Land and Stream Restoration Opportunities

Technical Summary Report

February, 2018

Purpose and Approach

This report identifies potential on-the-ground treatments to help achieve the management objectives identified through the Steamboat Springs Yampa River Health Assessment & Streamflow Management Plan stakeholder engagement process. The following types of treatments were considered:

- **Restoration** – actions aimed at improving river health and natural function by removing or mitigating causes of impairment: for example, replanting native vegetation to areas where it had been cleared, removing artificial levees[1] to open up floodplain access, realigning river segments that were historically channelized.
- **Enhancement** – manipulating the river or constructing features to optimize specific functions or uses: for example, artificial structures that create boating features, artificial fish habitat structures, diversions, clearing natural debris from the river.
- **Stabilization** – actions aimed at protecting property by preventing the river from moving or flooding to protect property: for example, bank armor and rip-rap, erosion-control structures, channelization, levees and dikes.

The consultant team evaluated feasibility and effectiveness of reach-scale opportunities by assessing the following:

- **Technical constraints** – whether the objective can be addressed using reach-scale restoration, enhancement, or stabilization treatments;
- **Practical constraints** – land ownership, desirability, conflict with other uses, and cost; and
- **Risk** – potential for causing harm to another aspect of river health.

For any given management action, benefits to river health were characterized by assessing potential improvement to relevant stream health variables as determined in the 2017 river health assessment (see Yampa River Health Assessment Report). Benefits related to

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[1] In this report, a **levee** is considered any artificial embankment that prevents overflow of a river onto its floodplain. The term is not used to imply a structure designed and constructed to contain or control the flow of water during a flood.

community values (e.g. recreation and regulatory compliance) were evaluated according to criteria identified by local stakeholders.

Recommended Projects

This section describes potential reach-scale projects by location and action type. Each project is assigned a high, medium, or low prioritization ranking. Project benefits relevant to each management objective are described, along with an analysis of relative cost, risk, and potential conflicts or tradeoffs. Order-of-magnitude cost is estimated according to the following categories:

- Low – less than $10,000 per stream mile
- Medium – $10,000 – $100,000 per stream mile
- High - $100,000 – $1,000,000 per stream mile
- Very high – more than $1,000,000 per stream mile

Projects are assigned a negligible, low, medium, high, or very high project risk ranking. Risk categories reflect the potential for the project to cause additional damage to some other aspect of river health.

Land Protection

An ounce of prevention is worth a pound of cure. Some of the best opportunities for managing stream health and community benefits are to protect functioning areas from future harm. Alongside efforts to restore, enhance, or stabilize the river, on-the-ground efforts towards protecting areas at risk may provide some of the best ways to make meaningful net gains in all the plan's management objectives. Land protection, in the form of acquisition for open space, conservation easement, or other mechanism is often less expensive than treating damages. It carries no risk of imposing further damage, and there are usually no conflicts or tradeoffs. The highest priorities for land protection are reaches in the best functional condition or ones that provide specific community benefits. Parcels at risk of development or other deleterious land use practice should be triaged to the top of the list. Although a specific inventory of high priority parcels for protection is beyond the scope of this project, it is a recommended action for the community to pursue in the future.

Fish Passage Improvement

Location: Entire area but focused on boating structures (Reaches 4.1 - 4.2), large diversion weirs (Reaches 1.5 and 4.4), and culverts and bridges on tributary streams (Figure 1).

Priority: High

Actions: Work with aquatic biologists to identify fish migration barriers with focus on the hydraulic conditions created by structures during periods when native fish are migrating through the section of the Yampa River near steamboat and its major tributaries. Consider modifications to existing structures and design requirements for future bridge, culvert, or in-channel structures.

Benefits:

Natural flow regime	N/A
Natural watershed	N/A
Natural form and processes	N/A
Floodplain connectivity	N/A
Riparian condition	N/A
Fish passage	Improved fish passage and aquatic habitat connectivity
Native fish	Improved fish passage and ability to migrate and access spawning and refuge habitat
Self-reproducing sport fishery	Increased ability to migrate and access spawning and refuge habitat
Water quality compliance	Cumulative effects of increased shading on thermal heating.

Relative cost: Medium

Risk: Low

Conflicts/tradeoffs: Reconfiguring structures may involve tradeoffs or compromise their intended uses. For example, making in-channel structures more suitable for fish passage could make them less desirable as recreational boating features.

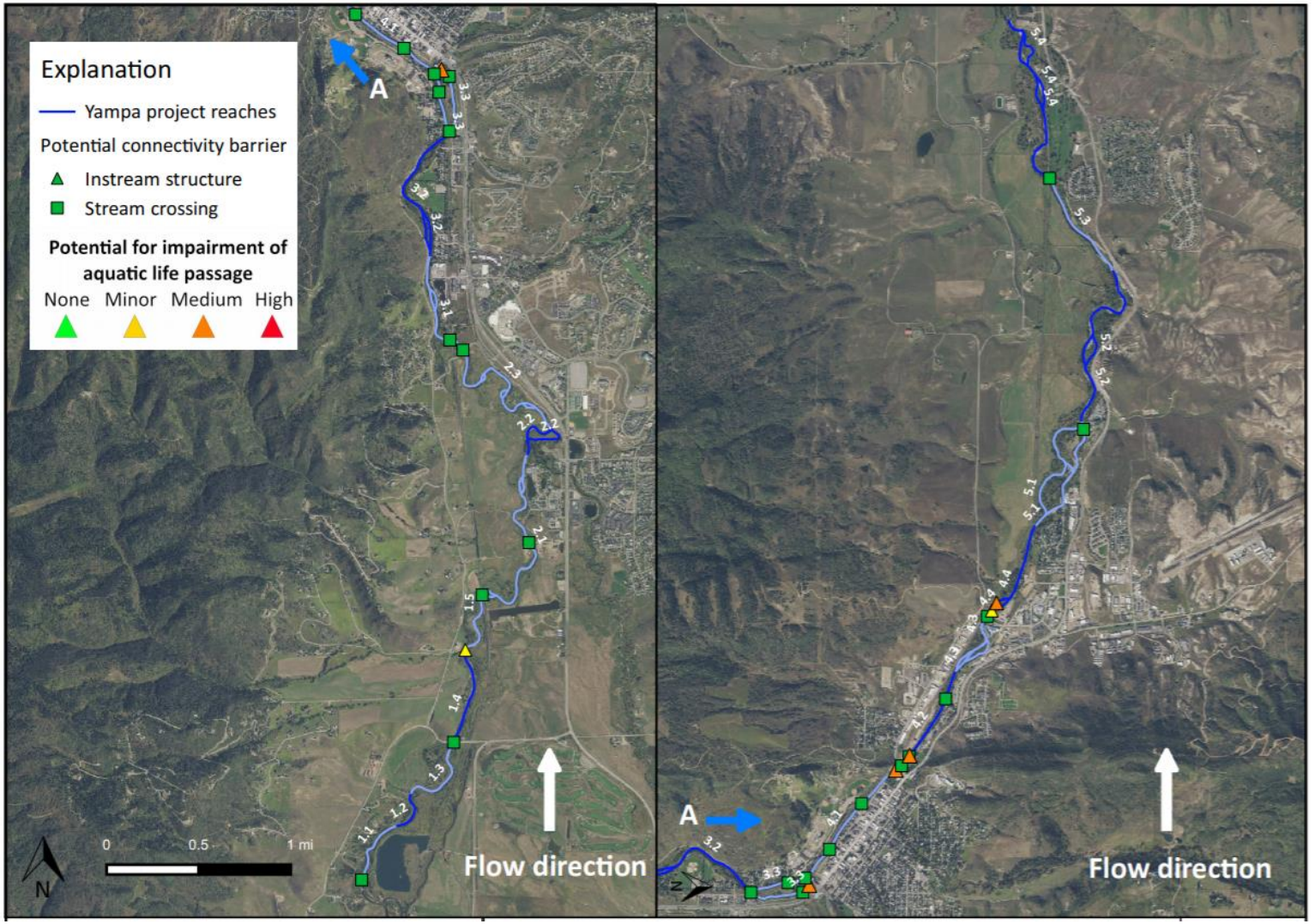

Figure 1: Potential connectivity barriers.

Upper Chuck Lewis SWA Riparian Revegetation

Location: Chuck Lewis SWA upstream of CR 14F (Reaches 1.1 and 1.3).

Priority: Medium

Actions: Plant native trees, shrubs, and hydric herbaceous vegetation in areas of the riparian zone that were historically cleared or disturbed. Manage for riparian vegetation establishment and persistence.

Benefits:

Natural flow regime	N/A
Natural watershed	N/A
Floodplain connectivity	N/A
Natural form and processes	Improved riparian vegetation helps support natural channel dynamics, stability, and habitat-sustaining processes. Increased wood and detritus supply.
Riparian condition	Increased woody vegetation production, canopy cover, proportion of native species, patchiness, and interspersion on treated areas. Increased extent of high-quality riparian habitat.
Native fish	N/A
Self-reproducing sport fishery	Minor improvement to stability, habitat, and temperature due to increased canopy shading
Water quality compliance	Cumulative effects of increased shading on thermal heating.

Relative cost: Medium

Risk: Low to none

Conflicts/tradeoffs: Planted areas must be managed for natural riparian vegetation over the long term. Some land uses changes would be required, including limitations to grazing and possible temporary exclosure and deferred hay harvest. River access may become slightly more difficult over time.

Lower Chuck Lewis SWA Riparian Revegetation

Location: Chuck Lewis SWA downstream of CR 14F (Reaches 1.4 and 1.5).

Priority: High

Actions: Plant native trees, shrubs, and hydric herbaceous vegetation on targeted areas where vegetation was historically cleared or disturbed. Manage for riparian vegetation establishment and persistence.

Benefits:

Natural flow regime	N/A
Natural watershed	N/A
Natural form and processes	Improved riparian vegetation helps support natural channel dynamics, stability, and habitat-sustaining processes. Increased wood and detritus supply.
Floodplain connectivity	N/A
Riparian condition	Increased woody vegetation production, canopy cover, proportion of native species, patchiness, and interspersion on treated areas. Increased extent of high-quality riparian habitat.
Native fish	N/A
Self-reproducing sport fishery	Minor improvement to stability, habitat, and temperature due to increased canopy shading
Water quality compliance	Cumulative effects of increased shading on thermal heating.

Relative cost: Medium

Risk: Low to none

Conflicts/tradeoffs: Planted areas must be managed for natural riparian vegetation over the long term which will require modifications to current agricultural practices including managed grazing and deferred hay harvest in treated areas.

Rotary Park Riparian Revegetation

Location: Rotary Park from the railroad bridge to Mt. Werner Road (Reaches 2.1 and 2.3)

Priority: High

Actions: Manage Reach 2.3 to preserve natural river form and function. Plant native trees, shrubs, and hydric herbaceous vegetation on targeted areas of Reaches 2.1 and 2.3 where vegetation was historically cleared or disturbed. Manage for riparian vegetation establishment and persistence.

Benefits:

Natural flow regime	N/A
Natural watershed	N/A
Natural form and processes	Improved riparian vegetation helps support natural channel dynamics, stability, and habitat-sustaining processes. Increased wood and detritus supply.
Floodplain connectivity	N/A
Riparian condition	Increased woody vegetation production, canopy cover, proportion of native species, patchiness, and interspersion on treated areas. Increased extent of high-quality riparian habitat.
Native fish	N/A
Self-reproducing sport fishery	N/A
Water quality compliance	Cumulative effects of increased shading on thermal heating.

Relative cost: Medium

Risk: Low to none

Conflicts/tradeoffs: Planted areas must be managed for natural riparian vegetation over the long term. Some land uses changes would be required, including limitations to grazing and possible temporary exclosure and deferred hay harvest. River access may become slightly more difficult over time.

Walton Creek Confluence Channel Reconstruction

Location: Rotary Park from the railroad bridge to Mt. Werner Road (Reach 2.2).

Priority: Medium

Actions: Partner or on river reconstruction project proposed by Colorado Parks and Wildlife for the Yampa River below the Walton Creek Confluence.

Benefits:

Natural flow regime	N/A
Natural watershed	N/A
Natural form and processes	Natural form and processes could be improved
Floodplain connectivity	Floodplain connection could be improved, but there is a risk that creating a channelized river form will result in decreased floodplain saturation frequency. The proposed alignment is a net loss of aquatic habitat.
Riparian condition	A massive construction effort would cause temporal decline in riparian condition, but it could improve over the long-term if effectively treated and managed
Native fish	Impacts unknown.
Self-reproducing sport fishery	Impacts unknown. Fishery managers believe that filling and disconnecting lentic habitat would help eliminate pike.
Water quality compliance	Cumulative effects of increased shading and water residence time on thermal heating.

Relative cost: Very high

Risk: Very high

Conflicts/tradeoffs: The constructed channel, as currently designed, will rely heavily on artificial stabilization and habitat features. This may improve natural form and function compared to the highly altered existing condition. Filling existing channel and ponds will result in a net loss of aquatic habitat, but some of this may be mitigated if filled channels are restored as wetland. The balance may be a net loss or gain in aquatic habitat and function, depending on how the project is completed. Construction disturbance will negatively impact riparian vegetation, but the effects may be temporary and could provide gains in the long term. The effects on native, nuisance, and sport fish habitat are not certain. Further study may be required to determine whether the benefits to habitat reduction for non-native northern pike outweigh the potential loss in mountain whitefish habitat.

Island Riparian Revegetation

Location: The Island between channel branches upstream of Rabbit Ears Motel (Reach 3.3).

Priority: Low

Actions: Plant native trees, shrubs, and hydric herbaceous vegetation on targeted areas where vegetation was historically cleared or disturbed. Manage for riparian vegetation establishment and persistence.

Benefits:

Natural flow regime	N/A
Natural watershed	N/A
Natural form and processes	N/A
Floodplain connectivity	N/A
Riparian condition	Increased woody vegetation production, canopy cover, proportion of native species, patchiness, and interspersion on treated areas. Increased extent of high-quality riparian habitat.
Native fish	N/A
Self-reproducing sport fishery	N/A
Water quality compliance	N/A

Relative cost: Medium

Risk: Low to none

Conflicts/tradeoffs: Planted areas must be managed for natural riparian vegetation over the long term.

Below Town Riparian Revegetation

Location: City properties downstream of town (Reaches 5.1 and 5.2).

Priority: Low

Actions: Identify areas on City property where vegetation has been cleared or disturbed and plant them with native trees, shrubs, and hydric herbaceous vegetation on targeted areas where vegetation was historically cleared or disturbed. Manage for riparian vegetation establishment and persistence.

Benefits:

Natural flow regime	N/A
Natural watershed	N/A
Natural form and processes	Improved riparian vegetation helps support natural channel dynamics, stability, and habitat-sustaining processes. Increased wood and detritus supply.
Floodplain connectivity	N/A
Temperature regime	N/A
Riparian condition	Overall reach-scale riparian condition improved Increased extent of high-quality riparian habitat Increased woody vegetation and canopy cover
Native fish	N/A
Self-reproducing sport fishery	N/A
Water quality compliance	N/A

Relative cost: Medium

Risk: Low to none

Conflicts/tradeoffs: Planted areas must be managed for natural riparian vegetation over the long term.

Revetment Revegetation

Location: Entire area, but focused on revetment areas that have no vegetation

Priority: Low

Actions: Identify bare bank areas, especially those with revetment, and plant trees there to increase riverside vegetation and canopy cover.

Benefits:

Natural flow regime	N/A
Natural watershed	N/A
Natural form and processes	N/A
Floodplain connectivity	N/A
Riparian condition	Modest improvement to riparian condition and canopy cover.
Native fish	N/A
Undesirable exotic fish	N/A
Self-reproducing sport fishery	N/A
Water quality compliance	N/A

Relative cost: Medium

Risk: Low

Conflicts/tradeoffs: Must be planned and designed so that plantings do not interfere with revetment or maintenance.

Block Fish Access from Ponds

Location: All areas with off-channel ponds that hold exotic fish

Priority: High

Actions: Install passage barriers (screens) in ditches that connect off-channel ponds to the river to prevent northern pike and other exotic fish from the ponds from entering the river.

Benefits:

Natural flow regime	N/A
Natural watershed	N/A
Natural form and processes	N/A
Floodplain connectivity	N/A
Riparian condition	N/A
Native fish	Decreased predation and competition from exotic fish.
Undesirable exotic fish	This is a low-cost way of minimizing the recruitment of exotic fish (especially pike) from entering the Yampa River system from off-channel ponds where they proliferate.
Self-reproducing sport fishery	Decreased predation and competition from exotic fish.
Water quality compliance	N/A

Relative cost: Low

Risk: None to low

Conflicts/tradeoffs: Must be maintained.

Analysis of Reach-Scale River Health Management Objectives

Reach-scale management objectives target on-site conditions of the river and riparian area. These factors can be addressed using reach-scale treatments, making restoration, enhancement, and stabilization actions potentially useful tools for maintaining or improving river health, natural function, and optimizing desired uses.

The following management objectives can be addressed through reach-scale treatments:

- Maintain or increase functional floodplain extent above and below town
- Maintain or increase extent and improve condition of riparian vegetation
- Protect native fish populations from further decline and promote range expansion where possible
- Promote a self-reproducing sport fishery

Objective: Maintain or increase functional floodplain extent above and below town

Floodplain connectivity is a keystone function of river health. Restoring natural floodplain function and extent brings about a host of other benefits including natural riparian vegetation recruitment and succession; geomorphic processes that naturally maintain stability, river form, and structure; and better habitat for native species. It is also the key component for restoring native wetland along the river and for optimizing alluvial aquifer recharge and storage.

Floodplain extent on this section of the Yampa River is primarily limited by unnatural river morphology including channelization, channel enlargement, straightening, bank armor, levees, and artificially high banks. Large portions of the floodplain are also cut off by elevated road and railroad grades and bridges or encroached upon by development. These impacts can be treated by restoring natural river and bank morphology, removing levees and other impediments to flooding, and regrading floodplain areas.

Practical opportunities for completing projects of this scope and scale are limited because it often would require the removal of roads, railroads, bridges, or other developments. Channelized river segments, high banks, and levees were constructed for a purpose—usually to prevent overbank flooding for protecting property or facilitating agriculture or other land uses—and we have come to rely on them. Landowners and society at large have come to depend on these modifications, so practical opportunities for restoring natural floodplains are limited to areas where the original structures and modifications are no longer serving their intended purposes.

Chuck Lewis SWA segment

One such opportunity may exist on the upper portion of the Chuck Lewis SWA (Reach 1.1) where river channelization and levees are a legacy of past gravel mining and reclamation efforts. Floodplain connectivity on this reach is currently rated D. The surrounding land is open space managed as natural area, and there is no immediate reason why floodplain access couldn't be restored there. However, there are practical reasons why this may not be such a good idea. Gravel-mined floodplain areas have been reclaimed as groundwater-fed ponds and depressional wetland areas that, while not entirely natural, are valued for recreation and wildlife habitat as part of the State Wildlife Area. They also support a diversity of native riparian and wetland vegetation. The value of these amenities must now be considered against potential gains to river health and natural function. Furthermore, reconstructing a natural river course and floodplain on the reach would be a massive undertaking and a major land disturbance requiring intensive revegetation efforts and active management for years to come. The project would be very expensive and there would be tremendous risk involved. The tradeoffs, costs, and risk of making things worse probably make such an endeavor unfeasible.

Just downstream, Reach 1.2 is afflicted by a similar set of historical impacts. This section of the floodplain is privately held, limiting the potential for the City to do work on the site.

Floodplain connectivity is rated D+ on the portion of the Chuck Lewis SWA just upstream of CR 14F (Reach 1.3). A levee/access road runs along the left side of the river separating it from floodplain area to the west. The channel becomes braided. Meanders and oxbows that are cut off from the main channel by the road are kept wet by alluvial groundwater. These areas can also be inundated by backwater during floods. The area supports high quality diverse riparian vegetation. Removing or perforating the levee/road may provide some long-term sustainability benefits related to floodplain scour and riparian recruitment. This project could be worthwhile if the treatments can be accomplished with minimal land disturbance and low cost.

The floodplain downstream of CR14F on Reaches 1.4 and 1.5 of the Chuck Lewis SWA are tightly constrained by the railroad line, the river is channelized, and floodplain connectivity is scored D+ to C-. River access to the narrow portion of remaining floodplain is inhibited by high bank features that were recently constructed on habitat enhancement projects. Restoring floodplain connectivity on these reaches may conflict with management efforts that aim to separate the river from off-channel wetland habitat, backwaters, sloughs, and side channels as a measure to control northern pike.

Rotary Park segment

The Rotary Park segment appears to have potential for reach-scale treatments to restore floodplain connectivity, especially since most of the floodplain on the left (west) side of the

river is owned by the City of Steamboat Springs. Factors that may potentially limit feasibility on this segment include land use and fishery management conflicts.

Floodplain connectivity is rated C+ on the upper reach (Reach 2.1). The primary stressor is the system of levees and railroad grade at the top of the reach that forces the river through a tight constriction under the railroad bridge. These effects could be mitigated, and floodplain extent increased, downstream of the bridge by reactivating side channels and floodplain swales. Doing so, however, may conflict with agricultural operations and other land uses on the ranchland just downstream, including the City's drinking water infiltration galleries. It also may conflict with sportfish management efforts. The unusual river morphology on the middle reach of Rotary Park segment (Reach 2.2) is a result of historical aggregate mining and reclamation. Despite these impacts, floodplain connectivity is not severely limited (B-). A November 2015 report by Stantec and CPW proposes a multimillion-dollar project aimed at creating a single-thread channel through this reach. The project would isolate the main channel from sloughs, backwaters, and adjacent wetlands to reduce habitat for non-native northern pike. Restoring floodplain connectivity on this reach would conflict with fishery management objectives. The lowest reach (Reach 2.3) has good floodplain connectivity (B-), excellent riparian condition, and relatively natural geomorphic form and processes, making it a prime candidate for preservation. The potential for minor improvements to floodplain connectivity is probably not worth the disturbance, cost, and risks associated with a major construction project. Protecting the existing high level of floodplain connectivity and riparian condition would be the best approach to maximizing stream health and function on the reach.

Below Town segment

The segments above and through town are naturally confined, and almost all potential floodplain area is developed, leaving no feasible opportunities for improving floodplain connectivity. Below town the valley bottom opens back up. Floodplain area on the left (south) side of the river on the first two reaches of this segment (Reaches 5.1 – 5.2) are part of a large private ranch. Improvements are technically feasible but may not be practical due to conflicting land use. The potential for improvement is not high, as these reaches are rated B for floodplain connectivity. Working to protect this condition is probably a better approach than trying to make incremental improvements at high cost.

Reach 5.3 is channelized, and floodplain connectivity becomes compromised (D+) by channelization, cross-valley road fills, and the railroad grade. The rail line ultimately confines the floodplain through a narrow bridge at the lower end of the reach. These factors, combined with the fact that the floodplain is a patchwork of property parcels with different private landowners, mean that floodplain restoration is likely unfeasible for technical and practical reasons. Private property and the alignment of the railroad also pose practical and technical constraints limiting opportunities to improve floodplain connectivity on Reach 5.4.

Objective: Maintain or increase extent and improve condition of riparian vegetation

Chuck Lewis SWA, Rotary Park, and Below Town segments

The primary cause of riparian impairment on the Chuck Lewis SWA, Rotary Park, and Below Town segments is land conversion. These areas were cleared long ago to create the highly productive ranchland. The condition and extent of native vegetation varies by reach depending on the amount of riparian area left undisturbed and intensity of land use over the 150 years since the region was settled. Diminished floodplain connectivity, lack of channel migration, and stabilization of disturbance regimes are secondary impacts that interrupt natural plant succession and woody vegetation recruitment. Most of the cleared pastureland and hay meadow vegetation is supported by a shallow groundwater table, sub-irrigation, and/or surface irrigation.

Riparian condition on these cleared areas could be partially restored by reestablishing native trees and shrubs, especially on areas within 100 meters of the main river channels where floodplain connectivity is still good. Treatments would involve aggressive planting and years of active management and maintenance to assure survival. These are moderately expensive treatments with very low risk to other aspects of river health. Reconverting pasture and hay meadow to native riparian vegetation obviously requires modifications to current agricultural operations to protect the restored areas, but these modifications can be planned carefully to maintain existing agricultural land use while restoring the riparian corridor.

Given the existing floodplain and river morphological condition on the Chuck Lewis SWA, the best opportunities for improving riparian condition are downstream of CR 14F (Reaches 1.4 – 1.5). More than half of the mapped riparian area on those reaches score in the C range or lower, and since the area is managed as a SWA there are no conflicting land uses. A challenge on these reaches will be establishing hydric vegetation and woody species on high banks left behind by historical channelization and on new bare banks that were recently built as a component of habitat enhancement projects.

Similar opportunities exist on the Rotary Park segment. Reach 2.1 is rated C for riparian condition—more than 40% of the riparian area scores C or less. Most of this land is owned by the City of Steamboat. The riparian area most in need of revegetation on Reach 2.3 is on private property, so feasibility is questionable. That reach is rated B for riparian condition, overall, so riparian restoration on this reach is less important than on Reach 2.1, but protecting the existing good condition should be a high priority.

The overall riparian condition rating for the Below Town segment is B-, but there are large patches on the south side of the river that have no woody vegetation and scores in the C range. Targeted riparian restoration on these patches would create local benefits and

cumulatively improve overall condition. These areas are private property, so restoration may be unfeasible.

Above Town and Through Town segments

The riparian zone on these segments is naturally narrower than it is upstream or downstream due to a geologically narrower valley bottom. The primary impacts to riparian condition are conversion for urban and residential development. Riparian condition on open-space and natural areas is generally good, and even urbanized sections tend to have a narrow strip of riparian vegetation and canopy cover along the river's edge. Given the extent of development in the natural riparian zone, few to no options for establishing new open-space for natural areas exist in the urban corridor. Significant improvement to current riparian condition scores (C above town, and D through town) is not feasible, but small-scale targeted riparian restoration and re-planting projects could be locally beneficial, especially in areas that are currently devoid of bank vegetation. Planting trees within armored and rip-rap banks, as recommended by the 2008 Yampa Structural Master Plan is one type of project that may provide limited local benefit and create opportunities for community engagement and education about the importance of streamside forest.

Objective: Maintain or improve natural form and processes

- Supply of organic material
- Natural river morphology
- Stability and resilience
- Physical habitat diversity

The feasibility of meeting objectives related to natural form and process via reach-scale river and riparian treatment is determined, to a great extent, by the potential for restoring natural floodplain and riparian vegetation. This is because natural form and process is predicated on floodplain connection and riparian function. The natural river type on the Chuck Lewis SWA, Rotary Park, and Below Town segments (as evidenced by historic aerial imagery) is a highly sinuous, branching, and meandering form that requires a wide natural floodplain with dense woody vegetation (trees and shrubs) to maintain stability, form and function. Habitat complexity and features such as deep pools, undercut banks, gravel riffles, log and wood jams, off-channel beaver ponds, backwaters, and wetlands are naturally created and sustained on these systems by ongoing processes of scour (erosion) and deposition that create complex patterns of channel migration and disturbance. Wood recruitment, which is a critical natural mechanism for maintaining habitat complexity and triggering episodic erosion or avulsion events, requires mature riparian forest vegetation. Gravel riffles that are critically important for trout and native fish spawning are also products of dynamic moving channels.

When floodplain connection is cut off, when trees and shrubs are removed, or when the river is channelized and/or stabilized and not allowed to branch and migrate, these dynamic

geomorphic processes shut down. The result is a mostly static system that has little capacity for creating and maintaining complex habitat. Process-based restoration, therefore, is dependent on the ability to recover historical floodplain, the extent of native woody vegetation, and the frequency and magnitude of historic channel migration and disturbance events. In areas where process-based restoration is feasible, planners must carefully consider the degree to which design treatments restore natural river form *and* processes.

Restoring natural river form, floodplain connectivity, and riparian condition on most of the impaired reaches of the Yampa River near Steamboat Springs, however, is probably not feasible. The contemporary static channel form will likely be the norm into the foreseeable future. River managers for the past 50 years have generally accepted this fact, and a succession of nearly annual river projects since 1980 have focused on artificial means to stabilize the river channel and to install artificial habitat and recreational features. There are currently 280 artificial in-stream habitat or recreation structures in the Yampa from Catamount Reservoir to the water treatment plant. These features represent a massive investment and heavy reliance on channel and streambank modifications to support fish habitat and other recreational uses. The 2008 Yampa River Structural Master Plan is the next phase in ongoing structural modification efforts. The Structural Master Plan provides project ideas to replace, repair, and add to previous work.

The primary risk involved with artificially channelizing, stabilizing, and otherwise artificially enhancing the river for specific uses is the potential loss of natural functions and services, poor sustainability, and decreased resilience. Where past actions and current land uses severely constrain the potential for restoring natural form and process, though, structural modifications may provide be the only feasible reach-scale treatment options. Enhancement efforts that work with natural processes such as channel migration, erosion, deposition, wood recruitment, and overbank flooding do more to promote long-term river health and reduced maintenance needs than those that rely on stability and static conditions.

Natural processes are most intact on the Rotary Park segment (especially Reach 2.3) and on portions of the segment below town (especially Reaches 5.1 and 5.2), which score B for overall river health. These reaches also have the best floodplain connectivity and riparian condition. Perhaps the best approach for meeting the goal of maintaining or improving natural river form and processes is to protect these reaches and to focus any future management activities on the preservation of intact natural processes rather than on stabilization or structural enhancement.

Objective: Protect native fish populations from further decline and promote range expansion where possible

The suspected primary causes of native mountain whitefish decline on the reach is competition with non-native species, habitat loss caused by channelization, floodplain

disconnection, and decreased connectivity with upstream reaches and tributaries. Physical habitat conditions on this section of the Yampa are much different than the conditions in which the native fish evolved and persisted prior to settlement. Most significantly, there is now much less connected off-channel habitat, and fewer pools and ponds which may be important for mountain whitefish, especially as fry and in juvenile stages. The current state of physical habitat on most reaches may be less favorable to mountain whitefish, especially during vulnerable stages, and more favorable to exotic competitor and predator fish species such as trout and pike. Water temperature on the Yampa River regularly exceeds thresholds identified for mountain whitefish juvenile and fry health.

Physical habitat limitations are complicated by interspecific interactions with other fish, especially exotics. Competition and predation by pike and large trout are likely important factors limiting the numbers and range of mountain whitefish. Biological management is likely the key to mitigating these factors. Eradicating predators is largely a biological management concern, but physical treatments are being implemented to reduce pike by eliminating connections between the river and off-channel backwater habitat, ponds, sloughs, and wetland. The effectiveness of these efforts towards reducing pike frequency and distribution is unknown, as are the potential benefits to native fish populations from decreased predation. Potential conflicts between these efforts and other river management objectives should be considered when implementing the physical habitat approach for managing pike to aid native fish recovery.

If degradation of natural physical habitat is indeed a limiting factor for native fish, then restoring native conditions, wherever possible, is a valuable tool for increasing the numbers and range of the species. Unfortunately, research on mountain whitefish migration behaviors and habitat preferences is sparse. Depending on what the actual physical habitat limitations of mountain whitefish are, the current trend in river aquatic habitat enhancement for trout may benefit or harm the species. Input from local aquatic biologists is critical when planning future habitat enhancement efforts so that they benefit native and introduced sport fish. Opportunities for restoring natural river form and processes are on the Yampa River near Steamboat Springs appear limited. Preserving areas where floodplain and riparian processes and conditions are mostly intact may be the most feasible approach for promoting native fish objectives.

While not much is known about mountain whitefish physical habitat needs, some information exists to assess the impacts of elevated temperatures on health and migration patterns. Adult mountain whitefish are present in the project area, and the reach is potentially important as a migration corridor that provides fish access from downstream areas to upstream tributary streams. Anecdotal evidence suggests that whitefish congregate below the confluence of the Yampa River and Fish Creek in low-flow high-temperature periods. This observation supports the notion that whitefish use tributaries as thermal refugia.

Maintaining fish passage through the study area is therefore another critical factor that can be addressed via reach-scale physical treatments. The dam on Lake Catamount represents an impassible structure that limits any utilization of the upper watershed by whitefish in the Steamboat Springs area. This reduction in potential native range makes longitudinal connectivity between the Yampa River and tributaries below the dam an important management focus. The most significant barriers to longitudinal connectivity appear to be in-stream boating structures and diversion structures on the mainstem. Culverts, bridges, and diversion structures on tributaries may also pose important fish passage barriers.

Thermal regime has also been implicated as a potential limiting factor for native fish health. One argument presented by local stakeholders is that development of reservoirs, reduction of riparian shading, and diversion of surface water from the river elevates stream temperatures in summer. Indeed, observed water temperatures regularly exceed the tolerance for mountain whitefish juvenile and fry, but the root cause of high summer stream temperature is still poorly understood. Small, but perhaps not insignificant, thermal benefits may result from increased stream shading following riparian revegetation efforts.

Objective: Promote a self-reproducing sport fishery

Establishing and supporting a quality trout sport fishery is a long-term community value on this section of the Yampa River. Along with biological management, massive efforts have been made to alter physical habitat on the river for the benefit of stocked trout. Physical treatment has also been used to try to improve the trout fishery by eliminating northern pike habitat—pike are an efficient predator on both juvenile and adult trout. Other physical methods for removing pike, such as screening ditches to prevent their infiltration from adjacent off-stream ponds, offer low-cost, low-risk opportunities to reduce predation and competition with trout.

We do not have any specific recommendations for using reach-scale treatments to support a trout fishery and suggest that the best approach will be to work with the CPW fisheries managers, biologists, and other experts who know these fisheries and their limiting factors. As in all physical habitat manipulations, especially those that employ artificial structures and stabilization measures, care should be taken to balance the potential fishery benefits against other river management goals.

As is the case with mountain whitefish, the thermal regime is implicated as a potential limiting factor for sport fish health. Observed water temperatures regularly exceed the Coldwater Tier II water quality standard, which is based on temperature tolerance of trout. Small thermal benefits from increased stream shading following riparian revegetation efforts may provide some relief.