Stake Plantings
- Riparian Plantings
- People Places Along your Stream
- Wildlife Tree/Snag
- Monitor bridge crossing and contact local OEM if woody material poses an immediate threat
- Floodplain Structure/Debris Removal

Strategies/Actions Requiring Outside Help (Engineering & Permitting)

- Fish Passage
- Boulder Clusters
- Log Rollers
- Constructed Riffles

A **Handy Ditch Diversion:** The Handy Ditch Diversion is directly upstream of the property and it is important that the landowner recognizes the functions and limitations of this structure. The structure diverts water from the Big Thompson mainly for agricultural irrigation in the Cache la Poudre valley. Having a large diversion structure directly upstream means that flows can quickly and dramatically change. The landowner should be familiar with the typically flow changes that occur with agricultural growing seasons as these will affect the river on their property. From an aquatic habitat perspective, the structure is a fish barrier that prevents aquatic organisms from moving further upstream into the canyon. If the structure needs repairs or replacement in the future, fish ladders or other types of fish passage could be considered.

Strategies: Become familiar with diversion flows, ***'Fish Passage'*** *[page 89]*

B **Riparian Bench Revegetation:** Just downstream of the dam and on the north side of the river, there is riparian bench that does not have much vegetation, if any. This riparian bench is an area that is close to the river and will have water flowing over it during higher flows. As a result, this area will be able to support healthy riparian plants like willows and cottonwoods. Willows and cottonwoods will also stabilize the loose soils on the river banks and provide shade and cover for fish in the river.

Strategy: ***'Willow Stake Plantings'*** *[page 119]*, ***'Riparian Plantings'*** *[page 101]*, ***'People Places Along Your Stream'*** *[page 99]*

C **Add Channel Complexity:** This stretch of the river lacks complexity that could improve aquatic and wildlife habitat. The channel is fairly straight with uniform banks and there are not many areas for fish to hide. If the landowner would like to improve fish habitat, they should consider adding boulder clusters. Other options may include log rollers or constructed riffles. As all of these involve working directly in the river and riffles would affect the creek's slope, they would require engineering and permitting for environmental and floodplain impacts.

Strategies: *'Boulder Clusters'* [page 82], *'Log Rollers'* [page 96], *'Constructed Riffle'* [page 85]


Stretch of river lacking complexity

D **Bank Revegetation:** On the south bank of the river, there are some grasses growing, but overall there is not much vegetation. Introducing larger, woody vegetation will provide more stabilization for the bank, as well as providing shade and cover on the river for fish habitat. The landowner can also use willow plantings to frame, or block certain views to and from Highway 34.

Strategy: *'Willow Stake Plantings'* [page 119], *'Riparian Plantings'* [page 101], *'People Places Along Your Stream'* [page 99]


Looking downstream


Revegetation will help stabilize the south banks

E **Downstream Crossing:** North County Road 31D crosses the Big Thompson River directly downstream of this project area. The landowner needs to aware of this crossing and should be quick to contact their local Office of Emergency Management if they have questions about large woody material or debris on their property. If there is large woody material or debris that is in the river channel and poses an immediate risk of creating a blockage at the bridge, the Office of Emergency Management should be contacted. Large woody material should be relocated on-site to areas away from the creek channel. They can then serve as valuable wildlife habitat.

Strategies: Monitor bridge, Contact OEM if concerned, *'Wildlife Tree/Snag (Dead Wood)'* [page 117], *'Floodplain Debris (non-woody) & Structure Removal'* [page 90]

Bibliography/Sources Cited:

1. **Steward**. (n.d.). Retrieved July 31, 2017, from http://www.macmillandictionary.com/us/dictionary/american/steward
2. **Waterway**. (n.d.). Retrieved July 20, 2017, from http://www.dictionary.com/browse/waterway?s=t
3. **Ecosystem**. (n.d.). Retrieved May 13, 2017, from http://www.dictionary.com/browse/ecosystem?s=t
4. **Riparian**. (n.d.). Retrieved June 18, 2017, from http://www.dictionary.com/browse/riparian
5. **Watershed**. (n.d.). Retrieved July 19, 2017, from http://www.dictionary.com/browse/watershed?s=t
6. **Smith, Justin (Photographer)**. (2013). *Narrows in Big Thompson* [digital image]. Retrieved May 14, 2017, from https://www.facebook.com/SheriffJustinSmith/photos/a.415768821844966.100567.407464109342104/503206203101227/?type=3&theater Used under Creative Commons Attribution 2.0 Generic
7. **Canada Thistle** (n.d.). Retrieved July 23, 2017, from https://www.colorado.gov/agconservation/Factsheets/CanadaThistleFactSheet.pdf
8. **Scotch Thistle** (n.d.). Retrieved July 23, 2017, from https://www.colorado.gov/agconservation/Factsheets/ScotchThistleFactSheet.pdf
9. **Russian Olive** (n.d.). Retrieved July 23, 2017, from https://www.colorado.gov/agconservation/Factsheets/RussianOliveFactSheet.pdf
10. **Wechsler, Doug/VIREO (Photographer)**. Retrieved July 25, 2017, from http://www.audubon.org/field-guide/bird/peregrine-falcon
11. **Curtis, Rob/VIREO (Photographer)**. Retrieved July 25, 2017, from http://www.audubon.org/field-guide/bird/canada-goose
12. **Brian E. Small/Vireo (Photographer)**. Burrowing Owl. Retrieved September 29, 2017, from http://www.audubon.org/field-guide/bird/burrowing-owl
13. **Colorado Parks and Wildlife (Photographer)**. Lynx in Winter. Retrieved July 25, 2017, from http://cpw.state.co.us/learn/Pages/SpeciesProfiles.aspx
14. **Colorado Parks and Wildlife (Photographer)**. Mountain Lion. Retrieved July 25, 2017, from http://cpw.state.co.us/learn/Pages/SpeciesProfiles.aspx
15. **Maccaferri (Photographer)**. Coir Log with Plantings. Retrieved July 19, 2017, from http://maccaferri.com/ca/wp-content/uploads/2015/03/Coir-Log-e1455017882635.jpg
16. **Coleman Moore Company (Photographer)**. Coir Log with Plantings. Retrieved July 19, 2017, from http://www.colemanmoorecompany.com/application/261/
17. **BHA Design (Photographer)**. Coir Log with Plantings. Retrieved July 26, 2017, from http://bhadesign.com/portfolio/cipo-canal-importation-ponds-outfall/
18. **E-Science News (Photographer)**. Beaver Dam Analogue. Retrieved July 26, 2017, from http://esciencenews.com/files/images/2016071012868111.jpg
19. **Geosyntec (Photographer)**. Boulder Clusters. Retrieved July 26, 2017, from geosyntec.com/npsmanual/image/boulderclustersrockriffles.jpg
20. **True North Trout (Photographer)**. Installing LUNKERS Box. Retrieved July 26, 2017, from http://truenorthtrout.com/wp-content/uploads/2012/12/Pollack-Bridge-Lunker-Structure.jpg
21. **The Garden Consultants, Inc. (Photographer)**. Highland Park. Retrieved July 26, 2017, from http://gardenconsultants.com/portfolio_page/highland-park/

22. **Hisgett, Tony (Photographer)**. 1024px-Golden_Eagle_in_Flight [digital image]. Retrieved September 29, 2017, from https://commons.wikimedia.org/w/index.php?curid=18249270 Used under Creative Commons Attribution 2.0 Generic

23. **BuBZ (Photographer)**. 1280px-Northern_Leopard_Frog [digital image]. Retrieved September 29, 2017, from https://commons.wikimedia.org/wiki/File:Northern_Leopard_Frog.JPG Used under Creative Commons Attribution 2.0 Generic

24. **Ellen Edmonson (Painter)/Wikipedia.** Longnose_dace [digital image]. Retrieved September 29, 2017, from https://commons.wikimedia.org/wiki/File:Longnose_dace.jpg Used under Creative Commons Attribution 2.0 Generic

25. **Arctic Wire Rope**. 3400-30-1-1 (Duckbill Anchor). Retrieved September 29, 2017, from https://www.arcticwirerope.com/awr-product/duckbill-88-earth-anchor-w-cable/

26. **U.S. Army Corps of Engineers (Phtographer)**. 130430-A-CE999-003 (Hydric Soil). Retrieved September 29, 2017, from https://media.defense.gov/2013/Apr/30/2000725525/-1/-1/0/130430-A-CE999-003.JPG

Extra Landowner Assessment Worksheets

The following pages contain extra copies of the Landowner Assessment Worksheet so that you can record the conditions on your property multiple times. By recording the conditions at different times throughout the year, you can begin to create a historical record of what is changing on your land.

Landowner Assessment Worksheet (page 1)

Landowner Name: _____ **Property Address:** _____

Stream Name/Watershed: _____ **Date:** _____

Description of Property/Interest Reach: _____

_____

_____

Noticeable Changes since Last Assessment: _____

_____

Flow Conditions and Season: _____

Entrenchment:

- ☐ Entrenched
- ☐ Moderately Entrenched
- ☐ Not Entrenched

Stream Slope:

- ☐ Steep Slope (>4%)
- ☐ Moderate Slope (1-4%)
- ☐ Gentle Slope (<1%)

Primary Streambed Material:

- ☐ Boulders (>10")
- ☐ Cobble (2.5-10")
- ☐ Gravel (2mm-2.5")
- ☐ Sand (<2mm)

Map/Sketch of Property/Site:

Map/Sketch Notes:

_____

_____

Landowner Assessment Worksheet (page 2)

Below, check any of the objective boxes that you checked while completing the Questionnaires earlier in this Chapter:

Stewardship & Recovery Objectives

- ☐ Bank Revegetation
- ☐ Grade Control
- ☐ Bank Armoring
- ☐ Bank Re-Shaping
- ☐ Floodplain Structure/Debris Removal
- ☐ Stream Re-Alignment
- ☐ Increase Floodplain
- ☐ Sediment Removal
- ☐ Crossing/Culvert Maintenance
- ☐ Remove/Relocate Woody Material
- ☐ Anchoring Woody Material
- ☐ Upland Revegetation
- ☐ Wetland Management
- ☐ Invasive Plant Management
- ☐ Undesirable Wildlife Management
- ☐ Wildlife Habitat
- ☐ Livestock Management
- ☐ Fish Passage
- ☐ Fish Habitat
- ☐ Channel Complexity
- ☐ Insect Habitat
- ☐ People Places
- ☐ Stream Access

Strategy Notes/Highest Priorities: _____

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- ☐ Wetland Management
- ☐ Invasive Plant Management
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- ☐ Livestock Management
- ☐ Fish Passage
- ☐ Fish Habitat
- ☐ Channel Complexity
- ☐ Insect Habitat
- ☐ People Places
- ☐ Stream Access

Strategy Notes/Highest Priorities: _____

Index

The idea for this handbook grew out of the recovery efforts after the 2013 Colorado flood and federally declared disasters. The Lefthand, Big Thompson, Little Thompson and Saint Vrain watersheds were all heavily impacted by the 2013 flood. All four watersheds have since been involved in numerous stream recovery and stewardship projects, many of which were funded by the state of Colorado through the Department of Local Affairs (DOLA) disaster recovery program. The projects included private landowners, government agencies, funding administrators, watershed coordinators, engineers, environmental scientists, landscape architects and river constructors.

Through the course of these projects, everyone involved learned valuable lessons about how streams function during and after a record-breaking flood, as well as how landowners can be good stewards of the stream system. From these lessons, the idea of a Handbook meant specifically for private landowners living along streams was born. DOLA funded the project, with the Lefthand (LWOG), Big Thompson (BTWC), Little Thompson (LTWC) and Saint Vrain (SVCC) Watershed Coalitions making up the Handbook Steering Committee.

Fall 2017

For more information and to find a digital copy of this Handbook, visit:

www.lwog.org/programs/stewardship

LEFTHAND WATERSHED oversight group

Little Thompson Watershed Restoration Coalition

BIG THOMPSON WATERSHED COALITION

SAINT VRAIN CREEK COALITION

CO DOLA

FALL 2017