Lower Rattlesnake Creek
Head-Cut and Bank Stabilization Project
Elk Mountain Ranch
Carbon County, WY

Prepared by

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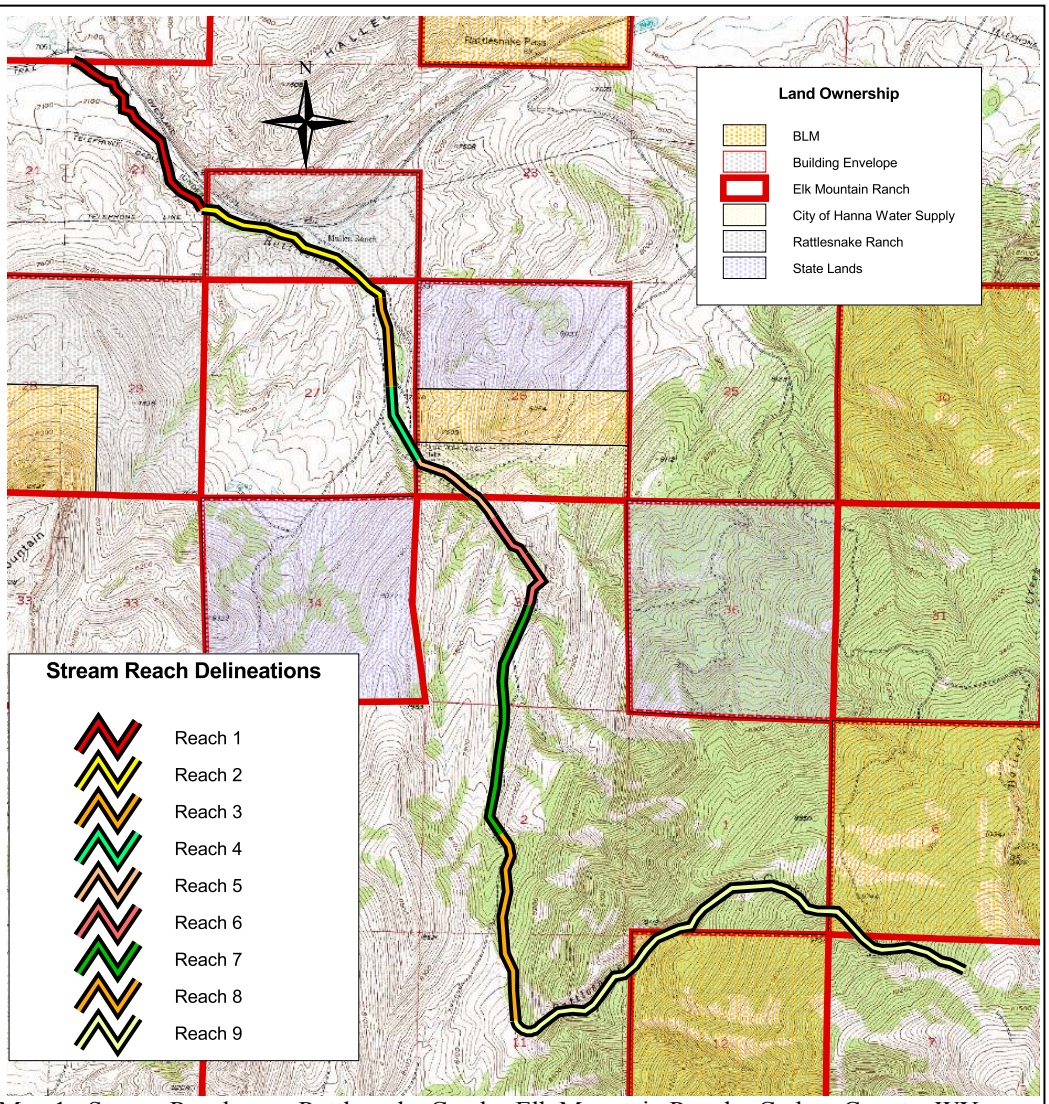
Elk Mountain lies on the watershed divide between the Medicine Bow River and Pass Creek watersheds, two major tributaries of the North Platte River in south central Wyoming. Within the Elk Mountain Ranch there are four perennial streams and over 25 ponds and lakes. The headwaters of two major streams, Rattlesnake and Halleck Creeks, are found on the ranch. Two other lesser headwater streams, Brush Creek and Johnson Creek, also originate on the ranch. Rattlesnake Creek begins near the west summit of Elk Mountain and flows to the southwest, down through a steep gorge for several hundred feet. Emerging from this gorge, the stream turns northwest and flows through a narrow valley between Sheep Head and the Elk Mountain massif, before exiting the ranch and eventually flowing to the west through a broad valley to it's confluence with Pass Creek.

A rapid, landscape scale assessment of aquatic habitat conditions was conducted by Land Stewardship Associates, LLC and FIN-UP Habitat Consultants, Inc. in August and September, 2006. The results of this assessment are contained in the documents *Elk Mountain Ranch - NATURAL RESOURCE MASTER PLAN - PARTS 1& 2* (LSA, LLC, 2006). The 2006 aquatic assessment identified limiting factors and potential restoration projects for fisheries on the streams within the Elk Mountain Ranch, including Rattlesnake Creek. Active head-cutting of the stream channel and bank erosion in the lower reaches of Rattlesnake Creek, downstream of the Hanna Water Supply Intake Forebay, were identified in the 2006 assessment as potential problem areas needing immediate treatment. In May, 2007, FIN-UP, Inc. returned to the Ranch to identify and map the existing head-cuts and actively eroding banks, collect stream channel dimension, pattern, and profile data, and develop treatment plans for stabilizing the identified problem areas. This document will describe the recommended treatment plan for addressing the head-cut and bank stability issues in the lower reaches of the creek.

Rattlesnake Creek likely has the greatest potential for sustaining a cold water trout stream fishery on the Elk Mountain Ranch. Restoration efforts on the lower reaches of the stream will focus on treating the actively eroding banks, either through mechanical treatments such as toe-slope stabilization and re-vegetation, or through natural processes. The riparian zone should continue to be managed to encourage robust willow growth and regeneration. With good riparian management, the stream downstream of the Rattlesnake Ranch may see beaver return and create pond habitats that will continue to support a viable cold-water fishery.

Project Reach Descriptions and Existing Conditions:
A map of the delineated stream reaches on Rattlesnake Creek within the Elk Mountain Ranch is provided in Map 1. Reach 1 on Rattlesnake Creek is characterized by a broad valley bottom with dense willow and a few cottonwood trees. It is apparent that there has been considerable historic beaver activity



Map 1: Stream Reaches on Rattlesnake Creek - Elk Mountain Ranch , Carbon County, WY

within the reach, and at its full potential, this reach might consist of significant beaver pond complexes with little or no definable stream channel. There is evidence of significant past flooding occurring in the reach, particularly in the upstream segment, where there has been a severe down-cutting of the channel, and abandonment of the adjacent floodplain. Some mass-wasting of materials is occurring where the river has eroded away the steeper adjacent uplands.

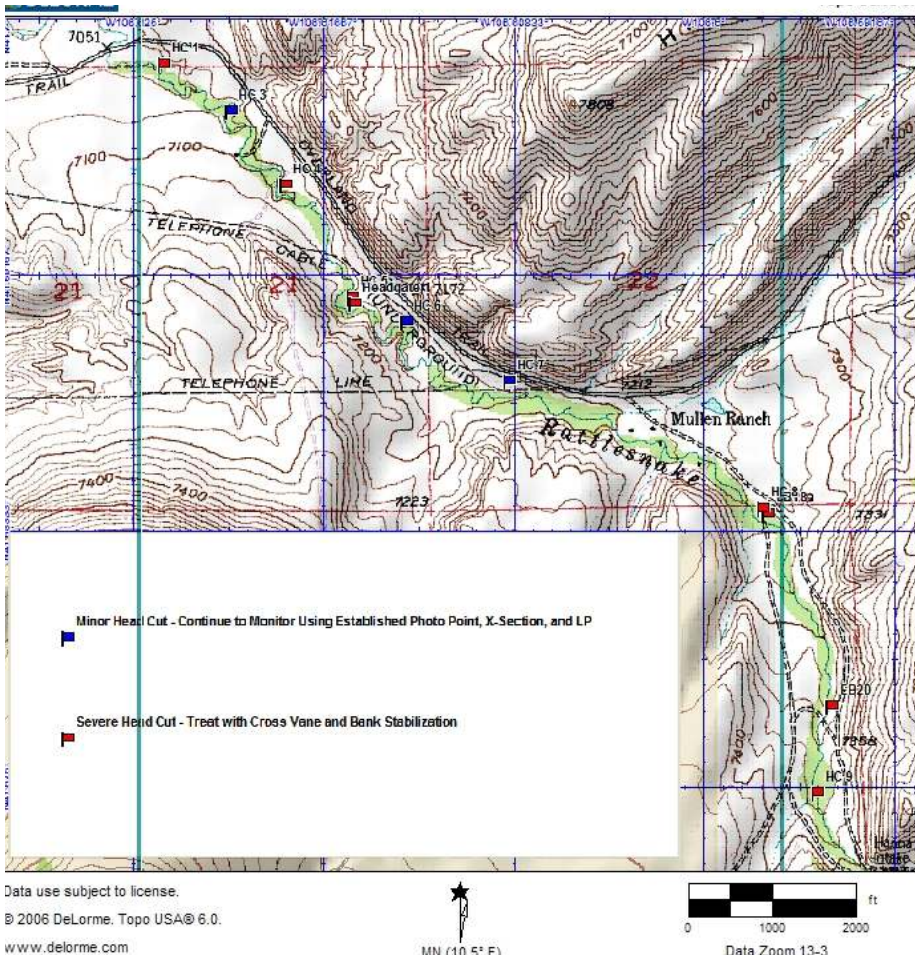
Most of the channel throughout the reach is classified as Rosgen C5. In the upper portion of the reach, the channel type is a F5, with a new C5 channel beginning to form in the bottom of the F channel as the vertical banks recover a sustainable angle of repose and the stream adjusts to it's new flood plain elevation. This channel type is typical of streams that have down-cut due to flooding or other event. In several areas throughout the reach, vertical instability is still an issue, with several severe head-cuts actively progressing up the stream channel. Stream bank condition is relatively poor in the reach,

particularly in the areas near the active head-cuts. Noxious weeds, principally thistle, are present throughout the riparian zone.

Reach 2 is entirely located on the Rattlesnake Ranch, a private in-holding within the boundaries of the Elk Mountain Ranch, and was not assessed in detail in 2006. Reach 2 is primarily a Rosgen channel type C5, and appears to exhibit many of the same characteristics of Reach 1.

Reach 3 extends from the Rattlesnake Ranch upstream to a road bridge that crosses the river and accesses the upland areas west of the creek on Sheephead Mountain. This reach is characterized by a relatively wide valley bottom and riparian corridor, with a sinuous, low gradient stream channel classified as a Rosgen C4. There is some evidence of past down-cutting due to flooding, and an old F channel is still apparent in the lower portion of the reach. The riparian zone in the reach exhibited good vigor with adequate willow regeneration, and was determined to be in properly functioning condition, although noxious weeds (thistle) were present along the stream throughout the reach. Initial reconnaissance indicated that Reach 3 exhibited a greater potential for a quality fishery than segments downstream, and appeared to be a good representation of habitat conditions in lower gradient C type channels found on Rattlesnake Creek.

Reach 4 extends from the road bridge upstream to the Hanna Water Intake forebay. This reach exhibits the same characteristics as Reach 3, and was classified as a Rosgen C4 channel.



Map 2: Locations of Active Head-cuts on Rattlesnake Creek - Elk Mountain Ranch, WY

Head-Cuts and Stream Channel Stability

The severe down-cutting occurring in the lower reaches of Rattlesnake Creek need to be immediately addressed. The active head-cuts can be controlled through the installation of boulder cross-vanes to control their migration upstream. If allowed to continue, this vertical instability will result in significant loss of adjacent riparian vegetation and wetlands as the stream abandons the existing floodplain for a new, lower elevation.

During the May, 2007 survey, eight active head-cuts were mapped using GPS along the four lower reaches of Rattlesnake Creek. These locations may be found in Map 2. Three of these head-cuts were observed to be relatively minor, and likely do not warrant treatment at this time. Photo-points were established at these minor channel incisions, and they should be monitored yearly to assure they do not become a problem in the future. The remaining five head-cuts are either severe, or threaten important quality habitat features or infrastructure upstream. The current condition of these head-cuts and recommended treatments are described below, beginning with the furthest downstream and proceeding upstream to the Hanna Water Supply Intake.

Photo 1: Head-Cut #1 Rattlesnake Creek

Head-cut #1 is found approximately 1,000 feet upstream of the boundary of the Elk Mountain Ranch on Rattlesnake Creek, within Reach 1. The head-cut was determined to be moderately severe, and there was evidence of considerable historic channel lateral migration and instability in the vicinity of the cut. The treatment priority is determined to be medium, with high value C and E channels upstream of the head-cut being at risk. A cross section and longitudinal profile of the 70 foot channel segment containing the cut were collected during the survey and are shown in Chart 1 below.

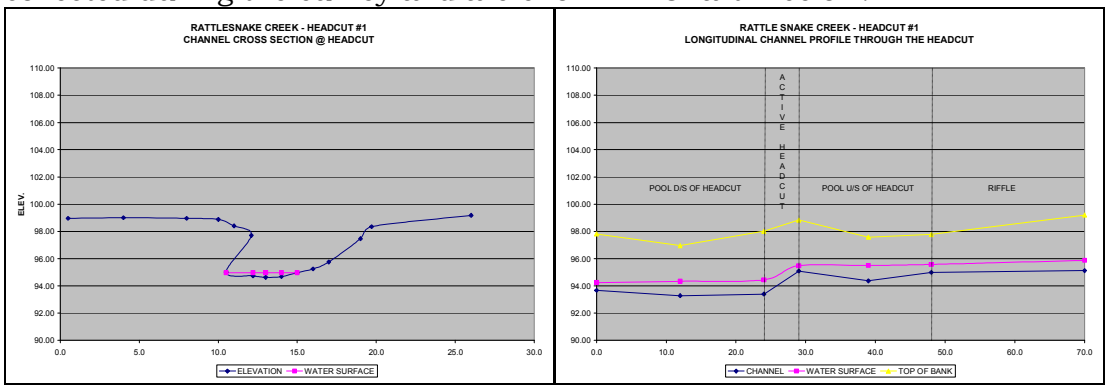


Chart 1: Cross Section and Longitudinal Profile of Head-Cut #1 - Rattlesnake Creek Reach 1.

A boulder cross vane (Drawings 1, 2, & 3 - Appendix) will be constructed at the top of the head-cut. The bank full width of the channel at the cross-vane is approximately 8 feet. The center of the cross-vane should be set to an elevation of 95.0, relative to the Left Head Pin 1 (LHP1 = 100.0). The elevation of the legs of the cross-vane, at the point where they intersect the stream bank, should be at the bank full stage, to be determined in the field using indicators upstream of the site. The legs of the cross vane will be firmly anchored into the stream bank by extending the structure at least 5-7 feet into each bank. These extensions should not exceed the bank full elevation referenced above, and will be buried and revegetated. The structure should be constructed of large flat boulders approximately 0.5 - 0.75 cubic yards in volume. It is estimated that approximately 15 - 20 boulders, including footers, will be required for the structure. Total estimated fill volume for this structure is approximately 7 -10 cubic yards within the bank full stage of the stream.

Once the structure is installed, it is recommended to treat the vertical, collapsing left stream bank downstream of the site, as well as a potential side channel ox-bow cutoff on the left bank approximately 12 feet upstream. These areas may be treated using 2 -3 pieces of large wood to create a stable toe and bank full bench on the bank, then the upper portion of the bank may sloped back and revegetated (Drawings 5 & 10 - Appendix). The bank full bench should be revegetated using locally available willow and sedge mats harvested from areas nearby the site. Estimated fill below the bank full stage for this structure type is estimated to be less than 0.1 cubic yard / linear foot of stream bank.

Head-cut #4 is found approximately 1/2 mile upstream of the boundary of the Elk Mountain Ranch on Rattlesnake Creek, adjacent to an old abandoned building on the south bank of the stream. The head-cut was determined to be very severe, and the treatment priority is high, with a large beaver pond complex immediately upstream of the head-cut being at risk. Once this head-cut migrates into the first beaver pond, it will rapidly continue upstream through the fine sediments accumulated in the ponds, resulting in significant sedimentation to habitats downstream A cross section and longitudinal profile of the 62 foot channel segment containing the cut were collected during the survey and are shown in Chart 2 below.

Photo 2: Head-Cut #4 - Rattlesnake Creek R1.

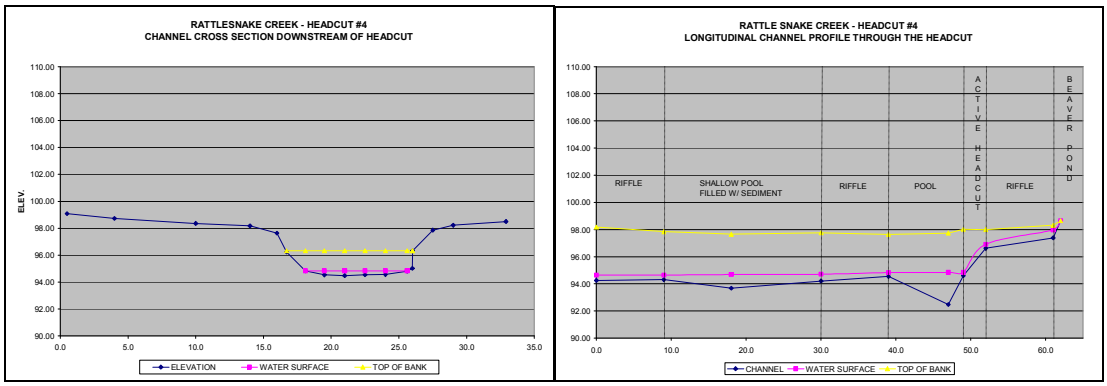


Chart 2: Cross Section and Longitudinal Profile of Head-Cut #4 - Rattlesnake Creek Reach 1.

A boulder cross vane should be constructed at the top of the head-cut. The bank full width of the channel at the cross-vane is approximately 9.3 feet. The center of the cross-vane should be set to an elevation of 96.6, relative to the Left Head Pin 2 (LHP2 = 100.0). The elevation of the legs of the cross-vane, at the point where they intersect the stream bank, should be at the bank full stage, at approximately 98.0 relative to LHP2. The legs of the cross vane will be firmly anchored into the stream bank by extending the structure at least 5-7 feet into each bank. These extensions should not exceed the bank full elevation referenced above, and will be buried and revegetated. The structure should be constructed of large flat boulders approximately 0.5 - 0.75 cubic yards in volume. It is estimated that approximately 25 - 30 boulders, including footers, will be required for the structure. Total estimated fill volume for this structure is approximately 11 -15 cubic yards within the bank full stage of the stream.

Once the structure is installed, it is recommended to treat the vertical, collapsing left stream banks downstream of the site be treated using the same toe-slope stabilization technique described for Head-cut #1. These areas will require 3 -4 pieces of large wood to create a stable toe and bank full bench on the bank, then the upper portion of the bank may sloped back and revegetated. The bank full bench can be revegetated using locally available willow and sedge mats harvested from areas nearby the site. Estimated fill below the bank full stage for this structure type is estimated to be less than 0.1 cubic yard / linear foot of stream bank.

Head-cut #5 is found approximately 0.8 mile upstream of the boundary of the Elk Mountain Ranch on Rattlesnake Creek, and was initially identified during the 2006 assessment. The head-cut was determined to be very severe, and the treatment priority is high, with a diversion structure and irrigation ditch immediately upstream of the head-cut being at risk. We propose to treat the head-cut, and also construct an additional cross-vane at the diversion structure to assure


Photo 3: Head-Cut #5 - Rattlesnake Creek R1.

delivery to the ditch during base flow conditions. Two cross sections, showing the active head-cut and the diversion structure, and a longitudinal profile of the 150 foot channel segment containing the cut and the head-gate were collected during the survey and are shown in Chart 3 and 4 below.

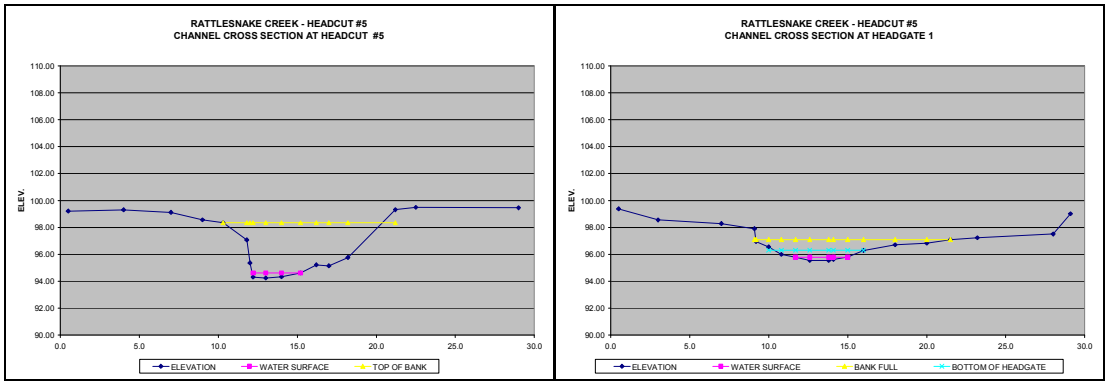


Chart 3: Cross Sections of Head-Cut #5 and Head-gate #1- Rattlesnake Creek Reach 1.

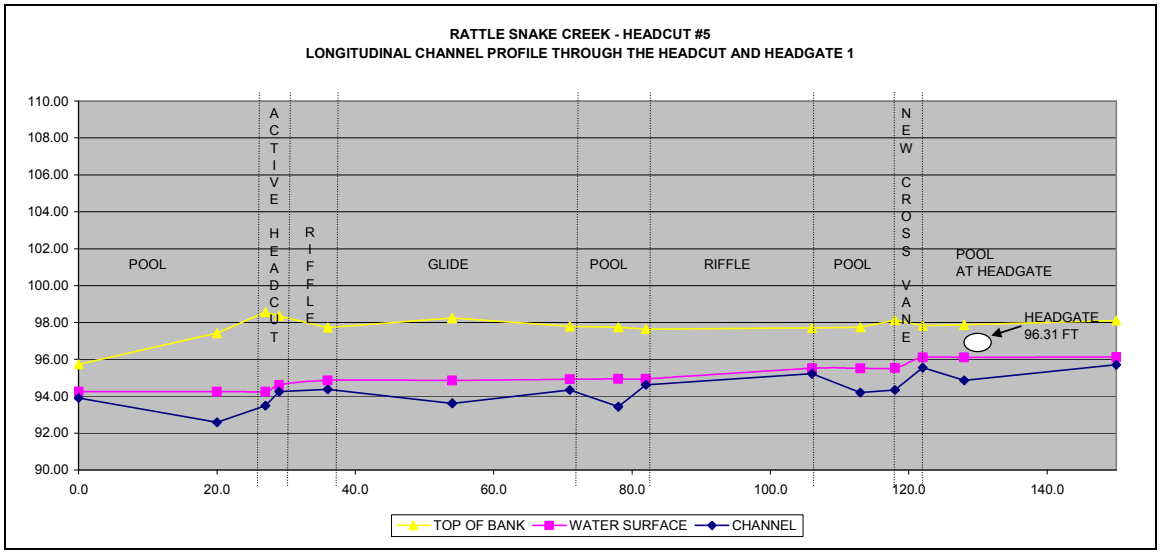


Chart 4: Longitudinal Profile of Head-Cut #5 and Head-gate #1- Rattlesnake Creek Reach 1.

A boulder cross vane will be constructed at the top of the head-cut. The bank full width of the channel at the head-cut cross-vane is approximately 9.5 feet. The center of the cross-vane should be set to an elevation of 94.3, relative to the Left Head Pin 3 (LHP3 = 100.0). The elevation of the legs of the cross-vane, at the point where they intersect the stream bank, should be at the bank full stage, at approximately 96.2 relative to LHP3. The legs of the cross vane will be firmly anchored into the stream bank by extending the structure at least 5-7 feet into each bank. These extensions should not exceed the bank full elevation referenced above, and will be buried and revegetated. The structure should be constructed of large flat boulders approximately 0.5 - 0.75 cubic yards in volume. It is estimated that approximately 25 - 28 boulders, including footers, will be required for the structure. Total estimated fill volume for this structure is approximately 11 -14 cubic yards within the bank full stage of the stream.

An additional boulder cross vane may be constructed at the riffle crest immediately below Head-gate 1. The bank full width of the channel at this cross-vane is approximately 12.3 feet. The center of the cross-vane should be set to an elevation of 96.3, relative to the Left Head Pin 3 (LHP3 = 100.0). The elevation of the legs of the cross-vane, at the point where they intersect the stream bank, should be at the bank full stage, at approximately 97.1 relative to LHP3. The legs of the cross vane will be firmly anchored into the stream bank by extending the structure into each bank. These extensions should not exceed the bank full elevation referenced above, and will be buried and revegetated. The structure should be constructed of large flat boulders approximately 0.5 - 0.75 cubic yards in volume. It is estimated that approximately 25 - 28 boulders, including footers, will be required for the structure. Total estimated fill volume for this structure is approximately 11 -14 cubic yards within the bank full stage of the stream.


Photo 4: Head-Gate 1 - Rattlesnake Creek R1.

Once the structures are installed, it is recommended to treat the vertical, collapsing left stream banks within the site using the same toe-slope stabilization technique described for Head-cut #1. These areas will require 7 -8 pieces of large wood to create a stable toe and bank full bench on the bank, then the upper portion of the bank may sloped back and revegetated. The bank full bench can be revegetated using locally available willow and sedge mats harvested from areas nearby the site. Estimated fill below the bank full stage for this structure type is estimated to be less than 0.1 cubic yard / linear foot of stream bank.

Head-cut #8 is found approximately 250 feet upstream of the boundary of the Rattlesnake Ranch on Rattlesnake Creek, near the downstream boundary of Reach 3. The head-cut was determined to be moderately severe, and the treatment priority is high, with a large beaver pond complex containing an irrigation diversion structure immediately upstream of the head-cut being at risk. Once this head-cut migrates into the first beaver pond, it will rapidly continue upstream through the fine sediments accumulated in the ponds, resulting in significant sedimentation to habitats downstream A cross section and longitudinal profile of the 116 foot channel segment containing the cut were collected during the survey and are shown in Chart 5 below.

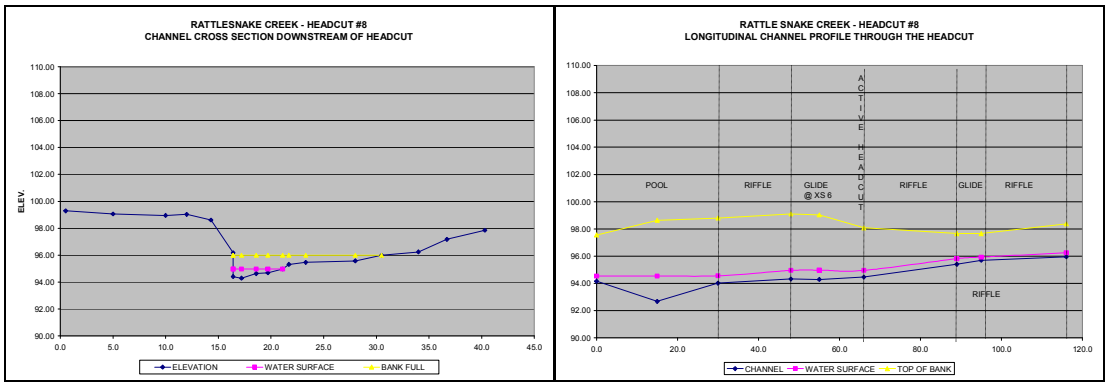


Chart 5: Cross Section and Longitudinal Profile of Head-Cut #8 - Rattlesnake Creek Reach 3.

A boulder cross vane may be constructed at the top of the head-cut. The bank full width of the channel at the cross-vane is approximately 14.1 feet. The center of the cross-vane should be set to an elevation of 94.5, relative to the Left Head Pin 6 (LHP6 = 100.0). The elevation of the legs of the cross-vane, at the point where they intersect the stream bank, should be at the bank full stage, at approximately 96.0 relative to LHP6. The legs of the cross vane will be firmly anchored into the stream bank by extending the structure at least 5-7 feet into each bank. These extensions should not exceed the bank full elevation referenced above, and will be buried and revegetated. The structure should be constructed of large flat boulders approximately 0.5 - 0.75 cubic yards in volume. It is estimated that approximately 28 - 30 boulders, including footers, will be required for the structure. Total estimated fill volume for this structure is approximately 11 -15 cubic yards within the bank full stage of the stream.


Photo 5: Head-cut #8 on Rattlesnake Creek Reach 3. Elk Mountain Ranch, WY.

Once the structure is installed, it is recommended to treat the vertical, collapsing left stream banks downstream of the site be treated using the same toe-slope stabilization technique described for Head-cut #1. These areas will require 3 -4 pieces of large wood to create a stable toe and bank full bench on the bank, then the upper portion of the bank may sloped back and revegetated. The bank full bench can be revegetated using locally available willow and sedge mats harvested from areas nearby the site. Estimated fill below the bank full

stage for this structure type is estimated to be less than 0.1 cubic yard / linear foot of stream bank.

Photo 6: Head-Cut #9 - Rattlesnake Creek R4.

Head-cut #9 is found approximately 1,000 feet upstream of the bridge at the beginning of Reach 4 on Rattlesnake Creek, on a small tributary entering Rattlesnake Creek from the south. The head-cut was determined to be moderately severe, and the treatment priority is high. This is a relatively easy head-cut to treat, given the small size of the tributary, and can be accomplished by constructing a small rock cross-vane of boulders approximately 0.5 cubic yards in volume. The cross vane should be constructed to hold the grade of the stream channel upstream of the cut, and will likely not exceed 3 -5 cubic yards of volume below the ordinary high water mark of the tributary.

The Bridge at the Reach 3/Reach 4 Boundary is currently at risk of failure, and is causing undesired channel modification and stream bank erosion both upstream and downstream of the structure (Photo 7). A stream bank stabilization structure on the right stream bank has failed, and is collapsing into the channel (Photo 8), deflecting the force of the stream into the support pilings on the left bank. The cross-sectional area of the stream channel under the bridge is severely reduced, and may result in complete failure of the structure in the near future. A cross-section of the current channel conditions and a facet slope profile of the channel beneath the bridge are shown in Chart 6 below.

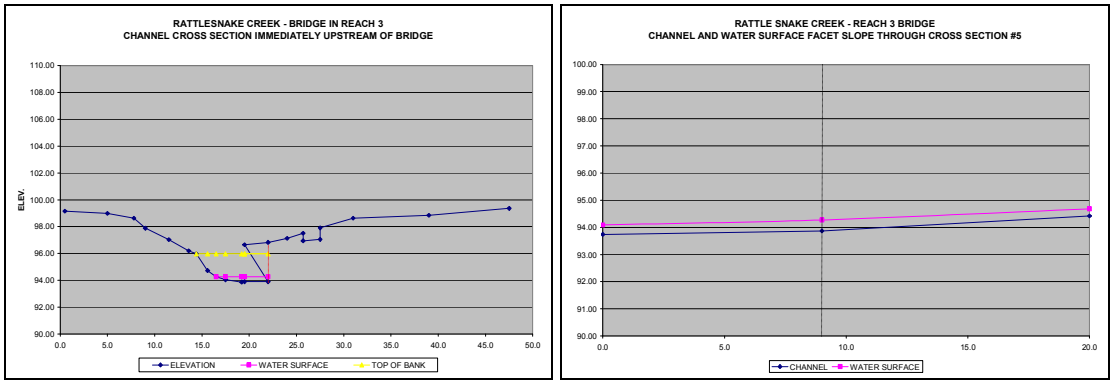


Chart 6: Cross Section and Longitudinal Profile of Head-Cut #8 - Rattlesnake Creek Reach 3.

It is recommended that the stream bank stabilization structure be removed from the bank, and a boulder cross vane installed immediately upstream of the bridge to protect the bridge foundations and direct the stream thalweg under

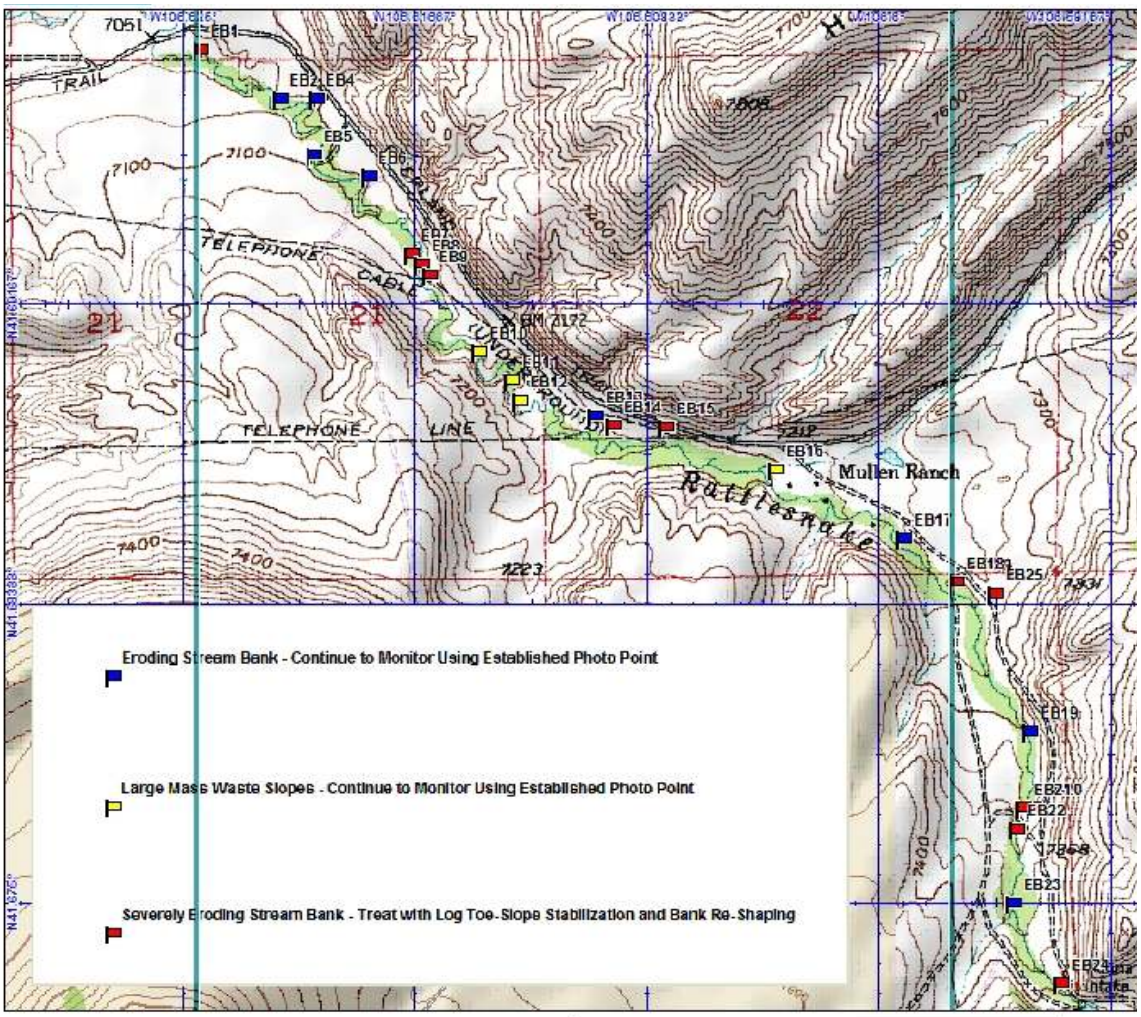
Photo 7: Bridge at the Reach 3 / 4 boundary.

Photo 8: Bridge at the Reach 3 / 4 boundary.

the center of the bridge. This will create a new bank full width of the channel of approximately 13 feet. The center of the cross vane should be set to an elevation of approximately 94.5 relative to Left Head Pin 5 (LHP5=100.0), and the bank full elevation is just under 96.0 relative to LHP5. The structure will require approximately 20-25 boulders and should not exceed a volume of 11 - 15 cubic yards below the ordinary high water mark of the stream.

Downstream of the cross-vane, the right bank will be stabilized using either large wood or small boulder for toe-slope stability, and will be revegetated using available willow transplants. There is considerable bank damage and over-widening of the stream channel below the bridge. A mid-channel bar immediately downstream of the bridge will be re-contoured to create a single thread channel, and the vertical, eroding stream banks will be treated with large wood toe-slope / bank full bench treatments described previously. 6 -8 large trees will be required to complete this work.

Unstable / Eroding Stream Banks:
The lower reaches of Rattlesnake Creek exhibit many steep banks that are slowly beginning to return to a sustainable angle of repose. The recovery of many of these banks may be accelerated by mechanically sloping back the banks, stabilizing the toe of the slope, and transplanting willow clumps. As part of the May 2007 survey, a rapid assessment and mapping of actively eroding stream banks was completed (Map 3).



Map 3: The locations of Actively Eroding Banks on the Lower Reaches of Rattlesnake Creek.

We found three distinct types of actively eroding banks. The first type of unstable bank observed in the reaches is the result of large scale slope failure and mass- wasting along edge of the valley floor. These mass-waste slopes typically exhibit bare banks up to fifty feet high, with toe-slopes consisting of

parent bed material and shale. An example of this eroding bank type is shown in Photo 8. While this eroding bank type continues to contribute sediment to the stream, much of the material entering the stream consists of shale fragments approximately 1/2" to 2" in diameter. Fine particle (<1/4") sedimentation in pools downstream of these slopes does not appear to be excessive, and given the cost to treat this bank type, it is recommended that these areas continue to be monitored through photo-points to determine if vegetative cover is increasing or decreasing on the bank slope. This eroding bank type is the least common found in the reach, and were mapped using GPS (shown as a Yellow Flag on Map 3)


Photo 8: Typical Mass-Waste Slope - EB16

The second type of eroding stream bank observed exhibit some new vegetative growth along the bank full edge of the stream channel, and appear to be healing reasonably well of their own accord. An example of this eroding stream bank is shown in Photo 9. These stream banks were mapped using GPS (shown with a Blue Flag on Map 3) and should continue to be periodically monitored using photo-points to ensure that they continue to heal.

The third type of eroding bank observed are extremely unstable, lacking any riparian vegetation along the bank full edge of the bank, and are actively contributing fine sediment to the stream. These eroding banks were mapped using GPS (shown with a Red Flag in Map 3), and the length of unstable bank was visually estimated. Left untreated, these banks will most likely become more unstable, and may contribute to undesirable lateral instability within the flood plain. These severely eroding banks tend to be associated with some of the head-cuts in the watershed, and on the outside banks of meander bends where the streamside riparian vegetation is less robust or has been disturbed. An example of this eroding stream bank type is shown in Photo 10.


Photo 9: Recovering Stream Bank - EB13


Photo 10: Actively Eroding Bank - EB18

A total of eight sites were identified in the lower reaches of Rattlesnake Creek where it may be desirable to mechanically treat the banks. Three of these sites are associated with the head-cut and channel work previously described (Head-cuts #5 & #8 and the Bridge at Reach 3/4). Of the remaining five sites, the cluster at EB7, EB8 and EB9 is the most significant and has the highest priority for treatment (Photo 11). This site is in the vicinity of the point along Rattlesnake Creek where an underground telephone line crosses the creek. There is also a collapsed bridge within this segment, which is easily seen from the road. Approximately 750 linear feet of stream bank, on either side of the channel, will be treated using large wood toe-slope stabilization (Drawings 5 & 10 - Appendix), bank re-contouring and sloping, and extensive willow and sedge planting. Approximately 25 large trees and 50 -60 boulders (0.5 - 0.75 cubic yards each) will be required to complete the work.

Photo 11: The segment of Rattlesnake Creek surrounding the collapsed bridge - EB7, EB8 & EB9.

Additionally, the collapsed bridge will be removed from the stream channel, new foundation supports will be constructed, and the bridge re-set on the new foundations. A cross vane structure or a series of small rock vanes (Drawing 8 - Appendix) upstream or downstream of the bridge may be required to protect the new foundations. This will be determined on site after the old bridge is removed. The cross vane structure is not expected to exceed 15 yd^3, and the rock vanes are not likely to exceed 6 yd^3 below the ordinary high water mark of the stream.

The remaining four sites (EB1, EB15, EB24 and EB25) range from 80 feet to 300 feet in length, and are scattered throughout the project reach. These areas will be treated using the same bank stabilization techniques described above. The total length of bank treatments at these for sites is 600 feet. Approximately 20 large trees and 40 boulders will be used to complete work on these sites. These structures are not expected to exceed greater than 0.2 cubic yards of fill per linear foot of stream bank below the bank full stage of the stream.

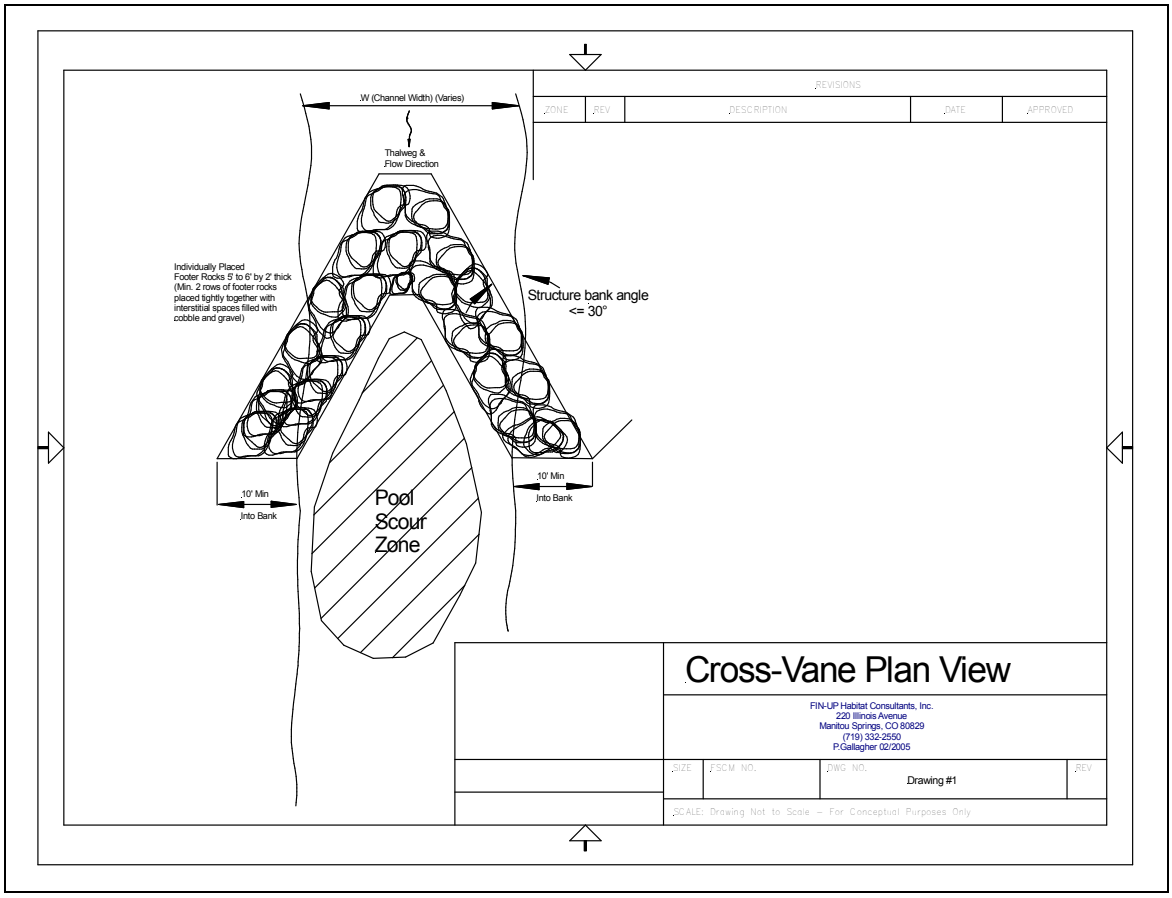
APPENDIX

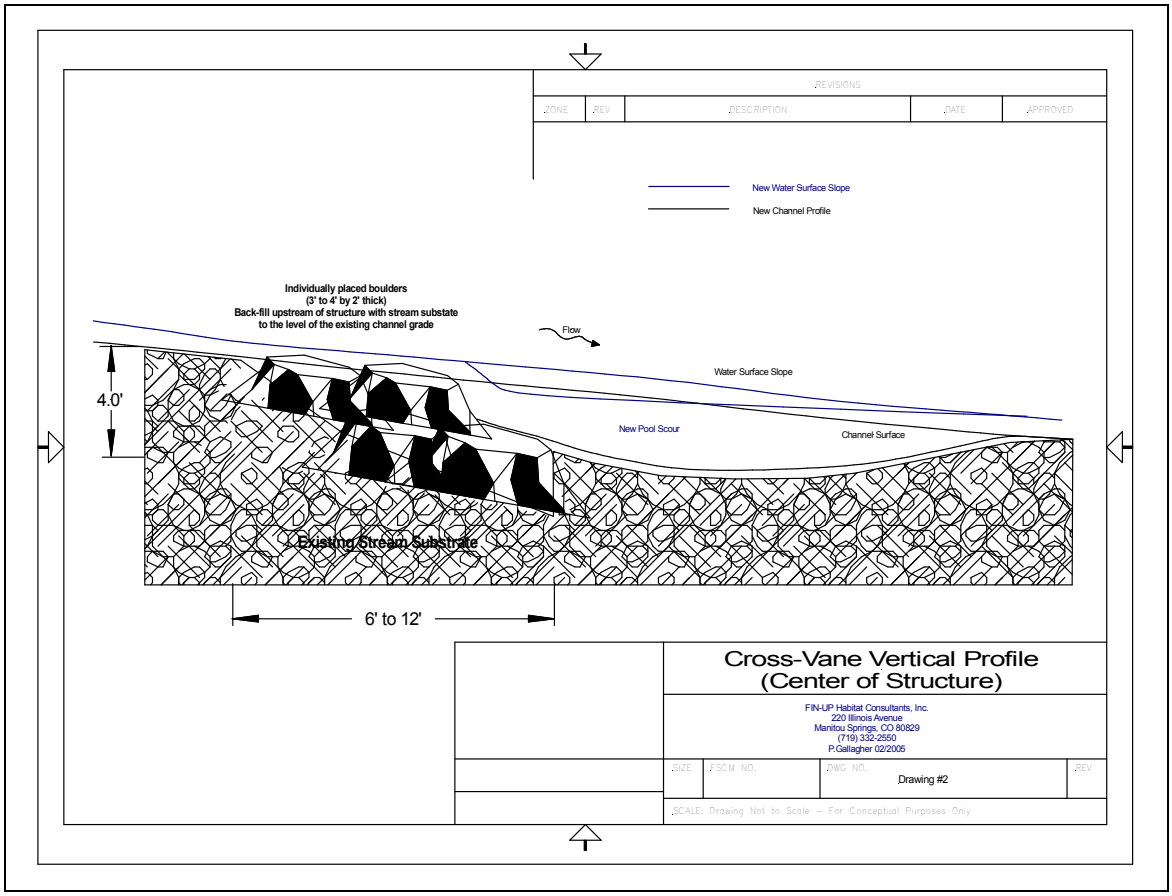
Stream Channel Structure and Treatment Drawings

Photographic Representations of Treatment Types

References

STREAM CHANNEL STRUCTURE DRAWINGS





REVISIONS

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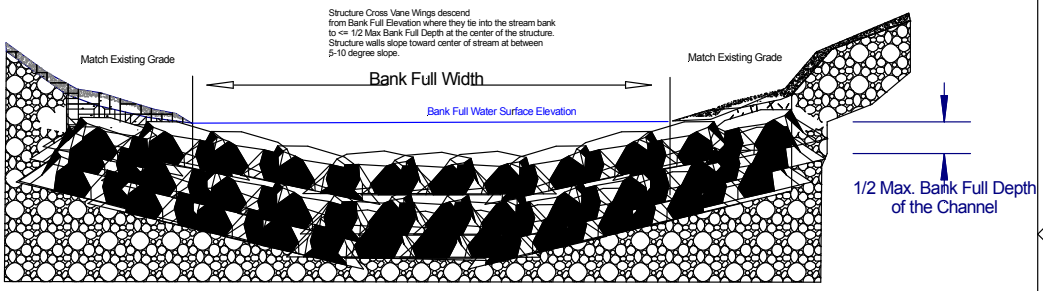

Cross-Vane Vertical Profile Cross Section Elevations)

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SIZE	FSCM NO.	DWG NO.	REV
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REVISIONS

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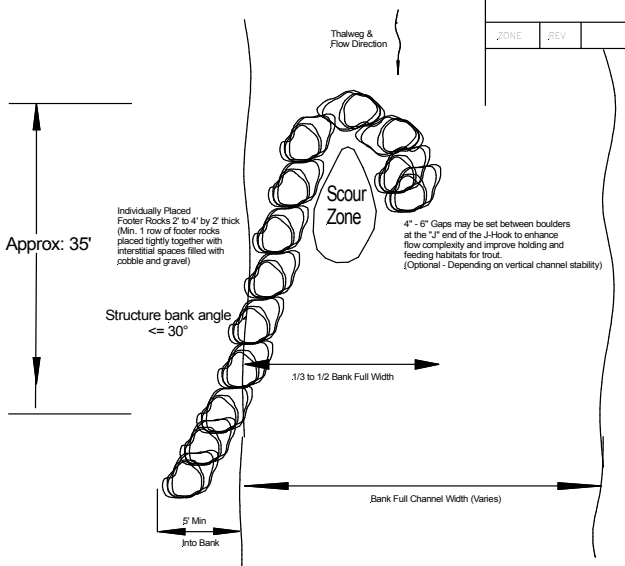

Rock J-Hook Vane - Plan View

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SIZE	FSCM NO.	DWG NO.	REV
		Drawing #8	

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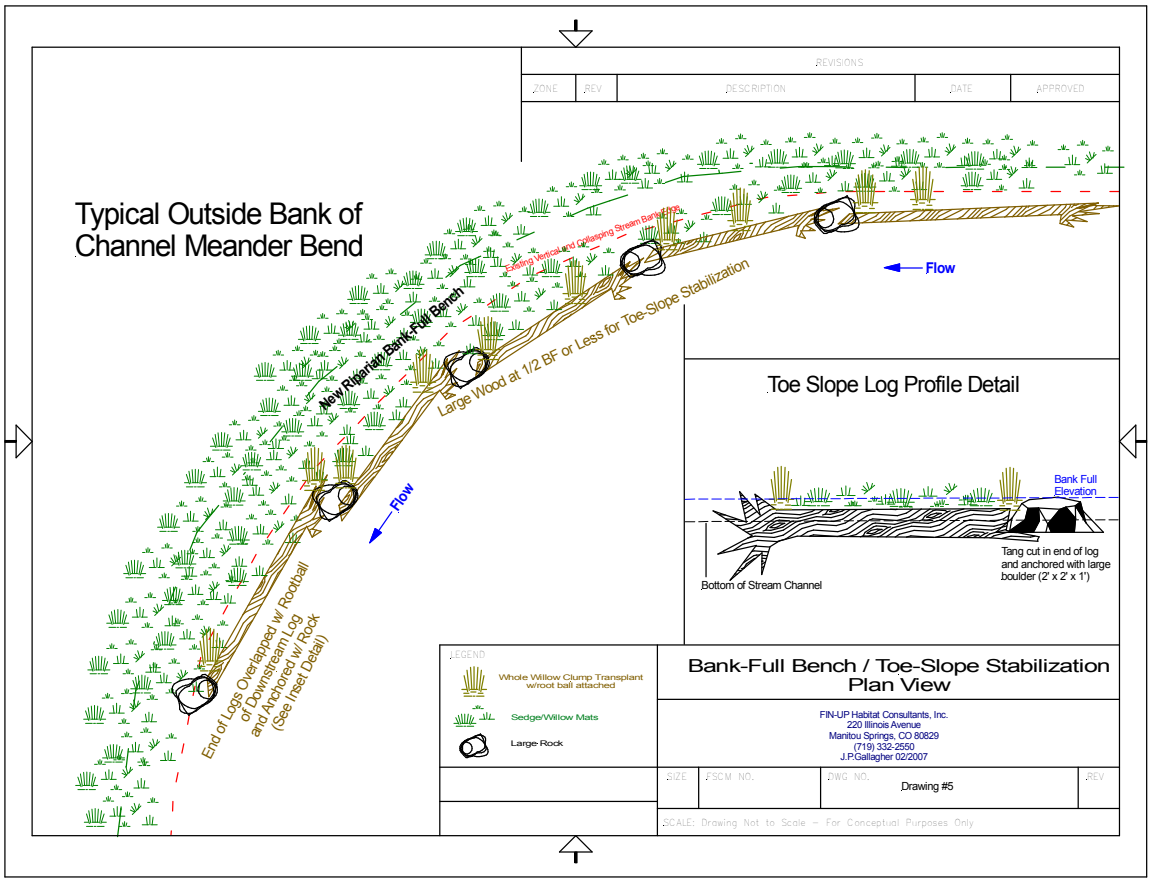
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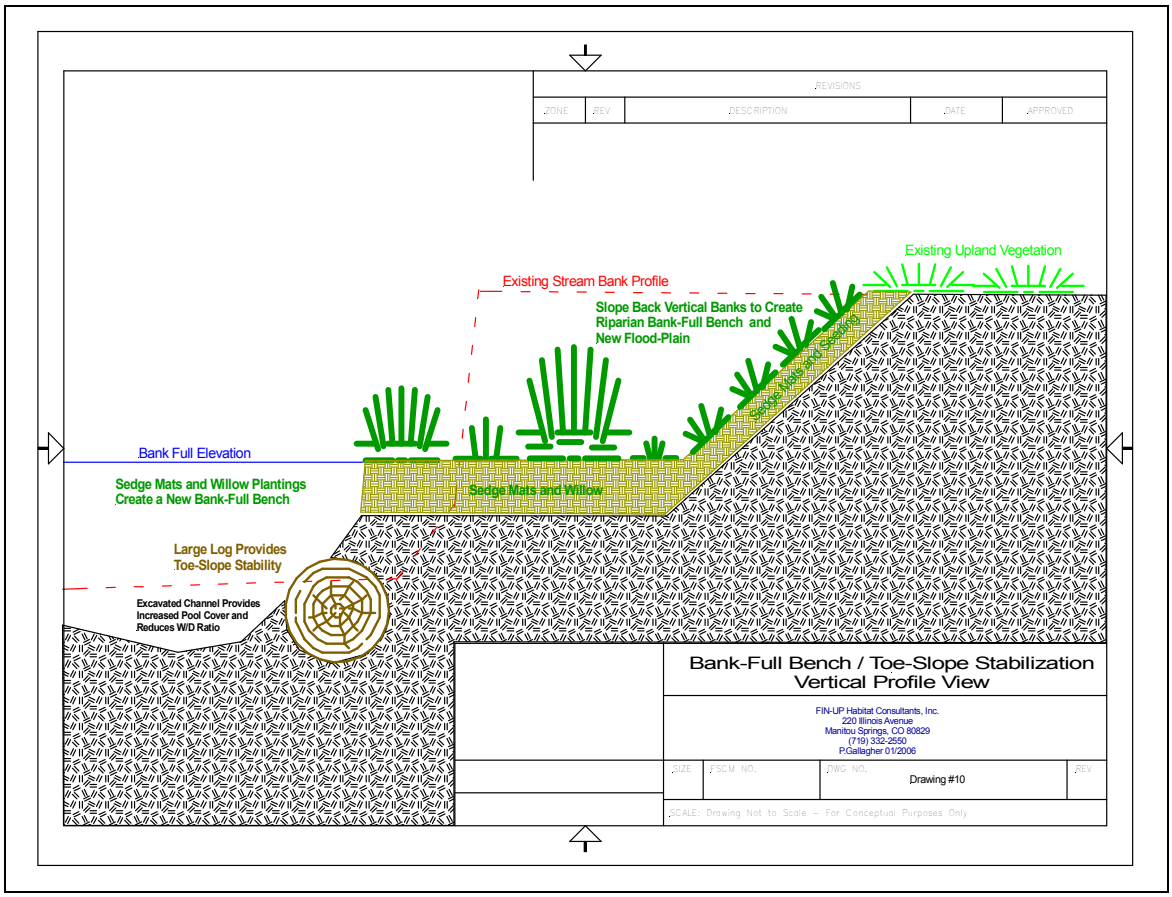
Typical Outside Bank of Channel Meander Bend
Existing Vertical and Collapsing Stream Bank Profile
New Riparian Bank-Full Bench
Large Wood at 1/2 BF or Less for Toe-Slope Stabilization
Flow
Flow
End of Logs Overlapped w/ Rootball of Downstream Log and Anchored w/ Rock (See Inset Detail)
Toe Slope Log Profile Detail
Bank Full Elevation
Tang cut in end of log and anchored with large boulder (2' x 2' x 1')
Bottom of Stream Channel
LEGEND
Whole Willow Clump Transplant w/root ball attached
Sedge/Willow Mats
Large Rock
Bank-Full Bench / Toe-Slope Stabilization
Plan View
FIN-UP Habitat Consultants, Inc.
220 Illinois Avenue
Manitou Springs, CO 80829
(719) 332-2550
J.P.Gallagher 02/2007
SIZE
FSCM NO.
DWG NO.
Drawing #5
REV
SCALE: Drawing Not to Scale – For Conceptual Purposes Only


REVISIONS
ZONE
REV
DESCRIPTION
DATE
APPROVED
Existing Upland Vegetation
Existing Stream Bank Profile
Slope Back Vertical Banks to Create Riparian Bank-Full Bench and New Flood-Plain
Sedge Mats and Willow
Bank Full Elevation
Sedge Mats and Willow Plantings Create a New Bank-Full Bench
Large Log Provides Toe-Slope Stability
Excavated Channel Provides Increased Pool Cover and Reduces W/D Ratio
Bank-Full Bench / Toe-Slope Stabilization
Vertical Profile View
FIN-UP Habitat Consultants, Inc.
220 Illinois Avenue
Manitou Springs, CO 80829
(719) 332-2550
P.Gallagher 01/2006
SIZE
FSCM NO.
DWG NO.
Drawing #10
REV
SCALE: Drawing Not to Scale – For Conceptual Purposes Only

PHOTOGRAPHS OF TREATMENT TYPES

Cross Vane Structure on Cheyenne Creek below I-25 Overpass. Colorado Springs, El Paso County, Colorado

Cross Vane Structure on Fountain Creek below 21st Street Bridge, El Paso County, CO.

Cottonwood trees used as toe-slope stabilization with riparian benches. Cucharas Creek, Huerfano County, Colorado.

Boulders placed in clusters to create pocket water micro vortex habitats. South Platte River, Park County, CO.

Eagle Rock Ranch - Rock J-Hook Vanes installed to protect stream banks and adjacent road,, 2003.


Picketwire Canyonlands, SE Colorado - Rock vanes used to protect dinosaur trackway. These structures were installed in 1998, and survived a 100 year event the following spring. Note the deposition and new willow vegetation taking hold in between the structures.

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